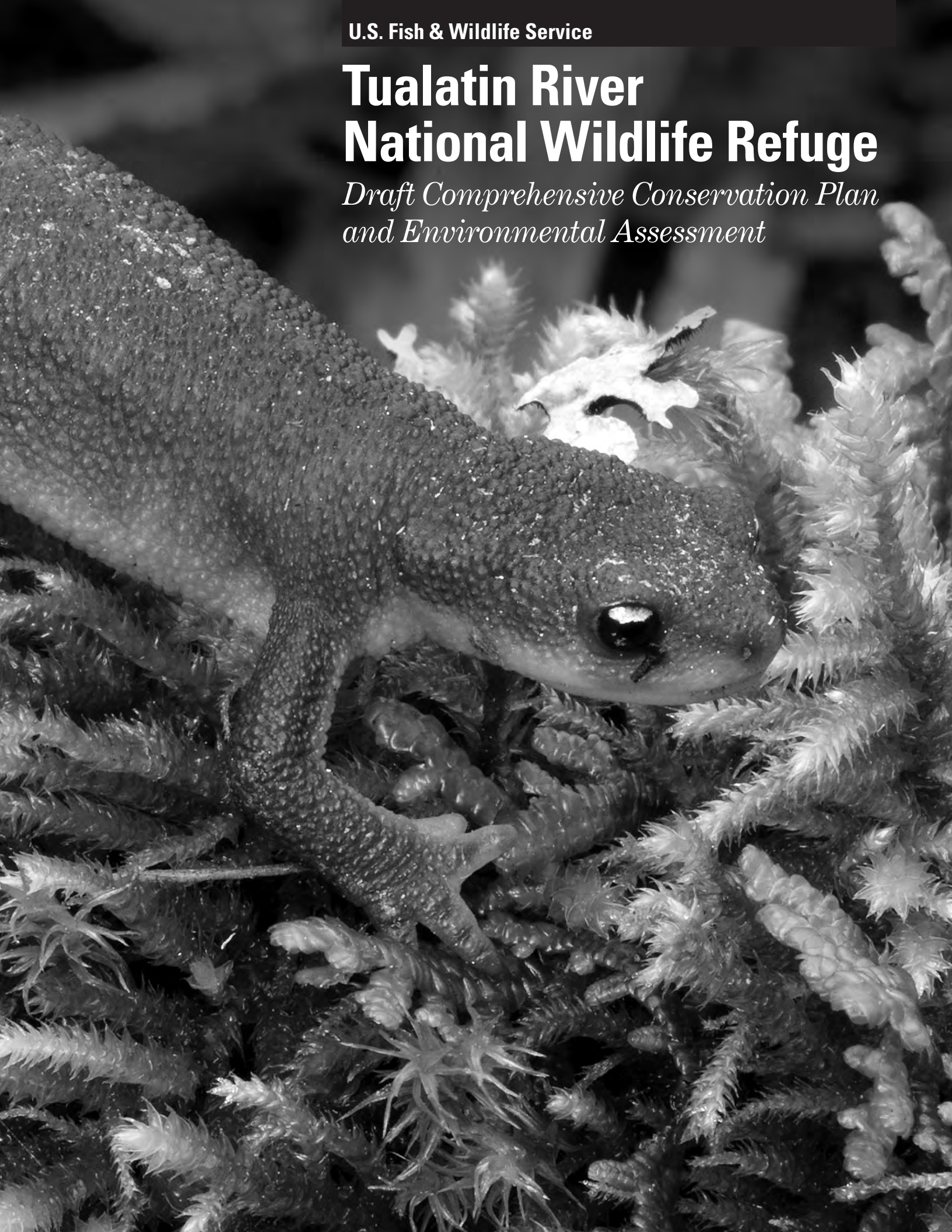
U.S. Fish & Wildlife Service

Tualatin River National Wildlife Refuge

Draft Comprehensive Conservation Plan and Environmental Assessment



An Image of the Future

Tualatin River National Wildlife Refuge is a natural treasure where an abundance of native wildlife thrive in a mosaic of wetland, prairie, forest and stream habitats characteristic of the Willamette Valley that the Atfalat'i people knew. The refuge is a sanctuary for both wildlife and people, a place where the ebb and flow of the river marks the natural rhythms of the refuge through the seasons. It's a special place, an icon where the stories of the refuge reflect the importance of the National Wildlife Refuge System. The refuge has a rich history of community vision where friends and neighbors helped create, and continue to care for, this urban refuge and the watershed that supports it. It's a model that combines excellence in landscape conservation, learning, and partnerships to strive for a healthy natural world. Tualatin River National Wildlife Refuge is a place where rich traditions, outdoor learning experiences, and discovery foster a love of and caring for nature that endures for generations to come.

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

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Chapter 1 Introduction and Background

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Chapter 1 Introduction and Background

1.1 Introduction

> *Just a few short miles from the center of Oregon's largest city, the honking of geese replaces the honking of cars. This special place is a refuge, a haven for wildlife and people. Born of a community's dream, and made possible by their support, a wildlife refuge now thrives in the backyard of a growing metropolis.*

Located on the outskirts of Portland, Tualatin River National Wildlife Refuge (the refuge) is one of a handful of urban national wildlife refuges in the country. Situated within the floodplain of the Tualatin River, the refuge comprises less than 1 percent of the 712-square-mile watershed (see Appendix P, Maps 1 and 3). Yet, due to its richness and diversity of habitats, it supports some of the most abundant and varied wildlife in the watershed. The refuge is home to nearly 200 species of birds, over 28 species of mammals, 14 species of reptiles and amphibians, and a wide variety of insects, fish, and plants. The refuge has also become a place where people can experience and learn about wildlife and the places they call home. Established in 1992 under the guidelines of the U.S. Fish and Wildlife Service's (USFWS's; Service's) Urban Refuge Policy (341 FW 1) (Smith 1991), Tualatin River National Wildlife Refuge has served nearly 100,000 visitors annually since it opened to the public in 2006. In 2007, the Wapato Lake Unit was established, more than doubling the size of the original acquisition boundary.

The Tualatin River National Wildlife Refuge, which includes the Wapato Lake and Sherwood Units (the Sherwood Units contain five subunits: Atfálat'i, Onion Flats, Riverboat, Rock Creek, and Tualatin River), is located in the northern portion of the Willamette Valley, in Washington and Yamhill Counties, Oregon (see Appendix P, Maps 4 and 5). The overall management focus cited in the Land Protection Plan (USFWS 1992a) is to "protect, enhance, and manage upland, wetland, and riparian habitats for a variety of migratory birds and resident fish and wildlife, as well as for the enjoyment of people." The Wapato Lake Unit serves a similar purpose and supports many of the same types of habitats found within the Sherwood Units. Currently, the established acquisition boundary of the refuge totals 7,370 acres, with 2,204 acres under management. The refuge may purchase lands within the boundary from willing sellers. Land currently owned or managed by the refuge is distributed among six management units: Riverboat (348 acres); Tualatin River (221 acres); Atfálat'i (555 acres); Onion Flats (126 acres); Rock Creek (75 acres); and Wapato Lake (879 acres). The refuge's landscape is predominately flat bottomland bordered by uplands. Habitats consist of rivers and streams; herbaceous and scrub-shrub wetlands; riparian forests; wet meadows; oak savanna; and mixed coniferous/deciduous forested uplands.

The refuge has a rich history in community involvement, beginning with the establishment of the refuge itself. In the late 1980s and early 1990s, many local residents and leaders recognized that the Tualatin River and its floodplain had been highly modified by both agriculture and urbanization. This recognition fueled a desire by local communities to preserve open greenspace and create an area where future generations could enjoy outdoor recreation and interpretation, while also leaving an educational legacy for children. This led a small group of citizens and local leaders to approach the Service to request having part of the 100-year floodplain, just north of Sherwood, be set aside as a national wildlife refuge. At the same time, the Service identified a need to protect and enhance floodplains, wetlands, riparian habitats, and upland buffers for a variety of wildlife and for the

enjoyment of people—in particular in urban areas. In 1992, grassroots and governmental support coalesced, and the Tualatin River National Wildlife Refuge became part of the National Wildlife Refuge System (Refuge System).

Photo 1-1. Entry to Tualatin River National Wildlife Refuge. USFWS.

1.2 Importance of the Refuge

Since the time of Euro-American settlement, habitats in the Willamette Valley have been converted to support a growing human population. Significant losses of habitat have occurred within the Portland/Vancouver metropolitan area and continue to occur (see Appendix P, Map 2). Commercial, agricultural, and residential encroachments into floodplains, which include wetlands, riparian forests, and uplands, have occurred during the past 150 years, resulting in lost habitat, increased pollution, increased human disturbance, and lower water quality. These habitats are important to resident, migrating, and wintering bird, mammal, fish, reptile, amphibian, and invertebrate species. Although these habitats are provided some degree of protection by Oregon's land-use planning process, the wildlife values of these habitats continue to be degraded.

Traditionally, fish and wildlife agencies have focused their efforts on management of lands and waters outside of urban areas where the majority of fish and wildlife resources occur. However, habitats of regional significance often occur in urban areas and are of great value to fish and wildlife. These habitats also provide important public benefits, such as open space, recreation, environmental education, aesthetics, flood control, and water quality enhancement. The proximity and availability of these public benefits are attributes for which the Portland/Vancouver metropolitan area is renowned. Many consider natural areas to be an essential component of the quality of life in this metropolitan area.

As an urban refuge, Tualatin River National Wildlife Refuge was established under the guidance of the Urban Refuge Policy and "may protect habitat of great significance to the conservation of fish and wildlife resources, including endangered and threatened species. However, the 'Primary

Purpose' for establishment of new urban refuges will be to foster environmental awareness and outreach programs to develop an informed, involved citizenry that will support fish and wildlife conservation … these refuges will provide public use benefits associated with fish and wildlife resources that include, but are not limited to, bird watching, fishing, scientific research, environmental education, open space in a urban setting, and protection of cultural resources" (Smith 1991).

Situated within the floodplain of the Tualatin River Valley, the refuge provides habitat for some of the most diverse and abundant wildlife in the valley. The refuge also provides a variety of recreational and educational activities focused on fish and wildlife and their habitats. Visitor facilities include a Wildlife Center, an environmental education shelter, trails, overlooks, an observation deck, a photography blind, environmental education study sites, and exhibit panels. Current visitation is approximately 100,000 people per year (USFWS 2010a).

Photo 1-2. Tualatin River National Wildlife Refuge lies on the outskirts of Portland, Oregon. © Bjorn Fredrickson.

1.3 Proposed Action

The Service manages wildlife refuges as part of the Refuge System. We propose to adopt and implement a Comprehensive Conservation Plan (CCP) for the refuge. This document is the refuge's draft Comprehensive Conservation Plan (draft CCP) and Environmental Assessment (EA). A CCP sets forth management guidance for a refuge for a period of 15 years, as required by the National Wildlife Refuge System Administration Act (Administration Act), as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act). The Improvement Act requires CCPs to identify and describe:

- The purposes of the refuge;
- The fish, wildlife, and plant populations, their habitats, and the archaeological and cultural values found on the refuge;
- Significant problems that may adversely affect wildlife populations and habitats and ways to correct or mitigate those problems; and

- Areas suitable for administrative sites or visitor facilities, and opportunities for fish- and wildlife-dependent recreation.

Refuge System planning policy (602 FW 3) states that the purpose of CCPs is to "describe the desired future conditions of a refuge and provide long-range guidance and management direction to achieve refuge purposes; help fulfill the Refuge System mission; maintain and, where appropriate, restore the ecological integrity of each refuge and the Refuge System; … and meet other mandates."

The action proposed in the CCP is the implementation of Alternative 2, which has been identified as the Service's preferred alternative. The Service has developed and examined three alternatives for future management of the refuge and discloses anticipated effects for each alternative, pursuant to the National Environmental Policy Act of 1969 (NEPA), as amended. The goals, objectives, and strategies under Alternative 2 best achieve the purpose of the refuge and the need for the CCP, while maintaining balance among the varied management needs and programs. Alternative 2 represents the most balanced approach for achieving the refuge's purposes, vision, and goals; contributing to the Refuge System's mission; addressing relevant issues and mandates; and managing the refuge with sound principles of fish and wildlife management.

The draft preferred alternative may be modified between the draft and final documents depending upon comments received from the public or other agencies and organizations. The Service's Regional Director for Region 1 will decide which alternative will be implemented. For details on the specific components and actions constituting the range of alternatives, see Chapter 2.

1.4 Purpose of and Need for Action

The purpose of this draft CCP is to identify the role the refuge would play in supporting the mission of the Refuge System, and to provide the Service, the Refuge System, partners, and the public with long-term guidance for managing programs and activities. This will be a 15-year management plan for improving the refuge's habitat conditions and infrastructure for fish, wildlife, and public use. The CCP is needed to:

- Communicate with the public and other partners in efforts to carry out the mission of the Refuge System;
- Provide a clear statement of direction for managing the refuge;
- Provide neighbors, visitors, and government officials with an understanding of the Service's management actions on and around the refuge;
- Ensure that the Service's management actions support the goals and intent of the Administration Act;
- To the extent practicable, ensure refuge plans will be consistent with the fish and wildlife conservation plans of the state and the conservation programs within the ecosystem;
- Provide a basis for development of budget requests for the refuge's operation, maintenance, and capital improvement needs;
- Address habitat management concerns; and
- Address increasing visitor use needs.

1.5 Legal and Policy Guidance

1.5.1 U.S. Fish and Wildlife Service

The Service is the principal Federal agency responsible for fish, wildlife, and plant conservation. The Refuge System is one of the Service's major programs.

> *The mission of the Service is working with others, to conserve, protect and enhance fish and wildlife and their habitats for the continuing benefit of the American people.*

In the late nineteenth and early twentieth centuries, America's fish and wildlife resources were declining at an alarming rate, largely due to unrestricted market hunting. Concerned citizens, scientists, and hunting and angling groups joined together and generated the political will for the first significant conservation measures taken by the Federal government. These actions included the establishment of the Bureau of Fisheries in the 1870s, the passage of the first Federal wildlife law in 1900, the Lacey Act, which prohibited interstate transport of wildlife taken in violation of state laws, and the creation of wildlife refuges across the nation.

Over the next three decades, the United States ratified the Migratory Bird Treaty with Great Britain, and Congress passed laws to protect migratory birds, establish more new refuges, and create a funding source for refuge land acquisition. In 1940, the U.S. Fish and Wildlife Service was created within the Department of the Interior, and existing Federal wildlife functions including law enforcement, fish management, animal damage control, and wildlife refuge management were combined into a single organization for the first time.

Today, the Service enforces Federal wildlife laws, manages migratory bird populations, restores nationally significant fisheries, conserves and restores vital wildlife habitat, protects and recovers endangered species, and helps other governments with conservation efforts.

1.5.2 National Wildlife Refuge System

In 1903, President Theodore Roosevelt designated the 5.5-acre Pelican Island in Florida as the nation's first wildlife refuge for the protection of native nesting birds. This was the first time the Federal government set aside land for wildlife. This small but significant designation marked the beginning of the Refuge System.

Over one hundred years later, the Refuge System has become the largest collection of lands in the world specifically managed for wildlife, encompassing more than 150 million acres within 556 refuges, 38 wetland management districts, and more than 3,000 waterfowl production areas providing breeding and nesting habitat for migratory birds. Today there is at least one refuge in every state as well as in Puerto Rico and the U.S. Virgin Islands.

The Tualatin River National Wildlife Refuge is managed as part of the Refuge System within a framework of legal and policy guidelines. The needs of wildlife and their habitats come first on refuges, in contrast to other public lands, which are managed for multiple uses. Refuges are guided by various Federal laws and executive orders, Service policies, and international treaties. The mission and goals of the Refuge System and the designated purposes of the refuge as described in

establishing legislation, executive orders, or other documents establishing, authorizing, or expanding a refuge are fundamental.

1.5.2.1 National Wildlife Refuge System Mission and Goals

The mission of the Refuge System is:

> *To administer a national network of lands and waters for the conservation, management, and where appropriate, restoration of the fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (National Wildlife Refuge System Administration Act of 1966, as amended).*

The goals of the Refuge System, as articulated in the Mission, Goals, and Purposes Policy (601 FW 1), are:

- Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered.
- Develop and maintain a network of habitats for migratory birds, anadromous and inter-jurisdictional fish, and marine mammal populations that is strategically distributed and carefully managed to meet important life history needs of these species across their ranges.
- Conserve those ecosystems, plant communities, and wetlands of national or international significance, and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts.
- Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation).
- Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats.

1.5.2.2 National Wildlife Refuge System Administration Act

Of all the laws governing activities on national wildlife refuges, the Administration Act undoubtedly exerts the greatest influence. The Improvement Act amended the Administration Act in 1997 by including a unifying mission for all national wildlife refuges as a system, a new process for determining compatible uses on refuges, and a requirement that each refuge be managed under a comprehensive conservation plan, developed in an open public process. In addition to the Improvement Act providing the mission for the Refuge System, it also stated that the wildlife and habitat vision for each unit of the Refuge System shall maintain the following principles.

- Wildlife comes first.
- Ecosystems, biodiversity, and wilderness are vital concepts in refuge and district management.
- Habitats must be healthy.
- Growth of refuges and districts must be strategic.
- The Refuge System serves as a model for habitat management with broad participation from others.

The Administration Act states that the Secretary of the Interior shall provide for the conservation of fish, wildlife, and plants, and their habitats within the Refuge System as well as ensure that the

biological integrity, diversity, and environmental health of the System are maintained. House Report 105–106 accompanying the Improvement Act states ‘‘… the fundamental mission of our System is wildlife conservation: wildlife and wildlife conservation must come first.’’ Biological integrity, diversity, and environmental health are critical components of wildlife conservation. As later made clear in the Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3), “the highest measure of biological integrity, diversity, and environmental health is viewed as those intact and self-sustaining habitats and wildlife populations that existed during historic conditions.”

Under the Administration Act, each refuge must be managed to fulfill the Refuge System mission as well as the specific purposes for which it was established. The Administration Act requires the Service to monitor the status and trends of fish, wildlife, and plants in each refuge.

Additionally, the Improvement Act identifies six priority wildlife-dependent recreational uses for the Refuge System. These uses are hunting, fishing, wildlife observation and photography, and environmental education and interpretation. Under the Improvement Act, the Service is to grant these six wildlife-dependent public uses special consideration in the planning, management, establishment, and expansion of units of the Refuge System. The overarching goal of the wildlife-dependent public uses program is to enhance opportunities and access to quality wildlife-dependent visitor experiences on refuges while managing refuges to conserve fish, wildlife, plants, and their habitats. When determined compatible on a refuge-specific basis, these six uses assume priority status among all uses of the refuge in question. The Service is to make extra efforts to facilitate priority wildlife-dependent public use opportunities.

When preparing a CCP, refuge managers must re-evaluate all general public, recreational, and economic uses (even those occurring to further refuge habitat management goals) proposed or occurring on a refuge for appropriateness and compatibility. No refuge use may be allowed or continued unless it is determined to be appropriate and compatible. Generally, an appropriate use is one that contributes to fulfilling the refuge purposes, the Refuge System mission, or goals or objectives described in a refuge management plan. A compatible use is one that, in the sound professional judgment of the refuge manager, would not materially interfere with or detract from the fulfillment of the mission of the Refuge System or the purposes of the refuge. Updated appropriate use and compatibility determinations for existing and proposed uses for Tualatin River National Wildlife Refuge can be found in Appendices A and B of this draft CCP.

The Improvement Act also requires that, in addition to formally established guidance, the CCP must be developed with the participation of the public. Issues and concerns articulated by the public play a role in guiding alternatives considered during the development of the CCP, and together with formal guidance, can play a role in selection of the preferred alternative. It is Service policy that CCPs be developed in an open public process, and the agency is committed to securing public input throughout the process. Public involvement details can be found in Appendix K of the draft CCP.

1.5.3 Other Laws and Mandates

Many other Federal laws, executive orders, Service policies, and international treaties govern Service and Refuge System lands. Examples include the Migratory Bird Treaty Act of 1918, the Refuge Recreation Act of 1962, the National Historic Preservation Act of 1966, and the Endangered Species Act of 1973. For additional information on laws and other mandates, a list and brief description of Federal laws of interest to the Service can be found in the Laws Digest at http://www.fws.gov/laws/Lawsdigest.html.

In addition, over the last few years, the Service has developed or revised numerous policies and Director's Orders to reflect the mandates and intent of the Improvement Act. Some of these key policies include the Biological Integrity, Diversity, and Environmental Health Policy (601 FW 3); the Compatibility Policy (603 FW 2); the Comprehensive Conservation Planning Policy (602 FW 3); Mission, Goals, and Purposes (601 FW 1); Appropriate Refuge Uses (603 FW 1); Wildlife-dependent Public Uses (605 FW 1); Wilderness-related Policies (610 FW 1-5); and the director's order for Coordination and Cooperative Work with State Fish and Wildlife Agencies (http://www.fws.gov/policy/). These policies and others in draft or under development can be found at: http://refuges.fws.gov/policymakers/nwrpolicies.html.

In developing a CCP, refuges must consider these broader laws and policies as well as Refuge System and ecosystem goals and visions. The CCP must be consistent with these and also with the refuge purpose.

1.6 Refuge Establishment and Purposes

1.6.1 Legal Significance of the Refuge Purpose

The purpose for which a refuge was established or acquired is of key importance in refuge planning. Purposes must form the foundation for management decisions. Refuge purposes are the driving force in the development of vision statements, goals, objectives, and strategies in a CCP and are critical to determining the compatibility of existing and proposed refuge uses.

The purposes of a refuge are 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.

Unless the establishing law, order, or other document indicates otherwise, purposes dealing with the conservation, management, and restoration of fish, wildlife, and plants, and the habitats on which they depend take precedence over other purposes in the management and administration of any refuge. Where a refuge has multiple purposes related to fish, wildlife, and plant conservation, the more specific purpose would take precedence in instances of conflict. When an additional unit is acquired under an authority different from the authority used to establish the original unit, the addition takes on the purpose(s) of the original unit, but the original unit does not take on the purpose(s) of the newer addition. When a conflict exists between the Refuge System mission and the purpose of an individual refuge, the refuge purpose may supersede the mission.

1.6.2 Purpose and History of Refuge Establishment

The Improvement Act of 1997 defines "purposes of the refuge" and "purposes of each refuge" as the purpose specified in or derived from the law or any of a number of specified documents that establish, authorize, or expand a refuge. This includes acquisition purposes in cases where land at a refuge has been acquired under authority other than the establishing authority.

The purposes of Tualatin River National Wildlife Refuge are defined as:

- " … the development, advancement, management, conservation, and protection of fish and wildlife resources … " 16 U.S. Code (U.S.C.) § 742f(a)(4) (Fish and Wildlife Act of 1956).

- " … the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude … " 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956).
- " … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions … " 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986).

1.6.3 Land Status and Ownership

Established in 1992 under the guidelines of the Service's Urban Refuge Policy, the Tualatin River National Wildlife Refuge became one of a handful of urban refuges in the country. The establishment of the refuge was in response to a growing concern in the community about urbanization replacing the rural way of life. Concerned about this urban growth, the community requested a study of the feasibility of creating a refuge. The need and endorsement for creating this refuge was officially approved on December 20, 1991, which then led to an Environmental Assessment that culminated in a decision to approve the refuge boundary on February 13, 1992 (USFWS 1992a). This Environmental Assessment (EA) approved acquiring and managing lands within an acquisition boundary of 3,058 acres by fee title purchase, conservation easements, and/or agreements. In 2004, an additional 2 acres were added, and more recently in 2007, the Wapato Lake Unit was established, adding an additional 4,310 acres to the acquisition boundary. Currently, the approved acquisition boundary incorporates 7,370 acres. Approximately 2,154 acres are under fee title or easement and are managed as a national wildlife refuge.

Numerous land parcels have been acquired since 1992 ranging from several acres to over 300 acres. These properties were purchased using different funding sources and under different authorities. Appendix J explains in further detail the acquisition history and authorities of individual tracts.

1.7 Relationship to Other Planning Efforts

When developing a CCP, the Service considers the goals and objectives of existing national, regional, state, and ecosystem plans and/or assessments. The CCP is expected to be consistent, as much as possible, with existing plans and assist in meeting their conservation goals and objectives. This section summarizes some of the key plans reviewed by members of the core team while developing the CCP.

1.7.1 Regional Plans

The Nature Conservancy's Willamette Valley-Puget Trough-Georgia Basin Ecoregional Assessment: This report addresses the most important places for conserving native species and ecosystems in the Pacific Northwest. Using this assessment, The Nature Conservancy selected target species and communities that represented various habitat types. This assessment is a guide for providing the most conservation benefit for the lowest cost.

1.7.1.1 Migratory Birds Plans

Birds of Conservation Concern: Based on the efforts and assessment scores of three major bird conservation efforts (Partners In Flight [PIF], the U.S. Shorebird Conservation Plan, and the North American Waterbird Conservation Plan [NAWCP]), this report (USFWS 2002a) identifies, by Service region and by Bird Conservation Region (BCR), the bird species most in need of conservation attention. The Tualatin River National Wildlife Refuge is located within BCR Region 5, for which 27 species are listed; however, several of these are seabirds that do not use the refuge.

PIF: The primary goal of the *Conservation Strategy for Landbirds in the Lowlands and Valleys of Western Oregon and Washington* (Altman 2000) is to ensure long-term maintenance of healthy populations of native landbirds. Specific management activities and strategies are recommended.

North American Waterfowl Management Plan (NAWMP): This plan, first formulated in 1986, provides a strategy to protect North America's remaining wetlands and to conserve waterfowl populations through habitat protection, restoration, and enhancement. The plan was updated in 2004 with an emphasis on strengthening the biological foundation, using a landscape approach, and expanding partnerships. The 2004 update contains species-specific population objectives and evaluations of whether the continental population is currently above or below the target. There are also flyway goals for production by species, but the plan did not target population objectives for wintering or migratory waterfowl by area (NAWMP Committee 2004). Implementation of this plan is accomplished at the regional level by partnership, within 11 Joint Venture areas. Tualatin River National Wildlife Refuge is located within the area of the Pacific Coast Joint Venture. Many of the projects identified to achieve the NAWMP objectives are eligible for funding under the North American Wetlands Conservation Act (NAWCA). NAWCA authorizes congressional funding for projects fostering public/private partnerships that support the conservation and restoration of wetland habitats and associated wildlife resources. Given the extent of historical wetlands and ongoing public/private partnerships in the Willamette Valley, this Act has been (and continues to be) a tremendous resource for the conservation community in the region.

Pacific Flyway Plans: Flyway management plans are the products of Flyway Councils, developed to help state and Federal agencies cooperatively manage migratory gamebirds. Several flyway management plans pertain to Tualatin River National Wildlife Refuge, especially those for the western and cackling Canada goose (Pacific Flyway Council 1999, 2000) and tundra swans (Pacific Flyway Council 2001). In addition, the *Plan for Northwest Oregon/Southwest Washington Canada Goose Agricultural Depredation Control* (Pacific Flyway Council 1998) details specific strategies and guidance by management area for reducing depredation by Canada geese within the Lower Columbia Region/Willamette Valley.

United States Shorebird Conservation Plan/Northern Pacific Coast Regional Shorebird Management Plan: These plans (Brown et al. 2001; Drut and Buchanan 2000) identify numerous landscapes within the northern Pacific coast that provide important habitat for shorebirds. The diversity of wetland habitat types in the Willamette Valley is specifically highlighted as being of regional importance for several species including dunlin, Wilson snipe, and killdeer.

Pacific Coast Joint Venture Willamette Valley Implementation Plan: This plan (Roth et al. 2004) is intended to provide a strategic framework for site-specific habitat protection and restoration projects within the Willamette Valley. The plan's primary focus is on migratory birds and their habitats including waterfowl, shorebirds, waterbirds, and landbirds.

1.7.2 State Plans

Oregon Conservation Strategy (OCS): This document, authored by the Oregon Department of Fish and Wildlife (ODFW) (2006), is an overarching strategy for conserving fish and wildlife within the State of Oregon. The strategy identifies specific Conservation Opportunity Areas where high-priority species and habitat conservation may be most efficiently addressed. Strategy (high-priority) habitats identified by the OCS within the Willamette Valley include grasslands, oak woodlands, riparian areas, and wetlands/wet prairies. Three mammals, 10 plants, five herptiles, four invertebrates, 23 fish species, populations, or segments, and 14 birds are listed as strategy (high-priority) species within the OCS; many of these are found within the Willamette Valley.

Oregon Elk Management Plan: This plan (ODFW 2003) outlines elk management guidelines within the State of Oregon. ODFW manages elk based on management objectives for winter population size and post-season bull ratios in each Wildlife Management Unit in the state. The current management objective size for Roosevelt elk in the Willamette Valley is zero. Tualatin River National Wildlife Refuge will be working cooperatively with ODFW on a step-down elk management plan for the refuge.

State Comprehensive Outdoor Recreation Plan (SCORP): The 2008-2012 Oregon SCORP (Oregon Parks and Recreation Department 2008) includes a comprehensive overview of state recreational trends. The SCORP provides guidance, information, and recommendations for Federal, state, and local government as well as the private sector in making policy and planning decisions regarding outdoor recreation in Oregon.

1.7.3 Additional Plans and Assessments

USFWS Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington: This plan (USFWS 2010b) outlines the main recovery areas, actions, and population objectives for five listed Willamette Valley plants and Fender's blue butterfly.

Oregon Chub Recovery Plan: This plan (USFWS 1998) outlines the main recovery areas, actions, and population objectives for Oregon chub.

Oregon Partners for Fish and Wildlife Program, Statewide Strategic Plan 2007-2011: This plan (USFWS 2007a) identifies the ecological importance of habitats that occur within the Willamette Valley Focus Area. Continued emphasis would be placed on conservation of rare and unique habitats that support declining species on private lands within the Willamette Valley through collaborative partnerships with private landowners, non-governmental organizations, and other agencies.

1.8 Special Designation Lands

1.8.1 Important Bird Areas

The Important Bird Areas (IBA) program is a global effort to identify the most important areas for maintaining bird populations and focusing conservation efforts on protecting these sites. Within the United States, the program has been promoted and maintained by the American Bird Conservancy (ABC) and the National Audubon Society (NAS). The ABC is coordinating the identification of nationally significant IBAs while NAS is working to identify sites in individual states. The NAS is

working within each state to identify a network of sites across the United States that provide critical habitat for birds. This effort recognizes that habitat loss and fragmentation are the most serious threats to birds across North America and around the world. By working through partnerships, principally the North American Bird Conservation Initiative, to identify places that are critical to birds during some part of their life cycle (breeding, wintering, feeding, migrating), the hope is to minimize the effects that habitat loss and degradation have on bird populations. The IBA program has become a key component of many bird conservation efforts. Tualatin River National Wildlife Refuge is in the bird conservation area known as the Northern Pacific Rainforest region. The refuge was designated as an Important Bird Area due to high population numbers of wintering geese and northern pintails, in addition to shorebirds. More information is available at http://web4.audubon.org/bird/iba/index.html.

1.9 Planning Process and Issue Identification

1.9.1 Planning Process

The Service prepared this draft CCP and EA in compliance with the Administration Act. The actions described within meet the requirements of the Council on Environmental Quality regulations for implementing NEPA. Figure 1-1 demonstrates the complete CCP planning process from conception to final document.

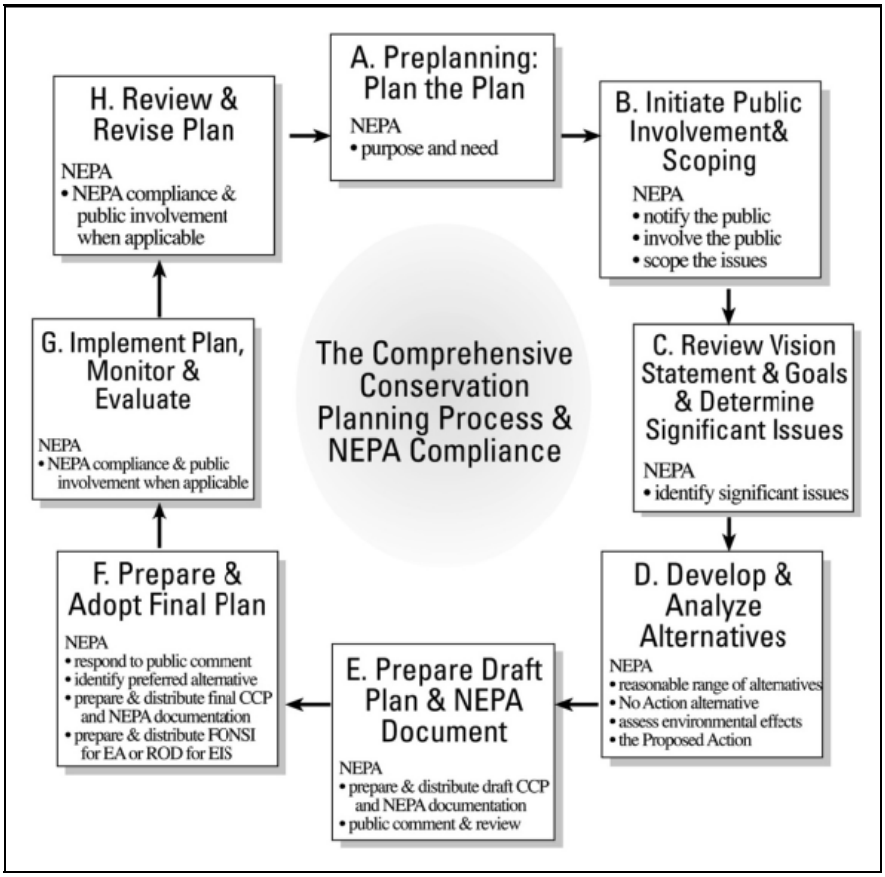

Figure 1-1. Overview of CCP planning process.

The Service began the pre-planning process in 2009 (Table 1-1) with the formation of the core planning team, which consists mostly of refuge staff and a regional planner. The extended planning team included other Service employees, fisheries biologists, refuge law enforcement officers, and other Federal, regional, and state employees. Early in the planning process, both teams cooperatively identified priority species, groups, and communities for the refuge, and most of the biological emphasis of the CCP is focused on maintaining and restoring these targets. Public use planning centered on developing goals, objectives, and strategies around the "big six" uses. Other nonwildlife-dependent uses that currently occur were also addressed.

Table 1-1. Summary of CCP Planning Process for Tualatin River National Wildlife Refuge

Date	Event	Outcome
December 15, 2009	Kick-off meeting and formation of core team	Planning team learned about the CCP process and discussed initial team list, mailing list, roles of team members, and planning schedule.
January 12-14, 2010	Wildlife and habitat review	Panel of wildlife and habitat experts from Federal, state, and regional agencies and other partners gathered to discuss and propose options for managing the refuge's wildlife and habitat resources.
October 14, 2010	Visitor services review	Panel of visitor services experts from Federal, state, and regional agencies met to discuss public use opportunities, issues, and concerns.
November 3, 2010	Notice of Intent publication	Notice of Intent to prepare CCP was published in the Federal Register.
November 2010	Planning Update #1 mailing	First update was sent to mailing list recipients; it described planning process and preliminary issues to be considered.
November 16, 2010	Interagency scoping meeting	Multiple agencies gathered to discuss issues, opportunities, and concerns.
November 30 and December 2, 2010	Public scoping meeting, Sherwood and Forest Grove, Oregon	Public attendees learned about CCP process and discussed issues and ideas for future management.
April 2011	Planning Update #2 mailing	Update discussed comments received from the public and summarized draft refuge goals.

Table 1-1. Summary of CCP Planning Process for Tualatin River National Wildlife Refuge

Date	Event	Outcome
May 2011-December 2011	Alternatives development and evaluation; objective and strategy development	Planning team developed alternatives, objectives, and strategies for refuge goals.
	Environmental consequences review	Team reviewed consequences of proposed alternatives.
	Map and figure review	Team discussed relevant maps and figures needed.
	Internal draft plan preparation	Planning team prepared draft CCP and EA, including maps. Document was prepared for editor to ready for internal review.
November 2011	Planning Update #3 mailing	Update #3 summarized the preliminary alternatives.
October 2012	Draft CCP distributed with Planning Update #4	Comment period opened for 30 days.

During the pre-planning phase, refuge staff identified and evaluated the issues and concerns raised during public scoping. These issues are defined as matters of controversy, dispute, or general concern, or interest in resource management activities, the environment, land uses, or public use activities. Issues are important to the planning process because they identify topics to be addressed in the CCP, pinpoint the types of information to gather, and help define alternatives for the CCP. It is the Service's responsibility to focus planning and analysis on major issues. Major issues typically suggest different actions or alternative solutions, are within the refuge's jurisdiction, and have a positive or negative effect on the resource. Major issues influence the decisions proposed in the draft CCP. Preliminary issues and goals that assisted in developing the draft preliminary alternatives for the draft CCP are listed below.

1.9.2 Key Issues Addressed in the Comprehensive Conservation Plan

1.9.2.1 Restoration of Native Habitats and Natural Water Regimes

One of the primary goals of the Tualatin River National Wildlife Refuge is to protect, manage, and restore native habitats of the Tualatin River Basin and ensure that the refuge's efforts contribute to the much larger landscape outside of the refuge's boundary. Native habitat restoration requires understanding basic resources that ecosystems are dependent on to make sound scientific decisions. Local-scale knowledge of soils, hydrology, and topography are important attributes to consider when planning to restore a given habitat type. Additionally, it is just as important to determine what the land supported historically and identify changes from the historical condition that would help guide restoration options for a given area. Refuge management must be able to answer the most basic questions of "why" and "where" to support decisions. One of the key components in making

restoration decisions is looking at the larger landscape both within and outside refuge boundaries. Habitats within the Tualatin River Basin are often fragmented into small, disconnected areas. Of primary concern is to provide larger contiguous blocks of a given habitat type, and maintain wildlife corridors to increase connectivity among habitat patches.

The Tualatin River is the "lifeblood" of the refuge, as a majority of refuge lands lie within its floodplain. Agricultural practices, development of dams, and urbanization have drastically altered hydrological patterns of the Tualatin River floodplain. Knowledge of current river functions is critical to support floodplain habitat restoration and support decisions to convert areas of the refuge to a more natural hydrologic-driven process.

One outcome of the CCP planning process was the development of computer modeling to help identify and map important floodplain habitat restoration opportunities using current land attributes and historical vegetation. The model would also help determine the historical, current, and future extent of frequency and duration of Tualatin River flooding in order to identify floodplain restoration opportunities and show how current river hydrology could be integrated into habitat management.

1.9.2.2 Species Posing Management Challenges

The refuge is known for its natural features and diverse and abundant wildlife. However, as a refuge in an urban/rural interface, the space for wildlife is limited and the potential for conflicting use, use that disturbs wildlife both within and outside refuge boundaries, poses wildlife management challenges.

To date there have been no mosquito-borne human health disease issues documented near the refuge, but public concern for potential disease transmission from wildlife to humans have increased as human populations have grown around the refuge. The CCP will explore the refuge's role and appropriate responses to these concerns in cooperation with local agencies.

Invasive species are a major issue on public lands throughout the United States, and national wildlife refuges are no exception. Some invasive species are so well established that eradicating them completely using existing technology is impossible. The CCP will examine what the most appropriate strategies are for controlling invasive species in a variety of habitat types. Nonnative invasive plant species include reed canarygrass, Himalayan blackberry, Bermuda grass, and common cocklebur. Efforts to control these and other species are ongoing.

Nonnative animal populations that occur on refuge lands include nutria, bullfrogs, carp and other nonnative fish species, and feral cats. These species degrade habitat and affect native wildlife populations directly or by displacement.

Some native species also pose management challenges. For example, beavers cause damage to water control structures and native vegetation; Canada geese numbers have increased significantly in the Willamette Valley and impact surrounding agricultural lands; ODFW has designated the Willamette Valley Management Unit as an elk de-emphasis area to minimize damage to agricultural crops—populations of elk reside less than a mile from the Wapato Lake Unit. The CCP will evaluate all wildlife management options and control strategies for these species to protect refuge resources.

1.9.2.3 Management of Special-status Species

The refuge has great potential to play a role in the protection and recovery of listed species, species of concern, and rare species occupying a variety of habitat types within the Willamette Valley. The CCP will explore management and landscape-level restoration actions that could include restoring riparian habitats to a more natural barrier-free system, providing wintering habitat for listed salmonids and other native fish. The conservation and restoration of rare and declining habitats such as wet prairie, oak savanna, and other habitat types would assist in the recovery of special-status species and possibly prevent future listings.

1.9.2.4 Refuge Access

Getting to and from the refuge as well as accessing areas within the refuge are important considerations for the CCP. Many transportation systems that would bring visitors to the refuge either already exist, are planned, or have the potential to be implemented in the future. The CCP will explore whether the existing facilities within the refuge are sufficient to provide access to the range of high-quality wildlife-dependent recreation opportunities, including those existing and those that may be implemented as an outcome of the CCP. Access must be considered through the lens of appropriateness and compatibility, evaluating disturbance/impacts to wildlife and their habitats, other compatible public uses, and refuge management programs.

1.9.2.5 Hunting and Fishing

Hunting and fishing are traditional recreational uses of renewable natural resources. The Administration Act, other laws, and the Service's policies permit hunting and fishing on a national wildlife refuge when it is compatible with the purposes for which the refuge was established and acquired.

National wildlife refuges exist primarily to safeguard wildlife populations through habitat preservation. The word "refuge" encompasses the idea of providing a haven of safety for wildlife, and as such, hunting might seem to be an inconsistent use of the Refuge System. However, habitats that normally support healthy wildlife populations produce populations that can sustain minor individual loss without impacting the population as a whole; therefore, the resource is renewable.

As practiced on refuges, hunting and fishing do not pose a threat to wildlife populations, and in some instances, are actually necessary for sound wildlife management. For example, on some wildlife refuges, deer populations will often grow too large for the refuge habitat to support. If some deer are not harvested, they destroy habitat for themselves and other animals and die from starvation or disease. The harvesting of wildlife on refuges is carefully regulated to ensure an equilibrium between population levels and wildlife habitat. The decision to permit hunting and fishing on national wildlife refuges is made on a case-by-case basis that considers biological soundness, economic feasibility, effects on other refuge programs, and public demand (USFWS 2011f).

Hunting and fishing are currently not offered at the Tualatin River National Wildlife Refuge. Hunting opportunities in the Portland metropolitan area are very limited, but there is potential to provide high-quality hunting and fishing opportunities on the refuge, in particular hunting at the Wapato Lake Unit and fishing at the Sherwood Units. Public scoping in 2010 revealed interest in offering hunting, including programs that offer youth hunts, and some interest in fishing. The CCP will examine what

types of hunting and fishing could be offered, based on appropriateness, compatibility, sustainability, and feasibility.

1.9.2.6 Entrance and User Fees

Charging entrance fees (to visit the refuge) and user fees (to participate in a specific program or use specific facilities) are options to financially support visitor service operations, including facility maintenance and salaries for park rangers, fee collectors, or hunter check station operators. Several aspects of a potential fee program will be evaluated during the CCP. The cost of managing a fee program will be weighed against the revenue that is likely to be generated. The refuge will consider whether the income generated by a fee program would be worth the potential loss of visitors who would not come to the refuge if a fee were required.

1.9.2.7 Wapato Lake Management

In 1952, the Wapato Improvement District (WID) was established to coordinate the various water needs for agricultural operations and maintenance of Wapato Lake. The WID operated and maintained the two pumps, 5+ miles of levees, weirs, canals, bridges, and culverts associated with water management of the lake. The district was comprised of all the landowners of the lake who paid assessments to WID to perform the necessary maintenance and operations to dewater the lake and deliver summer water to the lakebed landowners.

When the refuge first acquired lands within the Wapato Improvement District, it became a member of the WID and paid an assessment along with the other landowners to maintain the infrastructure. When the refuge became the majority landowner of the lakebed, the WID voted to no longer function as a district and in spring of 2012, the WID donated its assets to the Service. In the interim, until more detailed habitat management can be completed, the refuge will continue to dewater the lakebed to manage invasive species and provide additional forage for waterfowl. Since it is inconsistent with refuge purposes and Service policies the refuge cannot take on the responsibilities of WID that relate to the irrigation responsibilities of the Tualatin Valley Irrigation District. However, the refuge is committed to working with the local agencies to address immediate concerns until a long-term alternative to irrigation water delivery can be determined.

1.9.3 Issues Outside the Scope of the Comprehensive Conservation Plan

While CCPs are very comprehensive plans, no single plan can cover all issues. The planning team has compiled a list of issues that are currently considered to be outside the scope of this CCP.

Operations associated with raising of Scoggins Dam and raw water pipeline: At the Wapato Lake Unit, additional potential impacts to riverine and floodplain habitats and wildlife resources exist that are associated with a proposed raising of Scoggins Dam and the raw water pipeline project. Refuge and other Service staff will continue to be a part of this planning process.

Alignment of proposed I-5 and 99-W connection corridor: A new road development and associated right-of-way construction project has the potential to impact future acquisition needs and threaten refuge resources at several refuge unit locations. Alternative routes have been proposed that cross fee title refuge lands or are in close proximity to refuge parcels. Refuge staff will continue to monitor and comment on this planning process.

Washington County urban reserve planning process: As an urban refuge, the Tualatin River National Wildlife Refuge faces external threats that reflect the urbanization of the surrounding landscape. The City of Sherwood has been identified as one of the fastest growing cities in Oregon, with residential and commercial development continuing to expand at a high rate. Metro, the elected regional government for the Portland metropolitan area, has expanded the urban growth boundary since refuge establishment to accommodate growth of municipalities. Much of the habitat adjacent to the floodplain is now targeted for construction and development.

Hazardous material and contaminant issues: Land use surrounding the refuge includes a variety of operations that may adversely impact refuge resources, primarily through contamination of soils and waterways and urban-related runoff upstream and adjacent to the refuge. Examples of past and current operations include auto recycling facilities; landfills; abandoned and current industrial sites; quarries; and others. The Service will continue to engage and provide input on these types of concerns on a case-by-case basis, as appropriate and as authorized.

Willamette Valley Conservation Study Area: The Service has initiated a collaborative study of conservation opportunities within the Willamette Valley. The Willamette Valley Conservation Study Area is part of the America's Great Outdoors Initiative to develop twenty-first century conservation and recreation solutions. The initiative takes as its premise that lasting conservation solutions should rise from the American people. This landscape-level study will be accomplished with our partners and other stakeholders to focus on several key points (USFWS 2011a):

- Conserving rare and declining habitats;
- Assisting in recovering endangered, threatened, and candidate species;
- Connecting people to nature through outdoor recreation and education opportunities;
- Enhancing habitat connectivity and wildlife corridors;
- Conserving rural working farms, ranches, and forest with wildlife habitat values through partnerships and incentives; and
- Assisting in achieving Pacific Flyway Canada goose and other migratory bird objectives.

1.10 Refuge Vision and Goals

1.10.1 Expanded Vision Statement: An Image of the Future

Tualatin River National Wildlife Refuge is a natural treasure where an abundance of native wildlife thrive in a mosaic of wetland, prairie, forest, and stream habitats characteristic of the Willamette Valley that the Atfálat'i people knew. It's a special place, an icon where the stories of the refuge reflect the importance of the National Wildlife Refuge System. The refuge has a rich history of community vision where friends and neighbors helped create, and continue to care for, this urban refuge and the watershed that supports it. It is a model that combines excellence in landscape conservation, learning, and partnerships to strive for a healthy natural world.

The refuge is a sanctuary for both wildlife and people, a place where the ebb and flow of the river marks the natural rhythms of the refuge through the seasons.

Spring is a time when the melody of songbirds echoes through the canopy of the riparian forest and prairies are washed in the vibrant colors of wildflowers in bloom. Nature is alive

with the sights and sounds of animals as they fulfill their ancient ritual of courting and raising their young. Wetlands give way to mudflats as migrating shorebirds probe the mud for the insects and worms that will nourish them on their northward journey. The curiosity of school children is nurtured as they discover nature's surprises like a bird's nest, a vole tunnel, a duckling, a soaring hawk, or the slither of a snake.

The heat of summer dominates as wetlands dry and native plants continue to grow, setting the dinner table for the waterfowl that will arrive in fall. Turtles bask on logs, songbirds are fledging their young, the chorus of frogs resonates at sundown, and bats dart through the night sky eating insects on the fly. Volunteers and refuge staff are busy with the chores of caring for the refuge, while families explore the sunny expanse of tall meadow grasses and seek shelter in the cool shade of the green forest.

As fall approaches, the colors of the forest change to golden hues and the air fills with the sound of migrating geese and swans. Seasonal rains begin as the arriving waterfowl seek shelter and food in the wetlands that are beginning to flood. Deer and squirrels prepare for winter as they search for acorns under majestic oaks. Teachers gather at the refuge to learn how to share the sense of wonder that nature has to offer to their students.

Winter brings the awe of thousands of waterfowl, swirling overhead as they seek sanctuary. Rains pour down as ducks, geese, and swans forage in the wetlands, abundant with the seeds and roots that will nourish them through the cold season. People gather and marvel as bald eagles perch high atop leafless trees and patrol wetlands searching for a waterfowl meal. Fish migrate through rising rivers and streams, and seek shelter in the quieter waters of backwater sloughs. Late in the winter, the open water of the wetlands reflects the misty sunsets as waterfowl depart to their arctic breeding grounds.

Winter rains wane as the cycle begins anew in a place where rich traditions, outdoor learning experiences, and discovery foster a love of and caring for nature that endures for generations to come.

1.10.2 Condensed Vision: Summarizing the Core Values of the Refuge

Tualatin River National Wildlife Refuge is a natural treasure where an abundance of native wildlife thrive in a mosaic of wetland, prairie, forest, and stream habitats characteristic of the Willamette Valley that the Atfálat'i people knew. The refuge is a sanctuary for both wildlife and people, a place where the ebb and flow of the river marks the natural rhythms of the refuge through the seasons. It's a special place, an icon where the stories of the refuge reflect the importance of the National Wildlife Refuge System. The refuge has a rich history of community vision where friends and neighbors helped create, and continue to care for, this urban refuge and the watershed that supports it. It's a model that combines excellence in landscape conservation, learning, and partnerships to strive for a healthy natural world. Tualatin River National Wildlife Refuge is a place where wildlife, rich traditions, outdoor learning experiences, and discovery foster a love of and caring for nature that endures for generations to come.

1.10.3 Refuge Goals

Refuge management goals are descriptive, open-ended, and often broad statements of desired future conditions that convey a purpose, but do not define measurable units. Goals must support the refuge vision and describe the desired end result.

The CCP planning team has drafted a series of goals, objectives, and strategies to meet these goals and to address the concerns identified during scoping. Included below are draft goals.

- Maintain, enhance, and restore bottomland riparian habitats consistent with the historical range of variability representative of the Willamette Valley ecosystem to support breeding and migratory landbirds and other native species.
- Maintain, enhance, and restore mixed coniferous/deciduous forest habitat to a historical range of variability representative of the Willamette Valley ecosystem to support breeding and migratory landbirds and other native species.
- Maintain, enhance, and restore oak savanna habitat to a historical range of variability representative of the Willamette Valley ecosystem to support breeding and migratory landbirds and other native species.
- Maintain, enhance, and restore native Willamette Valley wet prairie habitat, with an emphasis on management for rare and listed species.
- Maintain, enhance, and restore a diversity of wetlands to support migratory landbirds, waterbirds, and shorebirds with special emphasis on wintering waterfowl.
- Maintain, enhance, and, where feasible, restore streams and off-channel backwater slough habitats to benefit salmonids and other native aquatic species.
- Cultivate and maintain croplands as an interim measure to control nonnative invasive species.
- Collect scientific information (surveys, scientific assessments, and research) as necessary to support adaptive management decisions that are associated with the goals of the refuge.
- Protect and manage the refuge's unique cultural resources for their cultural, scientific, and educational values, while consulting with appropriate Native American groups and preservation organizations and complying with historic preservation legislation.
- Provide visitors, local residents, volunteers, and partners with opportunities to understand and appreciate fish and wildlife conservation as well as the purpose, ecology, and management of the refuge and the Refuge System.
- Provide students and educators from the greater Portland area with compatible and high-quality opportunities to participate in environmental education.
- Provide refuge visitors with diverse, compatible, and high-quality opportunities to participate in wildlife-dependent recreation and interpretation.
- Build a broad-based natural resource conservation constituency with a focus on urban audiences to create a conservation ethic within urban communities; increase relevance of habitat conservation, wildlife heritage, and the Refuge System in the eyes of urban citizens; and instill a sense of empowerment for urban communities to work together to actively support conservation, in both local and global settings.

Chapter 2
Management Alternatives

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Chapter 2 Management Alternatives

2.1 Alternatives Development

In developing the alternatives for this draft Comprehensive Conservation Plan (CCP), the Tualatin River National Wildlife Refuge (the refuge) reviewed and considered a variety of natural and cultural resource, social, economic, and organizational information, ideas, and concerns important for managing the refuge. Much of this information is more fully described in Chapters 3, 4, and 5. As is appropriate for a national wildlife refuge, biological resource considerations were paramount in designing alternatives. A U.S. House of Representatives report accompanying the Refuge System Improvement Act stated, "the fundamental mission of our [Refuge] System is wildlife conservation: wildlife and wildlife conservation must come first."

The refuge planning team reviewed available scientific reports and studies to better understand ecosystem trends and the latest scientific recommendations for species, habitats, and public uses, including environmental and social effects of those uses. The planning team also identified refuge areas that, due to natural or cultural considerations, were especially sensitive to public uses and facilities, and identified refuge areas that provided special opportunities for public uses.

Refuge staff met with representatives from local, state, and Federal agencies and initiated contact with elected officials and the Confederated Tribes of Grand Ronde (Tribes) to ascertain issues, priorities, problems, and recommendations as perceived by others. Refuge staff also conducted scoping meetings with agencies and the general public to ensure that comments and ideas were considered from all interested parties during development of this CCP, including the alternatives. These consultation, coordination, and public participation efforts are more fully described in Appendix K.

The refuge planning team considered all of the above information and input, and identified and described a range of reasonable alternatives. A reasonable alternative is one that is technically and economically practical or feasible, would fulfill the purpose of and need for action without violating minimum environmental standards, and could be implemented. Each alternative was then evaluated for environmental and social effects and how it addressed the CCP issues. The Refuge then identified its preferred alternative—Alternative 2—which is labeled as the Proposed Action. Following public review and comment, the U.S. Fish and Wildlife Service (the Service; USFWS) will select a CCP alternative for implementation. This selected alternative may include elements from any of the alternatives evaluated herein.

2.2 Alternatives Considered but Eliminated from Detailed Study

During development of the alternatives, the refuge planning team considered the alternative actions discussed below. All of these actions were ultimately eliminated from further evaluation and inclusion in any alternatives for the reasons stated.

Expanding the refuge boundary. The refuge has been protecting habitat within the approved acquisition boundary through an active effort to acquire lands and waters for almost 20 years. The approved acquisition boundary was substantially increased in 2007 with the addition of the 4,310-acre Wapato Lake Unit (USFWS 2007b). As of June 2011, the refuge has acquired or has otherwise

gained management authority over approximately 2,204 acres of the 7,370 acres within the approved refuge acquisition boundary. Acquisition is from willing sellers through fee title or easements. Of those acres 2,154 acres are in fee title or easement and 50 acres are under memorandum of agreement with Metro for management. Refuge efforts now and into the foreseeable future are focused on securing the acreage yet to be acquired within the existing boundary from willing sellers. Therefore, expansion of the approved refuge acquisition boundary is not being considered as part of this CCP effort.

The Service has recently initiated a separate study of opportunities to conserve valuable fish, wildlife, and plant habitats throughout the Willamette Valley (USFWS 2011a). This new effort is part of the national America's Great Outdoors initiative and will involve collaboration among local communities, landowners, agencies, and organizations. Purposes of the study include conserving rare habitats; enhancing habitat connectivity; helping to recover and avoid listing species with declining populations; addressing goose management issues, including agricultural depredation; enhancing water quantity and quality; and increasing wildlife-dependent recreation and education opportunities. The study will evaluate voluntary conservation easements, private land incentives, potential expansion of existing or establishment of new national wildlife refuges; and other "land protection strategies that support local economies, conserve natural resources and provide increased outdoor recreation and education opportunities" (USFWS 2011a). One of the outcomes of this study may be the possibility of establishing the existing Wapato Lake Unit as its own national wildlife refuge. Several opportunities will be provided for the public to become involved in this new study. The refuge is participating in this Willamette Valley–wide conservation effort, but the initiative is not part of this CCP.

Cropland management for geese. In its plan to reduce goose depredation of private agricultural lands, the Pacific Flyway Council (PFC) recommended, among other things, that Federal refuges do "everything possible … to provide abundant, high quality goose forage" (PFC 1998). A task force created by the Oregon legislature in 2009 to evaluate this issue made similar recommendations and stated that, "Supplemental feeding of geese on … federal areas should be utilized when needed to reduce goose depredation on private farmlands" (Goose Depredation Task Force 2010). Although cooperative farming is used as an interim management tool prior to restoring acquired lands, the refuge planning team considered implementation of a permanent cropland management program on the refuge to provide winter forage for geese. This proposal was eliminated from further study for the following reason:

- Restoration and management of native habitat types on these refuge acreages support higher priority ecological values (i.e., remnant vegetation communities and wildlife species with declining populations) and directly support the purposes of the refuge.

Allowing certain nonwildlife-dependent uses. Uses found not appropriate have not been included in alternatives or carried forward in the CCP process (see discussion of the Refuge Administration Act in Section 1.5, Legal and Policy Guidance). The refuge planning team considered the appropriateness of providing opportunities for a broad range of recreational and commercial uses of the refuge that were suggested during CCP scoping or at other times prior to the start of the CCP process. These uses include dog training/walking, bicycling/jogging, plant harvesting, trapping, boat access, and geocaching.

Each of these uses was evaluated and found to cause unacceptable levels of disturbance to wildlife, create unacceptable public safety issues, and/or interfere with users engaged in compatible wildlife-

dependent uses. Therefore, these uses were found to be not appropriate on the refuge, and they are not included in any of this CCP's alternatives. These findings are documented in Appendix A, Appropriate Use Findings.

Providing boat access to the Tualatin River at the Wapato Lake Unit. Comments were made during public scoping and the public use review regarding the potential for boating access to the Tualatin River from the Wapato Lake Unit (SWCA Environmental Consultants 2010a, 2010b).

As it flows through the northern half of the Wapato Lake Unit, the Tualatin River is quite narrow and is bordered by strips of remnant riparian forest. As a result of flooding and natural tree fall, the river is regularly blocked by multiple brush and logjams. Maneuvering even a small human-powered craft through this reach of the river would require regular lifting of the craft over or around logjams, creating a potentially dangerous situation. If the refuge developed improved boat access to the river, the public would reasonably expect a relatively safe and enjoyable boating experience, which at this time, we are unable to provide. Additionally, large woody debris is often a valuable component of aquatic fisheries habitat and logs are best left in place to facilitate wildlife benefits. For these reasons, this proposal was determined impractical and was not further evaluated as part of this CCP.

2.3 Alternative Descriptions

2.3.1 Features Common to All Alternatives

As a unit of the National Wildlife Refuge System (Refuge System), the refuge is managed to conserve native fish, wildlife, plants, and their habitats, and to provide opportunities for compatible wildlife-dependent public uses. The refuge would continue to conduct core management programs regardless of which CCP alternative is eventually selected for implementation. Following are brief descriptions of the principles and programs that are common to all three alternatives evaluated in this CCP, including Alternative 1, Continue Current Management (for purposes of the National Environmental Policy Act [NEPA], Alternative 1 is also the No Action Alternative).

Adaptive management. Based upon the Service's Adaptive Management Implementation policy, refuge staff shall use adaptive management for conserving, protecting, and, where appropriate, restoring lands and resources. Adaptive management is defined as a system of management practices based upon clearly identified outcomes, where monitoring evaluates whether management actions are achieving desired results (objectives). The recently published *Adaptive Management Technical Guide* also defines adaptive management as a decision process that "promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood" (Williams et al. 2009). Adaptive management accounts for the fact that complete knowledge about fish, wildlife, plants, habitats, and the ecological processes supporting them may be lacking. The role of natural variability contributing to ecological resilience also is recognized as an important principle for adaptive management. It is not a "trial and error" process; rather, adaptive management emphasizes learning while doing based upon available scientific information and best professional judgment considering site-specific biotic and abiotic factors on refuge lands.

Appropriateness and compatibility. Consistent with relevant laws, regulations, and policies, prior to allowing any public use, including commercial use of the refuge, each such use would first need to be found appropriate and determined compatible. The Service would make preliminary findings and

determinations regarding the appropriateness and compatibility of each use included in each alternative. Prior to signature of a decision document for the CCP and its associated NEPA document, appropriateness findings and compatibility determinations would be finalized for each public use included in the Service's proposed action. Appropriateness and compatibility are further discussed in Appendices A and B.

Biological integrity. The Administration Act directs the Service to "ensure that the biological integrity, diversity, and environmental health of the [Refuge System] are maintained for the benefit of present and future generations of Americans …." The policy is an additional directive for the Service to follow while achieving a refuge's purposes and the Refuge System's mission. It provides for the consideration and protection of the broad spectrum of native fish, wildlife, and habitat resources found on the refuge. When evaluating the appropriate management direction for the Refuge (e.g., in compatibility determinations), the Service would use sound professional judgment to determine the refuge's contribution to biological integrity, diversity, and environmental health (BIDEH) at multiple landscape scales. Sound professional judgment would incorporate field experience, knowledge of refuge resources, an understanding of the refuge's role within the ecosystem, applicable laws, and best available science, including consultation with others both inside and outside the Service. The policy states that "the highest measure of biological integrity, diversity, and environmental health is viewed as those intact and self-sustaining habitats and wildlife populations that existed during historic conditions."[1]

Climate change. The Service considers and analyzes climate change in its decisions, long-range plans, and other activities. Habitat conditions and wildlife populations are directly and indirectly sensitive to climatic conditions, namely precipitation and temperature. As described in greater detail in Chapter 3, the area's hydrology is not particularly sensitive to changes in climate because the refuge is located in a rain-dominant system. However, increasing temperatures increase the risk of fire, disease, pests, and invasive species throughout the Pacific Northwest, and these trends may affect the refuge's forest, riparian, and upland habitats and species and their management.

The combined changes (temperature, precipitation, and hydrology) can affect the refuge's habitats and species directly, such as the timing of migratory arrival and many other phenological responses, and indirectly, such as by added vulnerability to other stressors including invasive species and pathogens. Predicting biological response at the population level, however, requires complex research and information and sophisticated models that can be validated with field studies over time. This highlights the importance of monitoring both habitats and species to establish potential correlations and adaptation options.

In summary, climate change has the potential to significantly impact the refuge's ability to achieve its purposes, goals, and objectives. Knowledge and monitoring of these regional and local trends would be used to assess potential changes or enhancements to the refuge's management actions and techniques and/or their timing, using the adaptive management approach described above. Most notably, the region's changing climate, specifically hotter and drier summer months, could challenge the refuge's goals and objectives for maintaining, enhancing, and restoring mixed coniferous/deciduous forest habitat to a historical range of variability, and for maintaining, enhancing, and restoring native Willamette Valley wet prairie and shrub-scrub wetland habitat.

[1] There is one caveat, however. Management for a refuge's purpose(s) is the highest priority, so maintenance and/or restoration of biological integrity, diversity, and environmental health cannot compromise or conflict with refuge purpose(s).

The refuge would monitor wildlife corridor analyses, vulnerability assessments, vegetative and species response modeling, and other efforts, including those underway at a landscape scale, such as the Great Northern Landscape Conservation Cooperative (LCC). LCCs are formal science-management partnerships between the Service, Federal agencies, states, Tribes, nongovernmental organizations (NGOs), universities, and other entities to address climate change and other biological stressors in an integrated fashion. LCCs provide science support, biological planning, conservation design, research, and design of inventory and monitoring programs. As needed, objectives and strategies would be adjusted to assist in enhancing refuge resources' resilience to climate change and to potentially manage for new assemblages of species in the future.

Energy efficiency, sustainability, and other green building concepts were among the key principles used in the design and construction of the refuge's Wildlife Center, environmental education shelter, and administration building in the past decade (USFWS 2003a). The refuge would continue to take steps to mitigate effects of climate change and reduce its carbon footprint to help achieve the Service's national commitment to become carbon neutral by 2020 (USFWS 2010a). Habitat restoration efforts under all alternatives would help to sequester carbon. Most restoration efforts involve planting grasses, shrubs, or trees, each of which would remove atmospheric carbon dioxide and store it within the plant materials. In addition, forest and scrub-shrub habitat types would increase shading along waterways, contributing to decreased water temperatures. Restoring and maintaining large blocks of habitat may also provide extended life history needs, such as cooler forest areas, for fish and wildlife as climate change occurs.

Coordination with the State. The refuge would continue to routinely coordinate with state agencies such as Oregon Department of Fish and Wildlife (ODFW), Oregon Department of Environmental Quality (DEQ), and the Department of State Lands (DSL). Key subjects of mutual interest include water quality; wetlands; management of dusky Canada geese, cackling Canada geese, and other waterfowl; goose and elk depredation; management of wildlife-dependent recreation, including hunting and fishing; management of nonnative and invasive species; and management of special-status species.

Coordination with the Confederated Tribes of Grand Ronde. The refuge would continue to coordinate and consult with the Tribes on subjects of mutual interest, including education and interpretation regarding cultural resources.

Cultural resources protection and National Historic Preservation Act (NHPA) compliance. The refuge would continue to uphold federal laws protecting cultural resources, including Section 106 of the NHPA. These laws also mandate consultation with Native American Tribes, the State Historic Preservation Office, and other preservation partners.

Facility management. The efficient and safe operation of refuge facilities is critical to achievement of refuge purposes, goals, and objectives, including conserving native fish, wildlife, plants, and their habitats, and providing compatible wildlife-dependent public use opportunities. Under all alternatives, the Service would continue to maintain, repair, upgrade, and/or replace refuge facilities as necessary and appropriate, consistent with available funding.

Fees. Some public lands, including national wildlife refuges, establish and use revenues generated by entrance and user fees to help support their programs. Federal law and policy requires the use of fee revenues to support visitor services programs, including maintenance and repair of visitor facilities. The refuge has received official approval to establish an entrance fee program (USFWS 2009a) but

has not implemented one to date. The refuge would continue to evaluate the desirability of establishing entrance fees to supplement Federal appropriations, grants and other less reliable funding, and volunteer support.

Funding and staffing. As a result of inflation, implementation of the No Action Alternative would likely require increased funding just to maintain current operations. Full implementation of Alternatives 2 or 3 would require funding levels substantially above current budget allocations to support the identified habitat and wildlife management activities and enhanced public use programs.

Aspects of the refuge's habitat and wildlife program, such as habitat restoration projects, have been funded with grants and cost-share moneys, and through mitigation and other agreements with other agencies. A much greater proportion of the refuge's visitor services program has been funded with one-time grants, cost-share programs, and funding from other outside sources. In addition, as discussed elsewhere in this chapter, both programs are supported through numerous partnership and volunteer efforts. Regardless of which alternative is selected for implementation, future programs on the refuge would continue to rely on grants, cost-share moneys, partnerships, and volunteers. Maintenance of public use activities at the levels provided at present is not guaranteed and is less certain than continuation of current habitat and wildlife management activities.

As noted at the beginning of this document, the purpose of this CCP is to provide long-term guidance for management decisions; set forth goals, objectives, and strategies needed to accomplish refuge purposes; and identify the Service's best estimates of future needs. Selection of a CCP alternative does not constitute a commitment for staffing increases, operational and maintenance increases, continued land acquisition, or construction of new projects. After the CCP is completed, actions and programs that are part of the selected alternative would be implemented over a period of 15 years, consistent with available funding and staffing.

Goose management. The refuge and partner agencies are grappling with several issues regarding goose management. Issues of concern include reduced numbers of dusky Canada geese and the abundance of cackling Canada geese, the loss of goose foraging habitat, and goose depredation on private farmland (PFC 1998, 1999, 2008). There are also concerns with increasing populations of resident Western Canada geese.

The refuge lies within the Willamette Valley and Lower Columbia River area, has agricultural lands as neighbors, and supports wintering dusky Canada geese and cackling Canada geese; thus, goose management is an important issue for the refuge. All CCP alternatives include winter surveys of refuge goose use and winter sanctuary areas that provide resting and foraging habitats for dusky Canada geese and other waterfowl.

Integrated pest management (IPM). Nonnative species, especially invasive species, and other pest plants and animals can disrupt native ecosystems and management of conservation lands. They can displace native plants and create monotypic habitats of little value to native fish and wildlife; they can prey upon native species; they can transmit diseases to other species, including humans; and they can damage facilities used to manage habitats and provide public use opportunities. Species posing the greatest current threats to the refuge include Himalayan blackberry, English ivy, common carp, bullfrogs, nutria, Bermuda grass, and reed canarygrass. Species that have been detected on the refuge but were immediately eradicated include Japanese knotweed and purple loosestrife. In addition, snapping turtles have been documented in the Tualatin River, but have not been observed by refuge personnel. Species that pose a significant threat to the refuge, but have not been documented, include

giant hogweed, zebra mussel, garlic mustard, and New Zealand mud snail. Control of such species is a high-priority refuge management activity in all alternatives. Because of their aggressive nature and high potential for harm, the refuge has zero tolerance for purple loosestrife and Japanese knotweed and would continue to take immediate action to remove these species from the refuge whenever they are found.

Other pest species, both native and nonnative, such as beaver, feral cats, catfish, cocklebur, mosquito fish, poison hemlock, mosquitoes, sunfish, teasel, bull thistle, Canada thistle, velvetleaf, and tansy, can also limit the refuge's ability to provide high-quality habitats and public use programs. Appropriate management actions, including control efforts, would continue to be taken for these species under all alternatives, consistent with need and available funding.

An IPM approach would be used, where practicable, to eradicate, control, or contain pest and invasive species (herein collectively referred to as pests) on refuge lands. IPM would involve using methods based upon effectiveness, cost, and minimal ecological disruption, which considers minimum potential effects to nontarget species and the refuge environment. Pesticides may be used where physical, cultural, and biological methods or combinations thereof are impractical or incapable of providing adequate control, eradication, or containment. If a pesticide is needed on refuge lands, the most specific (selective) chemical available for the target species would be used unless considerations of persistence or other environmental and/or biotic hazards preclude it. Pesticide use would be further restricted because only pesticides registered with the U.S. Environmental Protection Agency (EPA) in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and as provided in regulations, orders, or permits issued by EPA may be applied on lands and waters under refuge jurisdiction.

Environmental harm by pest species refers to a biologically substantial decrease in environmental quality as indicated by a variety of potential factors such as declines in native species populations or communities, degraded habitat quality or long-term habitat loss, and/or altered ecological processes. Environmental harm may be a result of direct effects of pests on native species, including preying and feeding on them (e.g., bullfrogs eating native amphibians); causing or vectoring diseases; preventing them from reproducing or killing their young (i.e., pushing eggs out of nests); outcompeting them for food, nutrients, light, nest sites or other vital resources; or hybridizing with them so frequently that within a few generations, few if any truly native individuals remain. Environmental harm also can be the result of an indirect effect of pest species. For example, decreased waterfowl use may result from invasive plant infestations reducing the availability and/or abundance of native wetland plants that provide forage during winter.

See Appendix G for the refuge's IPM program documentation. Along with a more detailed discussion of IPM techniques, this documentation describes the selective use of pesticides for pest management on refuge lands, where necessary. Throughout the life of the CCP, most proposed pesticide uses on refuge lands would be evaluated for potential effects to refuge biological resources and environmental quality. These potential effects would be documented in "chemical profiles" (see Appendix G). Pesticide uses with appropriate and practical best management practices (BMPs) for habitat management as well as cropland/facilities maintenance would be approved for use on refuge lands where there likely would be only minor, temporary, and localized effects to species and environmental quality based upon non-exceedance of threshold values in chemical profiles. However, pesticides may be used on refuge lands where substantial effects to species and the environment are possible (exceed threshold values) in order to protect human health and safety (e.g., to counter mosquito-borne disease).

Land acquisition and habitat protection. The approved refuge boundary for the Tualatin River National Wildlife Refuge totals 7,370 acres. As of June 2011, the Service had secured management authority over 2,215 acres. This authority was secured through fee title land acquisition, purchase of conservation easements, and management agreements. During the 15-year life of the CCP, the Service would continue actively securing management authority over lands and waters within the approved refuge boundary to protect habitat for native fish, wildlife, and plants and to provide opportunities for compatible wildlife-dependent public use. This high-priority effort would be accomplished with available funding under current management authorities, and would continue to be exclusively on a willing-seller basis.

Some residences and outbuildings acquired when lands were purchased for the refuge would be used to house refuge personnel, provide offices for Service personnel, and provide storage space. Outbuildings included with newly acquired lands would be opportunistically considered for reuse (e.g., to shelter environmental education activities or store equipment and supplies) or removed.

Partnerships. It is essential to partner with others to conduct programs and accomplish goals and objectives on national wildlife refuges. Tualatin River National Wildlife Refuge actively partners with a number of organizations, including other public agencies, nonprofit conservation organizations, schools, private businesses, and others to implement current programs. Partners provide funding, equipment and supplies, special expertise, and volunteers (see further discussion below). These partnerships would continue in the future.

Public uses and facilities in Atfálat'i Unit. At least the same types of public use opportunities and facilities currently available in the Atfálat'i Unit (see Section 2.3.2, Summaries of Alternatives) would continue to be available in the future under all CCP alternatives. Depending upon funding levels, the magnitude of these opportunities could change (e.g., changes could result in the numbers/frequency of programs offered, or the days or hours of operation).

Participation in planning and review of regional development activities. The Service would continue to participate in local planning and studies pertaining to future commercial, industrial, residential, and other urban development; transportation; recreation; contamination; and other potential concerns that may affect refuge resources. This includes maintaining relationships with local jurisdictions, other agencies, and private groups to stay abreast of ongoing planning, studies and current and potential developments. Outreach and education would continue to be used to raise awareness of refuge resources and their dependence on a healthy and functioning ecosystem.

Quality recreation programs. Refuge System policy provides specific criteria for managing compatible wildlife-dependent recreational uses (605 FW 1). This policy defines quality recreational programs as ones that:

- Are safe, accessible, and available to a diversity of citizens, and use facilities that blend into the environment;
- Promote responsible behavior and compliance with laws and regulations;
- Promote stewardship and conservation, understanding and appreciation of nature, and the refuge's role in resource management and conservation;
- Provide reasonable opportunities to experience wildlife;
- Minimize conflicts with fish, wildlife, and their habitats, other public uses, and neighboring landowners; and

- Use visitor satisfaction to define and evaluate programs.

Refuge programs would be developed and managed to ensure that high-quality opportunities are provided for all visitors.

Refuge revenue sharing. The Refuge Revenue Sharing Act provides a mechanism to make payments to counties in lieu of taxes. Lands acquired by the Service are removed from county tax rolls. However, this Act, amended in 1978, allows the Service to offset the tax losses by annually paying the county or other local units of government an amount that often equals or exceeds that which would have been collected from taxes if the lands had been in private ownership.

Regulatory compliance. Prior to implementation, all activities in all alternatives would undergo appropriate reviews and consultations. Permits and clearances would be secured as necessary to comply with legal and policy requirements.

Response to mosquito-borne disease. Mosquito populations on refuge lands would continue to be allowed to fluctuate and function unimpeded unless they pose a threat to human health. Mosquitoes inhabiting the refuge's aquatic habitats are native invertebrates that provide a forage base for fish and wildlife, including migratory birds and anadromous fish. To protect human health, the state or a local vector control agency would be allowed to control mosquito populations on refuge lands. Pesticide treatments (larvicides, pupacides, or adulticides) would be allowed on refuge lands only if local, current population monitoring and/or disease surveillance data indicate refuge-based mosquitoes pose a health threat to humans. Mosquito treatments would be in accordance with IPM principles applicable to all pests. Pesticides proposed for mosquito control would use appropriate and practical BMPs, given potential effects documented in chemical profiles. Under Service policy, pesticides may be used on refuge lands for mosquito control even though substantial effects to species and the environment are possible (i.e., exceed threshold values) in order to protect human health and safety.

The mosquito management compatibility determination in Appendix B provides details regarding allowed mosquito population monitoring, disease surveillance, and treatments. As noted earlier, Appendix G, describes the refuge's IPM program, which is applicable to all pests, including mosquitoes.

Following adoption of this CCP, the refuge would develop a disease contingency plan to address responses to mosquito-borne disease outbreaks on and/or adjacent to refuge lands. Much of the information contained in the compatibility determination for mosquito management would be incorporated with additional specificity, where necessary, in this plan. This plan would also include information on the history of mosquito-borne diseases on and/or adjacent to the Refuge as well as measures to protect refuge visitors, Service-authorized agents, and Service employees when a health threat or emergency is identified by health officials.

Restoration of ruderal habitats. The refuge contains many tracts of land that consist of fallow farmland, undeveloped lands that contain mainly nonnative vegetation, or lands that are otherwise not restored to native habitat types. These lands include both uplands and wetlands in degraded condition. On many of these tracts, the refuge has begun pretreatment work to restore native habitat types. Pretreatments may include mowing, discing, removal of nonnative trees, application of herbicide to remove nonnative plants, or other activities. These pretreatments are conducted with the expectation that the area would be restored to specific native habitat types as described in the habitat

goals listed below in this chapter. There are currently 181 acres of ruderal upland and 68 acres of ruderal wetland that would be restored to native habitat types.

Site restrictions. Selected tracts of land within the refuge boundary are encumbered with legal restrictions that limit the manner in which those tracts can be managed for fish, wildlife, and public use (see Appendix J). These site-specific limitations originate with management agreements and mitigation requirements (USFWS 1992a, 2010d). These site restrictions are common to all CCP alternatives for the refuge.

Sound professional judgment. Decisions regarding refuge management and actions taken to carry out these decisions would continue to be based on sound professional judgment. Federal regulations in 16 United States Code (USC) 668-668ee define sound professional judgment as "a finding, determination, or decision that is consistent with principles of sound fish and wildlife management and administration, available science and resources, and adherence to the requirements of the National Wildlife Refuge System Administration Act of 1966 and other applicable laws. Included in this finding, determination, or decision is a refuge manager's field experience and knowledge of the particular refuge's resources."

Step-down management plans. This CCP provides broad, long-range guidance for overall management of the refuge and its principal programs. Further work, including more data gathering and more detailed analyses, would be needed to develop more specific guidance for selected programs and elements. In these cases, step-down management plans would be developed. Step-down management plans would satisfy NEPA requirements and other relevant compliance requirements, and the development of these plans would include appropriate opportunities for public involvement. The following plans are scheduled for development, regardless of which alternative is selected for implementation.

Disease contingency plan. This plan would be developed in partnership with mosquito abatement, public health, and animal health authorities from the State of Oregon, Washington County, and Yamhill County. This plan would describe mosquito abatement, avian influenza, and other public and wildlife health threats. It is scheduled for completion in 2015.

Elk management plan. This plan would be developed in partnership with the Willamette Valley National Wildlife Refuge Complex and ODFW. It would describe how elk would be managed on national wildlife refuges in the Willamette Valley. Consideration of elk viewing and/or hunting opportunities, as appropriate, would be included.

Facilities management plan. This plan would be developed within 5 years of the completion of the CCP. The plan would include: 1) preparation of a historic buildings assessment; 2) evaluation of quarters buildings to determine number needed, best locations, and maintenance costs; and 3) evaluation of potential locations for a small administrative and maintenance facility at the Wapato Lake Unit.

Fire management plan. The refuge's 2008 fire management plan is being revised and updated. The current plan solely addresses fire suppression and pile burning. The updated plan would address the need for prescribed fire to support established habitat communities and would be developed in consultation with DEQ and concurrently with the CCP. See Appendix O for the draft revised fire management plan.

Inventory and monitoring plan. The Refuge System Administration Act charges the Service to "monitor the status and trends of fish, wildlife, and plants in each refuge." The refuge would participate in development of an inventory and monitoring plan as part of a larger effort in the Willamette Valley. This plan would provide guidance for establishment of baseline inventories and subsequent monitoring activities to ensure they use common standards and are conducted with appropriate statistical rigor. These inventory and monitoring efforts would be designed to address refuge information needs for adaptive management. Data gathered would feed into efforts across larger geographic areas to detect ecological changes caused by pollution, development, climate change, and other major environmental stressors.

Support the protection and recovery of federally listed, state-listed, and other special-status species. The refuge is undertaking projects to enhance and restore native prairie and savanna habitat types that may support recovery of federally and state-listed plant species, such as Bradshaw's lomatium, Kincaid's lupine, Nelson's checker-mallow, Willamette daisy, and others. Whenever possible, as these projects proceed, planting and maintenance of these species would be conducted in accordance with applicable recovery plans to help facilitate downlisting or delisting. Restoration and maintenance of in-stream, off-channel, and other habitat types may benefit various native fish species including upper Willamette River Chinook salmon, Oregon chub, Pacific lamprey, coastal cutthroat trout, and upper Willamette River steelhead. In addition, most habitat types encountered on refuge lands could support some or all life phases of any number of listed or special-status species such as bald eagle, band-tailed pigeon, Fender's blue butterfly, streaked horned lark, northern red-legged frog, northwestern pond turtle, willow flycatcher, and others. When planning and implementing various restoration projects, consideration would be given to strategies that would promote healthy populations of these species.

Urban refuge. The refuge is one of a handful of urban national wildlife refuges and was one of the first in the Refuge System specifically established under the Service's Urban Refuge Policy (Smith 1991; USFWS 1996). This policy states, in part, that the primary purpose for establishing urban refuges is to:

- "foster environmental awareness and outreach programs to develop an informed and involved citizenry that will support fish and wildlife conservation";
- " … provide public use benefits associated with fish and wildlife resources that include … bird watching, fishing, scientific research, environmental education, open space in an urban setting, and protection of cultural resources"; and
- include "education, interpretation and wildlife-oriented recreation … opportunities for partnerships with State and local governments, private individuals, or citizens groups … [and a] potential role of nonprofit or volunteer groups for management purposes."

The Refuge would continue in the future to be managed consistently with the guidance contained in the Urban Refuge Policy.

Volunteers. With the exception of law enforcement, personnel management, contracting, and select other functions prohibited by law, volunteers are involved in almost all aspects of the refuge's habitat and wildlife, and visitor services programs. In fiscal year 2010, volunteers donated over 15,000 hours of support to the refuge (USFWS 2010a). This equals more than seven full-time personnel and is valued at more than $327,000 (national volunteer value = $21.79/hour [Independent Sector 2011]).

As with partnerships, the level of volunteer involvement is essential to the variety, number, and quality of programs offered through the refuge. Volunteer contributions are especially valuable during times of static or declining budgets, and when grants and other funding are harder to secure. However, volunteers are not without cost. The success of the volunteer program relies heavily on management and oversight by the refuge's visitor services manager, the Friends of the Refuge, short-term interns, and grant-funded staff. Regardless, the refuge would continue in the future to encourage and support a large and active volunteer program.

Wapato Lake conceptual management. The Wapato Lake Unit was established in 2007 to restore the historic lake bed for the purpose of improving habitat conditions for a number of native species. The Wapato Lake Unit contains portions of the Tualatin River and tributary streams that may support listed fish species, as well as migratory birds including breeding landbirds and waterfowl species. It is the intent of the Service to restore the lake bed to protect, manage, and restore habitats for migratory birds, fish, and other native wildlife of the Willamette Valley (USFWS 2007b).

Management of this unit remains mostly conceptual as further analysis of the area is required before making specific management decisions on habitat restoration and public use opportunities. Future management decisions would support the purposes for which the Tualatin River National Wildlife Refuge was established as described in the 2007 *Tualatin River National Wildlife Refuge Proposed Wapato Lake Unit Land Conservation Plan and Environmental Assessment* (USFWS 2007b).

Key factors in establishment of the unit were to:

- Contribute to efforts across the Tualatin River Basin to improve watershed health and function;
- Protect patches of remnant rare native habitat such as herbaceous and scrub-shrub wetlands;
- Allow for the restoration of rare native habitat;
- Protect migratory bird habitat, especially wintering waterfowl and breeding neotropical songbirds;
- Improve and protect habitat for anadromous fish;
- Provide opportunities for people of all ages to enjoy wildlife-dependent recreation; and
- Enhance protection of cultural resources.

Currently, the Wapato Lake Unit is composed mostly of land that has been farmed since the 1930s. The land is mostly agricultural fields that, when left alone, are invaded by reed canarygrass that forms a monoculture. Reed canarygrass is an invasive plant that likes disturbed, moist soil conditions, and would prevent any native plants from becoming established. It does this by overcrowding the site and taking essential nutrients from the soil and water that would otherwise be used by native plants. The levees that were constructed to facilitate delivery of water to the lake bed during summer months are overrun with stands of Himalayan blackberry. The blackberry makes it nearly impossible to navigate the levees by foot, and they are also completely inaccessible by all-terrain vehicle (ATV) or other wheeled vehicles for maintenance purposes. The canals themselves are filled with water during the winter from the creeks and also during the summer months during irrigation. These canals may contain some fish species and invertebrates. Overall, due to the severity of the reed canarygrass and Himalayan blackberry invasion, it is unlikely that the Wapato Lake Unit currently supports a high diversity of species. However, the potential for restoring this area to a mixture of riparian forest, and scrub-shrub and herbaceous wetlands, is extremely high, and there are vast benefits to trust resources, including migratory birds and listed species. Restoration of this

historic lake bed would lead to a diverse and rich area that would protect, restore, and provide a diversity of habitats for migratory birds, including songbirds, wading birds, shorebirds, wintering waterfowl, and resident and anadromous fish.

To help determine the level of restoration needed at Wapato Lake, the Service has engaged the United States Geological Survey (USGS) to conduct studies to assist with the refuge's planning efforts. Actual management activities of the Wapato Lake Unit would be determined based upon adaptive management and the outcome of the Wapato Lake water management planning study.

While there are many unknowns for the future of Wapato Lake, there are some things that would occur regardless of the restoration direction the Services chooses to take. Interim goals, as defined in the 2007 *Tualatin River National Wildlife Refuge Proposed Wapato Lake Unit Land Conservation Plan and Environmental Assessment*, reflect the core mission of the Service to protect wildlife resources and the purpose for which the Wapato Lake Unit was established. There would continue to be cooperative farming on the lake bed to help control and eradicate reed canarygrass and other invasive species, and the refuge would provide public use and focus on habitat restoration.

Wapato Lake Water Management Planning Study. The Service is coordinating with the USGS's Oregon Water Science Center and others to conduct studies and evaluations to support planning for the Wapato Lake Unit (Buccola et al. ca. 2010). Results from these studies would allow the refuge to better define and evaluate the effects of water management and associated habitat restoration alternatives for Wapato Lake to benefit the habitat and species, as mentioned in the above section. These studies and evaluations would continue under all alternatives.

Interim water management at Wapato Lake. Water retention in and discharge from Wapato Lake would continue as they have in the recent past until a more detailed habitat management plan can be completed. That is, rain and naturally inflowing water would be allowed to fill the lake bed during the fall and winter. In the spring, the lake bed would be dewatered by pumping out and discharging water into the Tualatin River to allow cooperative farming to occur as an interim form of habitat management. On-going maintenance and repair of existing infrastructure would occur to the best of our ability and as appropriate, and no pumped discharges would be made with the large pump between May 1 and October 31 each year without approval of DEQ.

Although the Service recognizes the importance of irrigation water to the farming community, the delivery of irrigation water is not part of the Refuge System's mission or the official purposes for establishing the Tualatin River National Wildlife Refuge. Federal legislation mandates that, first and foremost, the mission of the Refuge System is wildlife conservation. In addition, before being allowed, any other use of a national wildlife refuge must first be determined compatible with the purposes for establishing the refuge. Regulations and policy establish specific guidance for making this determination.

Water quality. The Tualatin River is listed as a "water quality limited" waterway and as such was assigned a series of total maximum daily loads (TMDLs) for temperature, pH, chlorophyll a, bacteria, and dissolved oxygen. The existing TMDLs are currently being revised by DEQ. The refuge would continue to work with DEQ and other partners to address issues related to water quality and TMDLs in the Tualatin River.

Wilderness review. Service policy requires that a wilderness review be completed for each refuge as part of the CCP process. This review includes three phases: inventory, study, and recommendation. If

the wilderness inventory determines that some refuge lands and/or waters satisfy minimum criteria for wilderness designation, wilderness study areas are designated and the review enters the second (study) phase. See Appendix D for more information on the refuge's wilderness review, which recommended that the refuge not undergo further study for inclusion into the wilderness system because it does not meet specific criteria required for wilderness designation.

Wildlife-dependent public uses. The Improvement Act identified six wildlife-dependent public uses. They are: hunting, fishing, wildlife observation and photography, and environmental education and interpretation. These six wildlife-dependent public uses are to be given special consideration in refuge planning and management, and opportunities to allow these six uses are to be considered in each refuge CCP.

It is expected that participation in refuge visitor service programs would instill a sense of wonder; cultivate a connection with nature; foster a lifelong relationship with the refuge and the Refuge System; encourage a conservation ethic; and enhance the public's understanding of and appreciation for fish, wildlife, plants, and their habitats, as well as of refuge management programs to conserve these biological resources.

2.3.2 Summaries of Alternatives

A brief description of each alternative follows. Table 2-1 summarizes all three alternatives for comparison. All of the actions described in Section 2.3.1, Features Common to All Alternatives, would occur with each alternative and are not repeated here. Maps displaying the habitat types and visitor services features associated with the three alternatives can be found in Appendix P. Changes in habitat types and restoration objectives were derived from the philosophy of creating larger blocks of contiguous habitat types to reduce fragmentation and increase connectivity among habitat patches. In some instances we propose to eliminate small patches of rare habitat in favor of another habitat type that would result in less fragmentation. We would then enhance and/or restore more of the rare habitat type in another location to achieve the same goal.

2.3.2.1 Alternative 1 (No Action)

Alternative 1 describes continued implementation of the refuge's current management program and philosophy. This is known as the "No Action" Alternative.

Habitat and Wildlife

The refuge would continue efforts to acquire, restore, and conserve wetlands and other habitats to benefit native fish and wildlife resources (see Appendix P, Map 8). Migratory birds, including wintering waterfowl, would remain a focus.

Habitats on the refuge would be actively managed. A large focus of management would be on wetland habitats where levees, water diversions, water control structures, pumps, canals, and ditches would be used to manage water levels to mimic historic seasonal flooding and draining cycles. Wetland basins would be periodically mowed, disced, and/or selectively treated with herbicides to mimic natural disturbance cycles, limit plant succession, and suppress invasive plant species.

Future habitat restoration would consider soils, elevation, hydrology, adjacent relic habitats, habitat connectivity across the landscape, and other factors when determining which habitats to restore and manage on the refuge.

Refuge habitats, such as prairies, oak savannas, wetlands, and forests would be restored using a suite of techniques. These include: removal of nonnative plants; planting native grasses and forbs; planting native shrubs and trees; and weed control. Wildfire suppression would remain the only element of the refuge's fire management program. A cooperative farming program would provide winter forage for migratory birds and other wildlife and suppress invasive species as an interim measure prior to restoration.

The refuge would continue to monitor, protect, restore, and/or control selected fish and wildlife species. The screened diversion and fish ladder on Chicken Creek would be operated to protect migrating fish. The refuge would plant Nelson's checker-mallow to assist with recovery of this threatened plant species. Problem animals, such as beavers, nutria, and feral cats, would be removed.

Visitor Services

The refuge would continue to offer quality wildlife observation and photography, environmental education, and interpretation programs with an emphasis on serving the local urban population on the Atfálat'i Unit (see Appendix P, Map 11). There would remain no hunting or fishing opportunities. Programs would be supported by existing facilities. The refuge would offer teacher training and a handful of special events. There would continue to be no visitor activities or facilities offered at other refuge units. With a growing urban population in the Portland area, the refuge's popularity, and continued promotion and awareness of the refuge, it is expected that visitation would gradually increase over the next 15 years.

Administration

Existing staffing levels would remain the same, with six full-time permanent employees. Additional seasonal employees and other positions would continue to be filled as monies become available both from discretionary funds and from partners and grants.

2.3.2.2 Alternative 2 (Proposed Action)

Alternative 2 is the Service's draft "Preferred Alternative." This alternative represents a balanced approach among the many competing needs and issues that the refuge currently faces and is likely to experience in the next 15 years.

The refuge is currently composed of a mosaic of fragmented habitats. This proposed action would strive to combine some of these fragments into larger contiguous blocks of native habitat types within the landscape and also restore relic or disappearing habitat types (see Appendix P, Map 9). This alternative would benefit imperiled species that rely on prairie, scrub-shrub wetland, and oak savanna habitats. It would capitalize on opportunities to work with regional partners and increase the continuity of habitats as well as recreational connections beyond the boundaries of the refuge.

Habitat and Wildlife

Alternative 2 is largely driven by the typical hydrologic flows in the Tualatin River, with limited water control manipulation on the refuge. Prescribed fire would be added as an additional habitat management technique.

The habitat types of the Tualatin River, primarily riparian forest and herbaceous wetland, would not substantially change under this management alternative. In the upland, oak savanna and ruderal habitats would convert to mixed forest. The oak savanna that is currently identified on the refuge is habitat where management efforts have been made to begin converting ruderal uplands to oak savanna primarily through the treatment of invasive species and by some planting. The habitat is not mature oak savanna. However, through this CCP, the refuge has identified some areas that would provide more benefit as mixed forest. The conversion of oak savanna to mixed forest would not result in a “true” loss of oak savanna. The limited water manipulation on the Tualatin River Unit would continue. On the Rock Creek Unit, the ruderal wetlands would be converted to scrub-shrub wetland. Other actions included in this alternative intend to restore a mosaic of wetlands, riparian forests, oak savannas, prairies, and streams.

Habitats on the Riverboat Unit would largely remain the same as in Alternative 1, except that active water control management that artificially maintains a 30-acre herbaceous wetland would be discontinued. The wetland would be allowed to evolve into a mixture of wet prairie and scrub-shrub wetland. Approximately 4 acres of riparian forest on this unit would convert to wet prairie.

At the Atfálat’i Unit, Chicken Creek would be restored to its historical footprint. The current channelized Chicken Creek would be filled and the existing narrow band of riparian vegetation removed. The existing water diversion structure would be relocated to the east, allowing water management on approximately 158 acres of herbaceous wetland, 69 acres less than what is currently managed. These wetlands would be enhanced (e.g., recontouring ground surface and updating water control structures) to manage them more effectively. The remaining acres would be converted to a mixture of wet prairie, oak savanna, and scrub-shrub wetland. An additional 20 acres located in the northern portion of the unit would convert from seasonal wetlands and wet prairie to bottomland riparian forest.

Management of the Onion Flats Unit would take advantage of soils that are rare in the Willamette Valley and historically supported the disappearing scrub-shrub wetland type. Assuming further land acquisition occurs, Onion Flats Unit would convert from cooperative farming into a scrub-shrub wetland and oak savanna. These changes could benefit declining dusky Canada geese and the threatened Nelson’s checker-mallow plant. This alternative would also include restoring channelized Rock Creek to its historical channel.

Management of the Wapato Lake Unit would include a mixture of free-flowing hydrology and intensive water control with the intention of a more natural hydrology being implemented over the long term. Actual management activities of the lake bed would be determined based upon a Wapato Lake water management planning study.

Visitor Services

In this alternative, existing visitor service programs would remain and new opportunities would be added (see Appendix P, Map 12). A junior waterfowl hunt program would be developed in the

northern portion of the Riverboat Unit. Other expanded visitor services would include: one to three additional wildlife photography blinds; an environmental education off-trail study area; a fishing program from the River Overlook; and a nature exploration play area. The refuge would explore opportunities to connect to regional trail projects.

At the Wapato Lake Unit, opportunities for public use, such as hunting, photography, fishing, wildlife observation areas, a nature trail, and interpretive exhibits would be explored as adequate land and access are acquired and habitat restoration decisions are made. In the near term, the refuge would pursue environmental education and wildlife-dependent recreation opportunities in the community.

Administration

Full implementation of Alternative 2, including increasing habitat restoration projects and public use opportunities, would require, at a minimum, six additional full-time permanent employees. The refuge would continue to pursue additional staff over the life of the CCP.

2.3.2.3 Alternative 3

Under Alternative 3, the refuge would be managed with the least amount of water manipulation, instead relying on natural hydrologic cycles of the area. Habitat restoration and management would favor restoring large patches of contiguous riparian forest and mixed forest, with smaller areas of scrub-shrub wetlands (see Appendix P, Map 10). Prescribed fire would be added as an additional habitat management technique. Visitor services would focus less on expansion of opportunities and more on improving the quality of the existing programs.

Habitat and Wildlife

In the Tualatin River Unit, the existing 118 acres of riparian forest and ruderal habitats would be expanded to cover approximately 148 acres. The remainder of the unit would be covered with mixed forest. At the Atfálat'i Unit, all but 66 acres of the current 251 acres of ruderal and herbaceous wetland would be converted to riparian forest and scrub-shrub wetlands. The oak savanna, emergent wetland, and wet prairie in the northeastern portion of the unit would be converted to expanded riparian forest.

Like Alternative 2, this alternative would remove cooperative farming from the Onion Flats Unit. The hydrology would result in the same scrub-shrub wetland as in Alternative 2. The upland areas surrounding the scrub-shrub wetland would be managed to become mixed forest. At the Riverboat, Rock Creek, and Wapato Lake Units, actions under Alternative 3 would remain the same as those described in Alternative 2.

Visitor Services

As in Alternative 2, the refuge would continue to explore opportunities for connecting to regional trail projects under Alternative 3. At the Wapato Lake Unit, opportunities for public use on the refuge would be explored as adequate land and access are acquired and habitat restoration decisions are made. In the near term, the refuge would pursue education and recreation activities in the community. Alternative 3 provides a more limited expansion of the environmental education and recreation programs on the Atfálat'i Unit than Alternative 2. Alternative 3 does not include an off-trail study area, nature play area, junior waterfowl hunt, additional photo blinds, or a fishing

program. However, more emphasis would be placed on improving the quality of public use through evaluation of existing programs (see Appendix P, Maps 11 and 12).

Table 2-1. Summary of Alternatives for Comparison

Key Indicators of Comparison	Alternative 1 Current Management (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Alternative Action)
Acres of Each Habitat Type Under Various Alternatives*			
Bottomland riparian forest	388	413	657
Mixed coniferous/deciduous forest	49	126	178
Oak savanna	149	194	109
Wet prairie	27	129	45
Herbaceous wetland	294	187	64
Scrub-shrub wetland	20	200	196
Crops and improved pastures	942	0	0
Ruderal uplands	181	0	0
Ruderal wetlands	68	0	0
Developed land (buildings, etc.)	62	60	60
Water (river)	24	24	24
Restored acres of undetermined native habitat types at Wapato Lake Unit	0	871	871
Total acres*	2,204	2,204	2,204
Miles of Each Habitat Type Under Various Alternatives			
River frontage	7.2	7.2	7.2
Streams—maintain	4.0	1.4	1.4
Streams—restore	0	2.7	2.7
Backwater slough—maintain	0.9	0.9	0.9
Backwater slough—restore	0	1.6	1.6
Species Posing Management Challenges			
Nonnative, invasive, and pest plants	Continue IPM, without prescribed fire. Immediate early detection and rapid response actions to eliminate purple loosestrife, giant hogweed, garlic mustard, and Japanese knotweed if found.	Same as Alternative 1 and use prescribed fire.	Same as Alternative 2.
Nonnative, invasive, and pest animals	Continue IPM, plus eliminate problem beavers, feral cats, and	Same as Alternative 1.	Same as Alternative 1.

Table 2-1. Summary of Alternatives for Comparison

Key Indicators of Comparison	Alternative 1 Current Management (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Alternative Action)
	nutria. Immediate action to eliminate New Zealand mud snail, snapping turtle, and zebra mussel if found.		
Mosquitoes	Continue to allow mosquito populations on the refuge to fluctuate and function unimpeded unless they pose a threat to human health. Mosquito treatments would be in accordance with IPM principles.	Same as Alternative 1, and develop mosquito component of disease contingency plan in cooperation with state and/or local vector control agencies.	Same as Alternative 2.
Canada geese	Continue to provide wintering sanctuary.	Same as Alternative 1, and work with partner agencies to implement regional plans and agreements.	Same as Alternative 2.
Roosevelt elk	Continue to take no management actions.	Work with partner agencies to develop elk management plan.	Same as Alternative 2.
Management of Special-status Species			
Wetland, riparian, and upland habitats and species	Continue to support recovery of Nelson's checker-mallow.	Continue to support recovery of Nelson's checker-mallow and explore options to assist recovery of other listed species.	Same as Alternative 2.
Aquatic habitats and species	Continue to maintain and operate weirs, fish passage, and fish screening structures.	Same as Alternative 1, and where appropriate remove culverts and other passage barriers during restoration efforts.	Same as Alternative 2.
Wapato Lake Management			
	Existing lake bed infrastructure would be maintained. Lake water levels and downstream discharges would continue as in the past.	Interim management same as Alternative 1. Long-term management would include more natural, free-flowing hydrology.	Same as Alternative 2.
Public Information and Outreach			
General program	Continue to maintain	Expand information and outreach	

Table 2-1. Summary of Alternatives for Comparison

Key Indicators of Comparison	Alternative 1 Current Management (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Alternative Action)
	signs, brochures, websites, and limited media exposure.	materials to use broader range of techniques, more diverse use of social media, and aimed at a broader audience.	
Facilities and Access			
Facilities—Sherwood Units	Continue to maintain existing public use facilities.	Expand facilities to include: 1-3 additional wildlife photography blinds, 1 off-trail nature explore/play area, 1 off-trail environmental education study area.	Continue to maintain existing public use facilities.
Facilities—Wapato Lake Unit	Continue to have no facilities.	As habitat restoration proceeds, explore opportunities for observation areas, trails, interpretive exhibits, signs, photography blinds, and hunting and fishing facilities.	
Access—Sherwood Units	Continue to provide existing access to and within the Atfálat'i Unit.	Expand access to trails, blinds, and study/explore areas. Explore connecting refuge to existing regional trail systems. Conduct transportation and safety studies for new and existing access points.	Explore connecting refuge to existing regional trail systems. Conduct transportation and safety studies for new and existing access points.
Access—Wapato Lake Unit	No public access.	As habitat restoration proceeds, explore opportunities for public access to portions of the unit in support of compatible wildlife-dependent recreation and education.	
Refuge entrance and user fees	Refuge continues to have no entrance or user fees, but would continue to explore desirability of establishing an entrance fee.	Same as Alternative 1, plus explore desirability of user fees in support of waterfowl hunting, photo blind use, and special events and activities.	
Environmental Education			
Number of students served annually on refuge	1,900	5,000	1,900
Number of students served annually off-site	700	1,750	700

Table 2-1. Summary of Alternatives for Comparison

Key Indicators of Comparison	Alternative 1 Current Management (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Alternative Action)
Number of youth served in informal (non-classroom-based) education programs	800	2,000	800
Number of teacher workshops offered annually	2	2	2
Outreach to schools	Predominately schools within a 10-mile radius of Sherwood.	Expand to include schools within a 10-mile radius of Sherwood and Gaston.	
Number of volunteer naturalists trained annually in support of the education program	10	25	25
Education opportunities offered near the Wapato Lake Unit	None	Expand to offer teacher training, education materials to be housed at local schools, and education programs/events at locations within the community (e.g., schools, parks).	
Hunting and Fishing			
Hunting—Sherwood Units	Refuge would remain closed to hunting.	Junior hunt program would be developed on the Riverboat Unit. Includes 2 to 5 hunting blinds.	Refuge would remain closed to hunting.
Hunting—Wapato Lake Unit	Refuge would remain closed to hunting.	Explore opportunities for waterfowl hunting in concurrence with habitat restoration planning and implementation.	
Fishing	Refuge would remain closed to fishing.	Fishing program would be developed at the existing River Overlook on the Atfálat'i Unit.	Refuge would remain closed to fishing.
Urban Refuge Initiative			
Information clearinghouse for natural resources management		Provide information exchange on natural resource issues to encourage collaborative sharing within communities and organizations; agencies; businesses; and others.	
Information clearinghouse for environmental education		Provide information exchange and materials to educators, schools, and communities, including social science research supporting the benefits of nature-based education to people, with a focus on children.	

Table 2-1. Summary of Alternatives for Comparison

Key Indicators of Comparison	Alternative 1 Current Management (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Alternative Action)
Bring more urban citizens to the refuge to experience nature.		Identify barriers to connecting urban people to natural areas; hire youth in natural resource jobs; develop a transportation strategy to bring urban audiences to the refuge.	
Increase relevance of natural resources to urban citizens		Provide outreach that supports the value of natural resources for communities—for human health, economic health, watershed health; provide education materials that address conservation and community issues such as invasive species, pollinators, urban wildlife, and climate change.	

*All figures are based on GIS analysis using the data shown in the Alternatives maps in Appendix P.

2.4 Goals, Objectives, and Strategies

Goals and objectives are the unifying elements of successful refuge management. They identify and focus management priorities, resolve issues, and link to legal mandates (including refuge purposes) for managing a refuge, Service policies that step down from legal mandates (e.g., Improvement Act), and the Refuge System Mission.

A CCP describes management actions that help bring a refuge closer to its vision. A vision broadly reflects the refuge purposes, the Refuge System mission and goals, other statutory requirements, and larger-scale plans as appropriate. Goals then define general targets in support of the vision, followed by SMART (Specific, Measurable, Achievable, Results-oriented, Time-fixed) objectives that direct efforts into incremental and measurable steps toward achieving those goals. Strategies identify specific tools and actions to accomplish objectives.

The draft goals for Tualatin River National Wildlife Refuge for the life of the CCP, after its approval, are presented in the tables on the following pages. Each goal is followed by the objectives that pertain to that goal. Some objectives pertain to multiple goals and have simply been placed in the most reasonable spot. Similarly, some strategies pertain to multiple objectives.

The goal order does **not** imply any priority in this CCP. Priority actions are identified in the staffing and funding analysis in Appendix C.

Readers, please note the following:

The objective statements as written apply to the Service's Preferred Alternative, Alternative 2.

The objective statement identifies specific attributes (e.g., acreages) that vary in the other alternatives. How those items vary is displayed in the short table under each objective statement.

Below each objective statement are the strategies that could be employed to accomplish the objectives. Note the following:

- Check marks (✓) alongside each strategy show which alternatives include that strategy
- If a column for a particular alternative does not include a check mark for a listed strategy, it means that strategy will not be used in that alternative.
- Other symbols used in the following tables include:
  % percent sign
  > greater than
  < less than
  ≥ greater than or equal to
  ≤ less than or equal to

Refer to Appendix P, Maps 8 through 12, for maps of alternatives described below.

Goal 1: Maintain, enhance, and restore bottomland riparian habitat consistent with the historical range of variability representative of the Willamette Valley ecosystem to support breeding and migratory landbirds and other native species.

Objective 1.1 Enhance and maintain bottomland riparian forest

Throughout the life of the CCP, enhance and maintain 322 acres of bottomland riparian forest on Tualatin River National Wildlife Refuge for the benefit of breeding and migrating landbirds (e.g., Pacific slope flycatcher, yellow warbler) and a diverse assemblage of other native species (e.g., northern red-legged frog). Bottomland riparian forest is characterized by the following:

- >60% overstory canopy cover of trees (e.g., Oregon ash, bigleaf maple, Douglas-fir, grand fir) that are >50 feet tall (Altman 2000)
- >20% understory canopy cover of trees (e.g., willow, redosier dogwood, Pacific yew, cascara, and hazel) that are ≥12 feet tall
- Habitat patches >100 feet wide along streams (Altman 2000)
- 30%-80% understory cover of shrubs (e.g., snowberry, swordfern) 3-12 feet tall (Altman 2000)
- Herbaceous layer dominated by native grasses and forbs
- >5 snags/acre >6 inches diameter at breast height (DBH) with at least 2 per acre >10 inches DBH and 6 feet tall (Altman 2000)
- <20% cover of invasive plants (e.g., reed canarygrass, Himalayan blackberry, English ivy, English holly)

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	349	322	338
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological means, to control or eradicate invasive species (see Appendix G).	✓	✓	✓

Map invasive plant distributions every 5 years, during the spring and summer months when most plants are easily identified.	✓	✓	✓
Place protective tubes on naturally recruiting saplings/seedlings.	✓	✓	✓
Establish a permanent biological technician position to conduct habitat maintenance and perform habitat inventory and monitoring such as vegetation parameters and wildlife species diversity and density.		✓	✓
Rationale: Bottomland riparian forest is a rare, native plant community in the Willamette Valley. It provides habitat for over 100 migrating and breeding landbird species (Roth et al. 2004) and summer habitat near wetlands for native amphibians. Enhancing and/or maintaining existing bottomland riparian forest would reduce additional habitat fragmentation that is occurring in the valley at large and is consistent with refuge purposes and the Service's BIDEH Policy. It provides habitat connectivity and movement corridors for many species. Riparian areas often serve as off-channel backwater habitat for outmigrating salmonid species during winter flooding. In addition, riparian areas help to slow, absorb, and filter rainwater and runoff. Riparian areas also provide shade and woody structure to adjacent streams, rivers, and wetlands. Some of the areas to be maintained under this objective were recently restored and would not reach a mature growth form for many years. They would not achieve the full attributes described above, but would provide a diversity of benefits as they continue to grow. Riparian areas are important to achieve purposes of the refuge to conserve fish and wildlife. Mapping invasive species would provide for a targeted approach to their removal or control, and provide a basis for adaptive management when evaluating efficacy of treatments. By using IPM techniques to maintain and enhance this habitat type the refuge would provide enhanced habitat for a myriad of fish and wildlife species. Placing tree protective tubes on naturally recruiting trees would help to both identify and protect trees during invasive species control, and protect them from herbivory by deer, voles, and other species.			

Objective 1.2 Restore bottomland riparian forest

By 2020, bottomland riparian forest would be restored from a mixture of ruderal uplands, herbaceous wetland, and wet prairie habitat types. Then these 140 acres of bottomland riparian forest would be protected and maintained on the Tualatin River National Wildlife Refuge for the benefit of breeding and migrating landbirds (e.g., Pacific slope flycatcher, yellow warbler). Mature bottomland riparian forest is characterized by the following:

- >60% overstory canopy cover of trees (e.g., Oregon ash, bigleaf maple, Douglas-fir, grand fir) that are >50 feet tall (Altman 2000)
- >20% understory canopy cover of trees (e.g., willow, redosier dogwood, Pacific yew, cascara, and hazel) that are ≥12 feet tall
- Habitat patches >100 feet wide along streams (Altman 2000)
- 30%-80% understory cover of shrubs (e.g., snowberry, swordfern) 3-12 feet tall (Altman 2000)
- Herbaceous layer dominated by native grasses and forbs
- >5 snags/acre >6 inches DBH with at least 2 per acre >10 inches DBH and 6 feet tall (Altman 2000)
- <20% cover of invasive plants (e.g., reed canarygrass, Himalayan blackberry, English ivy, English holly)
- Swales connecting to rivers or streams to provide backwater fish habitat and species diversity

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**

Acres	39	90	318
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Pretreat for 1-2 years to exhaust non-native seed bank prior to restoration actions.	✓	✓	✓
Plant native tree and shrub species at a high stocking density of 870-1,450 plants/acre.	✓	✓	✓
Tube and mulch around planted saplings/seedlings to prevent girdling by small mammals and browsing by deer.	✓	✓	✓
Seed native herbaceous species using local genotypes, where needed.	✓	✓	✓
Where appropriate, construct swales using heavy equipment to increase plant diversity and connect with the river or nearby streams providing off-channel refugia for native fish.		✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological means, to control invasive species (see Appendix G).	✓	✓	✓
Monitor survival and growth of planted woody species.	✓	✓	✓
Map invasive plant distributions every 5 years, during the spring and summer months when most plants are easily identified.	✓	✓	✓
Establish a permanent engineering equipment operator position to restore riparian forest.		✓	✓

Rationale: See rationale for Objective 1.1.

Pretreatment is recommended for 1-2 years prior to planting native trees and shrubs in order to remove invasive plant seed sources in the soil. Pretreatments may consist of mechanical removal (e.g., mowing, discing) of invasive plant species, and/or application of Service-approved herbicide in accordance with the IPM plan (Appendix G). Planting trees and shrubs at a high density would ensure desired attributes of canopy and shrub cover are achieved while allowing for natural mortality of newly installed plants during the first few years. To ensure successful restoration, >70% survival of woody species is needed during the first year after planting. Tubing and mulching around newly planted trees and shrubs retain soil moisture, act as a weed barrier, and prevent girdling by small mammals. Where appropriate backwater swales can be constructed to provide floodplain connection with nearby streams or rivers. Backwater swales would enhance biodiversity of the flora and fauna in the area and provide enhanced habitat attributes for native resident and anadromous fish (Jeffres et al. 2008). Restoring this floodplain connection is one of the most critical areas to achieve benefit for aquatic, riparian, and upland species (ODFW 2006). Restored areas would not reach the full attributes described during the 15-year life span of the CCP, but management would be directed toward reaching those characteristics.

Goal 2: Maintain, enhance, and restore mixed coniferous/deciduous forest habitat to a historical range of variability representative of the Willamette Valley ecosystem in order to support breeding and migratory landbirds and other native species.

Objective 2.1 Enhance and maintain mixed coniferous/deciduous forest

Throughout the life of the CCP, enhance and maintain 46 acres of mixed coniferous/deciduous forest on the refuge for the benefit of breeding and migrating landbirds (e.g., orange-crowned warbler, Bewick's wren) and a diverse assemblage of other native species (e.g., black-tailed deer, northwestern salamander,

little brown bat). Mixed coniferous/deciduous forest is characterized by the following:

- 40%-60% canopy cover that is Douglas-fir–dominated with mixtures of grand fir, western redcedar, western hemlock, bigleaf maple, Garry oak, Pacific dogwood, Pacific yew, and red alder
- 10%-50% subcanopy trees (Spies and Franklin 1991)
- >30% cover in understory layer <15 feet tall consisting of snowberry, hazel, swordfern, and other shrubs
- >5 snags/acre >6 inches DBH with at least 2 per acre >10 inches DBH and 6 feet tall (Altman 2000)
- <20% cover of non-native invasive plants (e.g., Himalayan blackberry, English ivy)

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	49	46	49
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control or eradicate invasive species (see Appendix G).	✓	✓	✓
Map invasive plant distributions every 5 years, during the spring and summer months when most plants are easily identified.	✓	✓	✓
Use common forest health practices including prescribed fire and mechanical removals to create variable age structure.		✓	✓
Create snags, where needed, using mechanical methods (e.g., girdling).	✓	✓	✓

Rationale: Mixed coniferous/deciduous forests provide valuable habitat for breeding and migrating landbirds. Cavity-nesting birds such as woodpeckers benefit from snags and dying trees. Mannan and Meslow (1984) found higher abundance of bird species in forests with more and larger snags. Fallen trees and branches provide substrate for salamanders and nutrients for future plant growth. These habitats support a diversity of other native species (deer, bats, amphibians) to meet various life history requirements. Using common forest management strategies such as prescribed fire and mechanical manipulation would allow the refuge to create uneven age structures to support a variety of species needs. These strategies also address rising fire risks due to a changing climate, specifically hotter and drier summer conditions, which are projected to continue and accelerate into the future. Mapping invasive species would provide for a targeted approach to their removal or control, and provide a basis for adaptive management when evaluating efficacy of treatments.

Objective 2.2 Restore mixed coniferous/deciduous forest

By 2017, mixed coniferous/deciduous forest would be restored from ruderal uplands and oak savanna habitat types (ruderal species are the first to colonize disturbed lands) and then these 153 acres of mixed coniferous/deciduous forest would be protected and maintained on the refuge for the benefit of breeding and migrating landbirds (e.g., orange-crowned warbler, Bewick's wren) and a diverse assemblage of other native species (e.g., black-tailed deer, northwestern salamander, bat species). Mixed coniferous/deciduous forest is characterized by the following:

- 40%-60% canopy cover that is Douglas-fir–dominated with mixtures of grand fir, western redcedar, western hemlock, bigleaf maple, Garry oak, Pacific dogwood, Pacific yew, and red

alder
- 10%-50% subcanopy trees (Spies and Franklin 1991)
- >30% cover in understory layer consisting of snowberry, hazel, sword fern, and other native shrubs
- <20% cover of invasive plants (e.g., Himalayan blackberry, English ivy)

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	0	80	129
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
See strategies for Objective 2.1.	✓	✓	✓
Pretreat for 1-2 years to exhaust nonnative seed bank prior to restoration actions.	✓	✓	✓
Plant native tree and shrub species at a high stocking density of 870-1,450 plants/acre.	✓	✓	✓
Tube and mulch around planted saplings/seedlings to prevent girdling by small mammals and browsing by deer.	✓	✓	✓
Seed native herbaceous species using local genotypes, where needed.	✓	✓	✓
Monitor survival and growth of planted woody species.	✓	✓	✓
Map invasive plant distributions every 5 years, during the spring and summer months when most plants are easily identified.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Use prescribed fire as appropriate to control invasive species and reduce the build-up of unwanted fuel.		✓	✓

Rationale: See rationale for Objective 2.1. Restoring mixed coniferous/deciduous forest near or adjacent to existing forest could create larger tracts of contiguous forest habitat beneficial to forest-dwelling species (songbirds), creating larger travel corridors, and helping to prevent invasion from edge species such as brown-headed cowbirds. These strategies fit into refuge purposes and Service policy of maintaining biological integrity and species diversity.

Pretreatment is recommended for 1-2 years prior to planting native trees and shrubs in order to remove invasive plant seed sources in the soils. Prescribed fire could be used to control invasives and clear understories of unwanted fuels. Tubing and mulching around newly planted trees and shrubs retain soil moisture, act as a weed barrier, and prevent girdling. Planting trees and shrubs at a high density would ensure desired attributes of canopy and shrub cover are achieved while allowing for natural mortality of newly installed plants during the first few years. To ensure successful restoration, >70% survival of woody species is needed during the first year after planting. Restored areas would not reach the full attributes described during the 15-year life span of the CCP, but management would be directed toward reaching those characteristics.

Goal 3: Maintain, enhance, and restore oak savanna habitat to a historical range of variability representative of the Willamette Valley ecosystem in order to support breeding and migratory landbirds and other native species.

Objective 3.1 Enhance and maintain oak savanna

Throughout the life of the CCP, enhance and maintain 115 acres of oak savanna on the refuge for the benefit of breeding and resident landbirds (e.g., western bluebird, white-breasted nuthatch, acorn woodpecker) and a diverse assemblage of other native species (e.g., western gray squirrel, black-tailed deer). Oak savanna is characterized by the following attributes:

- Trees dominated by widely spaced (1/acre), mature Garry oak 16->40 inches DBH with cavities (Thilenius 1968)
- Native grass and forbs <3 feet tall in understory
- Few to no woody species in understory, where tree and shrub cover is <10%
- Viable and reproducing populations of listed plant species such as Nelson's checker-mallow
- <5% cover of invasive shrubs (e.g., Himalayan blackberry)
- <20% cover of nonnative grasses (e.g., velvet grass) and <10% nonnative forbs (e.g., Canada thistle, tansy ragwort)

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	149	115	109
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Use prescribed fire, with burn interval of 3-5 years, to reduce encroachment of woody species and to reduce thatch.		✓	✓
Plant listed species, as appropriate.	✓	✓	✓
Use mechanical treatments (e.g., mowing) during late summer/early fall to promote native herbaceous ground cover.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Use mechanical thinning to reduce density of oak with removals limited to trees <15 inches DBH.	✓	✓	✓
Use mechanical thinning to remove encroaching conifers, as needed.	✓	✓	✓

Rationale: Oak savanna is a rare and unique habitat in the Willamette Valley that has been reduced to <1% of its historic extent; it provides habitat for migratory birds that are high priority and specific to purposes of the refuge. Oak savanna habitat in the Willamette Valley supports five federally listed species (USFWS 2010b) and along with prairie habitats supports the greatest number of rare upland animals in the Willamette Valley (Titus et al. 1996). Fire historically maintained oak savanna habitat by removing competing vegetation and stimulating regeneration of native fire-associated plants. Fire suppression has allowed shrubs and conifers to encroach into oak savanna (ODFW 2006). Mowing during the fall season promotes native plant response while reducing the growth of undesirable trees and shrubs. Mowing during the fall would also reduce impacts to migratory birds by avoiding disturbance during their nesting cycle. Late summer/early fall prescribed fire on a rotational basis could help reduce encroachment of woody species such as Himalayan blackberry and poison oak and invigorate soil for establishment of native plants. Using IPM techniques ensures the best control of pest species with the

lowest possible impact to fish and wildlife resources (Appendix G). Planting listed species would support recovery of plant and butterfly species identified in the *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010b).

Objective 3.2 Restore oak savanna

By 2020, oak savanna would be restored from ruderal uplands and early successional riparian forest habitat types. These 111 acres of oak savanna would be protected and maintained on the refuge for the benefit of breeding and resident landbirds (e.g., western bluebird, chipping sparrow, grasshopper sparrow) and a diverse assemblage of other native species (e.g., coyote). Oak savanna is characterized by the following attributes:

- Scattered oaks (1/acre)of individual trees (Thilenius 1968) or tight small clusters
- 60%-80% ground cover composed of native grasses and forbs
- <5% cover of invasive shrubs (e.g., Himalayan blackberry)
- <20% cover of nonnative grasses (e.g., velvet grass) and <10% nonnative forbs (e.g., Canada thistle, tansy)

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	0	79	0
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Pretreat for 1-2 years to exhaust nonnative seed bank prior to restoration actions.	✓	✓	✓
Plant acorns, seedlings, and/or potted oaks in clusters of 10-100 at a spacing of 100-300 feet between clusters (5-50/acre).	✓	✓	✓
Use tubing or other protection to protect seedlings and saplings from herbivores.	✓	✓	✓
Plant native grasses and forbs.	✓	✓	✓
Conduct supplemental watering during first year.	✓	✓	✓
Plant appropriate listed species such as Nelson's checker-mallow and Willamette daisy.	✓	✓	✓
Use prescribed fire during spring to control nonnative species prior to initial planting.		✓	✓
Use prescribed fire during fall, with burn intervals of 3-5 years to reduce thatch and control invasive species.		✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Monitor plantings to determine survival and growth; replant if below target level or thin if too dense.	✓	✓	✓

Rationale: See rationale for Objective 3.1. Restoring oak savanna habitat is consistent with refuge purposes, the Service's mission to support the recovery of listed species associated with rare and unique habitat (e.g., Kincaid's lupine, Willamette daisy), and with Service policy of maintaining BIDEH. Pretreatment would involve mowing, burning, and spraying of invasive shrub and grass species to create open grassland settings for the establishment of native forbs and grasses associated with this habitat type, and would thus be beneficial to listed species adapted to the oak savanna community.

Prescribed fire use in the spring would help purge invasive plant seed banks prior to planting native species. Planting at a higher than desired density allows for natural mortality and provides a larger volume of oak substrate for wildlife while slow-growing oaks are small in the sapling stage. Oaks can later be thinned to achieve the final desired spacing. Placing tree protective tubes on trees would help to both identify and protect trees during invasive species control, and protect them from herbivory by deer, voles, and other species. Planting native grasses and forbs (wild flowers) is essential to restore the full suite of native vegetation for this plant community. Fall fires would be used to reduce thatch build-up and promote the health of native grass and forb communities. Protecting seedlings for up to 15 years would allow them to gain important establishment on the refuge. Intensive pretreatment is necessary to ensure establishment of a diverse native community and, in turn, the long-term success of oak savanna restoration. Planting and maintenance of listed species would aid in their recovery (USFWS 2010b).

Goal 4: Maintain, enhance, and restore native Willamette Valley wet prairie habitat, with an emphasis on management for rare and listed plant species.

Objective 4.1 Enhance and maintain native wet prairie

Throughout the life of the CCP, enhance and maintain 15 acres of wet prairie habitat on the refuge for the benefit of migratory birds (e.g., Wilson's snipe, northern pintail, American kestrel, western meadowlark) and a diverse assemblage of other native species. Wet prairie habitats are characterized by the following:

- Diverse community of native sedges, rushes, native grasses (e.g., *Deschampsia* sp.) that may be >3 feet tall, and a diversity of native forbs (e.g., camas, blue-eyed grass, popcorn flower) (Titus et al. 1996; USFWS 2010b)
- Intermittent ponding of water and saturated soils from November to April (Titus et al. 1996)
- Very few scattered shrubs or trees (especially Garry oak) >66 feet apart
- <5% total canopy cover of shrubs and trees
- <20% cover of invasive plants (e.g., reed canarygrass, cocklebur, blackberry, Bermuda grass)

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	27	15	15
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Maintain/protect relic oaks at very low density.	✓	✓	✓
Plant native grasses and forbs, where necessary, using local genotypes.	✓	✓	✓
Plant appropriate listed species, such as Nelson's checker-mallow.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Use prescribed fire at burn intervals of 3-5 years.		✓	✓
Conduct haying or mowing after July 15 to protect ground-nesting birds and reduce woody encroachment.	✓	✓	✓
Evaluate the potential for prescription grazing during later growing season.		✓	✓

Rationale: With less than 1% remaining, prairie habitats are one of the rarest plant communities in the

Willamette Valley and provide important habitat for breeding and migrating birds. Loss of prairie habitat is due in large part to conversion to agriculture and urbanization as well as fire suppression during the past 150 years. Enhancing and maintaining wet prairie would support the purposes of the refuge and BIDEH. Prairie habitats support federally listed plant species including Nelson's checker-mallow, and provide opportunities to contribute to recovery of other federally listed plants. Wet prairies generally occur in the floodplain on heavy, poorly drained soil (USFWS 2010b). Prescription grazing, mowing, and haying would occur in late season after seed has set and migratory bird nesting is complete. Determining which method to use would depend on best available science, objectives, and availability of resources. Generally, haying or mowing would occur only once per year. These techniques are necessary to set back succession of woody plant species, reduce thatch, control invasive plants, and stimulate new growth of native plants. Planting listed species would support recovery of plant and butterfly species identified in the *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010b). Historically, many habitats such as wet prairie were maintained by disturbance. The primary disturbance was fire, but also included flooding, wind, and storms (ODFW 2006). Regular disturbance regimes are essential to maintain prairie and prevent encroachment of woody species as well as to promote a diversity of native plant species. Burning can reduce thatch and stimulate growth and health of native plants. Timing of prescribed burns would depend on the objective of the burn (e.g., reduce thatch, address invasive species), weather, and plant response to burns, and may occur during spring, late summer, or fall. Mowing may be used in some years to control the growth of woody species, but it does not reduce thatch. Mowing should be conducted after July 15 to protect ground-nesting birds. By July 15, most bird species have completed nesting and young have fledged.

Objective 4.2 Restore native wet prairie

By 2025, wet prairie would be restored from herbaceous wetland and early successional riparian forest habitat types. Then the refuge would protect and maintain 114 acres of wet prairie on the refuge for the benefit of migratory birds (e.g., Wilson's snipe, northern pintail, green-winged teal) and a diverse assemblage of other native species. Wet prairie habitat types are characterized by the following:

- Diverse community of native sedges, rushes, and native grasses (e.g., *Deschampsia* sp.) that may be >3 feet tall, and a diversity of native forbs (e.g., camas, blue-eyed grass, popcorn flower) (Titus et al. 1996; USFWS 2010b)
- Intermittent ponding of water, and saturated soils from November to April (Titus et al. 1996)
- Very few scattered shrubs or trees (especially Garry oak) >66 feet apart
- <5% total canopy cover of shrubs and trees
- <20% cover of invasive plants (e.g., reed canarygrass, cocklebur, blackberry, Bermuda grass)

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	0	114	30
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Pretreat (e.g., herbicide, discing) for 1-2 years to exhaust nonnative seed bank prior to restoration actions.	✓	✓	✓
Use prescribed fire during spring to control nonnative species prior to initial planting.		✓	✓
Plant native grasses and forbs, where necessary, using local genotypes.	✓	✓	✓
Maintain/protect relic Garry oaks at low density.	✓	✓	✓

Plant listed species, as appropriate.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control or eradicate invasive species (see Appendix G).	✓	✓	✓
Where appropriate, construct swales using heavy equipment to increase plant diversity and connect with the river or nearby streams, providing off-channel refugia for native fish.		✓	✓
Use mechanical treatments to remove encroaching woody species.	✓	✓	✓
Evaluate the potential to use prescription grazing during later growing season.		✓	✓
Evaluate the potential use of prescription grazing, mowing, and/or haying after July 15 to protect ground-nesting birds.	✓	✓	✓
Use prescribed fire at burn intervals of 3-5 years.		✓	✓
Rationale: See rationale for Objective 4.1. Restoring wet prairie is consistent with refuge purposes and the Service's mission to support recovery of listed species associated with this rare and unique habitat, and it fits the Service policy of BIDEH. Pretreatment would involve a rotation of herbicide, discing, and prescribed fire over a 1-2 year period to exhaust nonnative seed banks and reduce aggressive invaders like reed canarygrass. This would prepare sites and better ensure the establishment of a diverse native community and, in turn, the long-term success of wet prairie. Planting listed species would aid in the recovery efforts as spelled out in the *Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington* (USFWS 2010b). Mechanical and chemical treatments such as mowing and spraying would reduce woody species and open up ground for native grasses and forbs. Periodic prescribed burns would maintain the integrity of the wet prairie, clearing thatch, encroaching on nonnatives, and invigorating growth of natives species. Restoration sites would be selected considering connectivity with existing or to-be-restored prairie, both on and off refuge lands. Intensive pretreatment is necessary to ensure establishment of a diverse native community and, in turn, the long-term success of wet prairie restoration.			

Goal 5: Maintain, enhance, and restore a diversity of wetlands to support migratory landbirds, waterbirds, and shorebirds with special emphasis on wintering waterfowl.

Objective 5.1 Enhance and maintain herbaceous wetland
Throughout the life of the CCP, enhance and maintain 187 acres of herbaceous wetland on the refuge for the benefit of migrating and wintering waterfowl (e.g., northern pintail, cackling Canada goose, tundra swan) and a diverse assemblage of other native species (e.g., waterbirds, shorebirds). Herbaceous wetlands are characterized by the following: • Most wetlands with shallow water depths averaging 4-18 inches deep from October to June • Other wetlands with deeper water averaging 18-48 inches deep, sometimes year-round • >60% cover of desirable and/or native wetland plants including moist-soil annuals (e.g., smartweeds, wild millet, water plantain), wapato, sedges, and rushes • In deeper water, >50% cover of submergent plants (e.g., *Potamogeton* sp., *Callitriche* sp.) • <20% cover of native emergent species (e.g., cattail, bulrush) that are >5 feet tall • <30% cover of undesirable/invasive plants including reed canarygrass • Presence of large woody debris

• Minimal damage to wetland infrastructure by nutria			
Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	294	187	64
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Initiate flood-up to full pool from October through December.	✓	✓	✓
Irrigate, as needed, during summer to stimulate early season wetland annual plants and/or control invasive species.	✓	✓	✓
Initiate drawdown of 10%-20% of seasonal wetlands in early April to provide mudflats for migrating shorebirds.	✓	✓	✓
Initiate drawdown of most seasonal wetlands between May and July to stimulate germination of moist-soil annual plants.	✓	✓	✓
Allow selected wetlands to dewater by natural evapotranspiration to provide extended wet season for BIDEH species.	✓	✓	✓
Where feasible, provide supplemental flooding throughout the growing season to control nonnative invasive plants (e.g., cocklebur) and promote moist-soil annual plants.	✓	✓	✓
Use mowing and/or herbicides to remove encroaching woody vegetation.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, water management, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Use mowing and discing as a disturbance regime to stimulate growth of desirable species.	✓	✓	✓
Reconfigure water control structures and dikes/levees where necessary, to promote more precise water level management.	✓	✓	✓
Install low-level berms, where necessary.	✓	✓	✓
Work closely with National Oceanic and Atmospheric Administration (NOAA) Fisheries in the design and operation of flashboards, spillways, and other refuge water-control structures to enable proper operation to benefit water management without adversely affecting special-status fish species.	✓	✓	✓
Use heavy equipment to recontour wetland basins to allow for complete drawdown and/or to promote water flow. Allowing for complete drainage would help reduce the presence of nonnative species such as reed canarygrass, bullfrogs and carp.	✓	✓	✓
Investigate the viability of using screens to exclude nonnative species such as bullfrogs and carp from wetlands.	✓	✓	✓
Use lethal control methods (e.g., shooting or trapping) to remove nutria and problem beaver.	✓	✓	✓
Where necessary, plant trees along wetland boundaries to provide a buffer from disturbance such as hunting on	✓	✓	✓

neighboring lands.			
Mow wetland margins prior to flood-up to provide waterfowl access to adjacent uplands.	✓	✓	✓
Use prescribed fire to reduce extent of emergent plants and/or remove encroaching woody species (e.g., willow, ash).		✓	✓
Install logs, large trees, or root wads for turtle basking and waterfowl resting and preening.	✓	✓	✓
Schedule strategic drawdowns to entrap invasive species such bullfrogs and carp.	✓	✓	✓

Rationale: Historically, herbaceous wetlands were a dominant feature on the landscape within the Willamette Valley, but considerable wetland loss has occurred due to conversion to agriculture, urban development, and changes in hydrology such as dam building and channelizing streams and rivers (Taft and Haig 2003). A multitude of native fish and other animals use wetlands for at least part of their annual life cycles. Seasonal herbaceous wetlands are essential for providing moist-soil plant food resources for migratory waterfowl and waterbirds, and amphibians and reptiles. Flood-up/drawdown scenarios provide foraging substrate for spring and fall migratory shorebirds. Maintaining most wetlands with shallow water would benefit waterfowl, shorebirds, and wading birds. Using various water management scenarios (drawdown and irrigation) would set back Bermuda grass and cocklebur growth/expansion. Summer irrigation is used to both control certain invasive species (e.g., common cocklebur) and to stimulate growth of moist-soil plants. Maintaining some wetlands with deeper water in a permanent or semipermanent condition provides habitat for overwater nesters such as pied-billed grebes, marshbirds, turtles, etc. Many shallow wetland areas would naturally convert to forested areas if encroaching vegetation were not controlled. Mowing or herbicide application is periodically required to set back woody vegetation and reinvigorate annual plants. Reconfiguring water control structures and dikes/levees, and installing low-level berms, would provide greater water-level management flexibility for wetland habitat rotations. Heavy equipment can be used to recontour wetland basins for a more diverse topography and to allow complete drawdown. Allowing for complete drawdown would help control invasive species such as carp and bullfrogs. Removal of nutria would protect management infrastructure and habitat from degradation. Native turtles would benefit from basking logs placed in many of the refuge's wetlands.

Objective 5.2 Enhance and maintain scrub-shrub wetland

Throughout the life of the CCP, enhance and maintain 20 acres of scrub-shrub wetlands on the refuge for the benefit of breeding migratory birds (e.g., willow flycatcher, red-winged blackbird, common yellowthroat, sora) and a diverse assemblage of other native species (e.g., northern red-legged frog, northwestern salamander). Scrub-shrub wetlands are characterized by the following:

- Water depths typically averaging 3-10 feet with some water remaining during most of the year
- Vegetation dominated by willow species, rose, and Douglas spirea with some Oregon ash, red-osier dogwood, black cottonwood, and other species
- Presence of large woody debris
- <20% cover of invasive plants (e.g., reed canarygrass)

Alternatives	Alt 1 (no action)	Alt 2 (proposed action)	Alt 3
Acres	20	20	20

Strategies Applied to Achieve Objective:	Alt 1	Alt 2	Alt 3
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Map invasive plant distributions at least every 5 years.	✓	✓	✓
Use prescribed fire to increase diversity in older stands.		✓	✓
Install logs, large trees, or root wads for turtle basking and waterfowl resting and preening structure.	✓	✓	✓
Rationale: Scrub-shrub wetlands are a unique habitat type in the Willamette Valley, characterized mainly by peat soils. Scrub-shrub wetlands are important habitats for breeding and migrating landbirds and waterbirds. When breeding, native amphibians require these important habitats for egg mass attachment on emergent vegetation. Prescribed fire can be used to invigorate vegetation communities and to create mosaics of habitat patches where there are monotypic willow stands. Removing some willows would create openings and increase heterogeneity/diversity in habitat structure. In consideration of preserving peat soils, prescribed fire use would be timed with water inundation cycles. Changing climate, especially hotter and drier summer conditions, are projected to continue and accelerate. This could affect the ability of these wetlands to remain wet throughout the summer months, bringing potential new management needs. The refuge would monitor changing conditions and consider alternative strategies as needed, and practicable. Mapping invasive species would provide for a targeted approach to their removal or control, and provide a basis for adaptive management when evaluating efficacy of treatments.			

Objective 5.3 Restore scrub-shrub wetland

By 2020, scrub-shrub wetlands would be restored from a mixture of ruderal wetlands, croplands, and herbaceous wetlands. The refuge would then protect and maintain 180 acres of scrub-shrub wetlands on the refuge for the benefit of breeding migratory birds (e.g., willow flycatcher, red-winged blackbird, common yellowthroat, sora) and a diverse assemblage of other native species (e.g., northern red-legged frog, northwestern salamander). The range of acres is due to the uncertainty of the direction of the Wapato Lake Unit restoration. As previously mentioned, restoration would be dependent on the outcome of a hydrology study currently being conducted by USGS. Scrub-shrub wetlands are characterized by the following:

- Water depths typically 3-10 feet with some water remaining during most of the year
- Vegetation dominated by willow species, rose, and Douglas spirea with some Oregon ash, red-osier dogwood, and black cottonwood
- Presence of large woody debris
- <20% cover of invasive plants (e.g., reed canarygrass)

Alternatives	Alt 1 (no action)	Alt 2 (proposed action)	Alt 3
Acres	0	180	176
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Pretreat (e.g., herbicide, prescribed fire, discing) for 1-2 years to exhaust nonnative seed bank prior to restoration actions.	✓	✓	✓
Create swales using heavy equipment.	✓	✓	✓
Install water control structures, spillways, levees, and/or low berms as necessary.	✓	✓	✓

Plant cuttings, plugs, and potted plants of native shrubs and trees.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Map invasive plant distributions at least every 5 years.	✓	✓	✓
Establish a permanent refuge operations specialist position to oversee restoration and operations at the Wapato Lake Unit.		✓	✓
See also strategies under Objective 5.1.	✓	✓	✓
Rationale: See rationale for Objective 5.2. Restoration of scrub-shrub wetlands would add and protect a significant amount of this unique habitat and associated species on the refuge in large contiguous tracts, helping to achieve refuge purposes and the Service policy of BIDEH. Restoration of scrub-shrub wetlands in the Onion Flats Unit is dependent on further land acquisition. Without further acquisition any restoration efforts would impact neighboring lands and restrict the full spectrum of restoration desired.			

Goal 6: Maintain, enhance, and, where feasible, restore streams and off-channel backwater slough habitats in order to benefit salmonids and other native aquatic species.

Objective 6.1 Enhance and maintain streams (in-channel) and backwater sloughs (off-channel)

Throughout the life of the CCP, enhance and maintain 7.2 miles of river frontage, 1.4 miles of streams, and 0.9 mile of backwater sloughs on the refuge for the benefit of salmonids (e.g., coastal cutthroat trout, steelhead), migratory birds (e.g., belted kingfisher), and a diverse assemblage of other native species (e.g., northwestern pond turtle, mink, Pacific lamprey).

In-channel stream is characterized by the following:

- Barrier-free river and stream channels
- Intact riparian areas along the banks with shade provided by large native trees
- Coarse woody debris inputs for in-stream structure

Backwater sloughs are characterized by the following:

- Temporary flooding and draining with a connection to nearby creek or river
- <20% cover of invasive plants (e.g., reed canarygrass, Canada thistle)
- Barrier-free sloughs with connections to stream or river channels providing for access and egress for native fish species during flood events
- Coarse woody debris for slough structure

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Miles of river frontage	7.2	7.2	7.2
Miles of in-channel stream	4.0	1.3	1.3
Miles of backwater slough	0.9	0.9	0.9

Strategies Applied to Achieve Objective:	Alt 1	Alt 2	Alt 3
Where fish passage barriers exist, either remove or modify barriers to allow passage, for example on an unnamed creek at the Riverboat Unit and on Rock Creek at the Rock Creek Unit.	✓	✓	✓
Plant cuttings, plugs, and potted plants for native shrubs and trees as necessary.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Maintain structures that enhance fish passage in tributary streams.	✓	✓	✓
Place woody debris as necessary to provide subsurface structure for native fish, and basking areas for native turtles and other wildlife.	✓	✓	✓
Inventory and monitor freshwater mussels.	✓	✓	✓
Where necessary install erosion control mats along river/stream banks.	✓	✓	✓
Use BMPs with respect to the refuge cropland management program, including unfarmed buffers to ensure minimal runoff and erosion into streams and rivers.	✓	✓	✓
Rationale: River and stream habitat at the refuge includes the mainstem of the Tualatin River, and Chicken and Rock Creeks at the Sherwood Units; the Tualatin River, Wapato, Ayers, Scoggins, Harris, and Hill Creeks at the Wapato Lake Unit; and many smaller tributary perennial and ephemeral streams. Functioning stream corridors provide access for upstream adult salmonid migration as well as downstream and off-channel migrating, foraging, and sanctuary habitat for outmigrating juvenile fish. In addition, headwater streams are important breeding areas both for salmonids and lamprey species. Intact riparian areas adjacent to river and stream channels serve many functions including providing water-quality benefits, shade, organic matter via leaf fall, and coarse woody debris. A host of wetland-dependent wildlife species thrive along river and stream channels including beaver, mink, muskrat, black-tailed deer, belted kingfisher, and northwestern pond turtle. Removing barriers such as culverts in the Rock Creek and Riverboat Units would enhance fish passage.			

Objective 6.2 Restore streams (in-channel)

By 2027, restore 2.7 miles of in-channel stream on the refuge for the benefit of salmonids (e.g., coastal cutthroat trout, steelhead), migratory birds (e.g., belted kingfisher), and a diverse assemblage of other native species (e.g., northwestern pond turtle, mink, Pacific lamprey).

In-channel stream is characterized by the following:

- Barrier-free river and stream channels
- Intact riparian areas along the banks with shade provided by large native trees
- Coarse woody debris for in-stream structure

Alternatives	Alt 1 (no action)	Alt 2 (proposed action)	Alt 3
Miles of in-channel stream	0	2.7	2.7

Strategies Applied to Achieve Objective:	Alt 1	Alt 2	Alt 3
By 2017: Develop a restoration plan for Chicken Creek.		✓	✓
By 2020: Develop a restoration plan for Rock Creek.		✓	✓
Conduct topographic surveys to determine location and elevation of stream channel and backwater channels/sloughs.		✓	✓
Locate and reestablish the historic channels of perennial streams (e.g., Chicken Creek, Rock Creek).		✓	✓
Use heavy equipment to remove plugs to reconnect historic oxbows to channels.		✓	✓
Remove culverts and other fish passage barriers on tributary streams including on an unnamed stream at the Riverboat Unit and on the Rock Creek Unit.	✓	✓	✓
Improve river and stream connectivity with the floodplain (e.g., through removal or relocation of levees, channelized reaches, or other features restricting seasonal inundation of the floodplain).		✓	✓
Plant cuttings, plugs, and potted plants for native shrubs and trees.	✓	✓	✓
Maintain structures that enhance fish passage in tributary streams.	✓	✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Place woody debris as necessary to provide subsurface structure for native fish, and basking areas for native turtles and other wildlife.	✓	✓	✓
Install gravel bars as necessary for native fish and mussel habitat.		✓	✓
Use BMPs with respect to the refuge cropland management program, including unfarmed buffers, to ensure minimal runoff and erosion into streams and rivers.	✓	✓	✓
Rationale: See rationale for Objective 6.1. Removing culverts and other fish passage barriers directly supports the strategies outlined by the Willamette Restoration Strategy (Jerrick 2001). Stream restoration activities would require additional analysis and regulatory compliance.			

Objective 6.3 Restore backwater sloughs (off-channel)

By 2020, restore 1.6 miles of backwater sloughs on the refuge for the benefit of salmonids (e.g., coastal cutthroat trout, steelhead), migratory birds (e.g., belted kingfisher), and a diverse assemblage of other native species (e.g., northwestern pond turtle, mink, northern red-legged frog).

Backwater sloughs are characterized by the following:

- Temporary flooding and draining with a connection to nearby creek or river
- <20% cover of invasive plants (e.g., reed canarygrass, Canada thistle)
- Barrier-free sloughs with connections to stream or river channels
- Coarse woody debris for slough structure

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Miles of backwater slough	0	1.6	1.6
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Conduct topographic surveys to determine location and elevation of backwater channels/sloughs.		✓	✓
Use heavy equipment to remove plugs to reconnect historic oxbows to channels, and to create new backwater areas in conjunction with other restoration activities (See Objectives 1.2, 4.2, and 5.3).		✓	✓
Improve river and stream connectivity with the floodplain (e.g., through removal or relocation of levees, channelized reaches, or other features restricting seasonal inundation of the floodplain).		✓	✓
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Place woody debris as necessary to provide subsurface structure for native fish, and basking areas for native turtles and other wildlife.	✓	✓	✓
Use BMPs with respect to the refuge cropland management program, including unfarmed buffers, to ensure minimal runoff and erosion into backwater sloughs.	✓	✓	✓
Rationale: Off-channel backwater areas have been shown to be important for spawning and juvenile rearing of native fish (Colvin et al. 2009). Henning et al. (2007) found that oxbow habitats were dominated by coho salmon. Jeffres et al. (2008) found that Chinook salmon experienced higher growth rates in off-channel habitats than in perennial habitats. These ephemeral habitats may also provide breeding and foraging sites for amphibians such as northern red-legged frogs and northwestern salamanders. Backwater sloughs also provide a diversity of plant growth as they dry out in summer, providing a variety of benefits for native wildlife.			

Goal 7: Cultivate and maintain croplands as an interim measure to control nonnative invasive species.

Objective 7.1 Cultivate small cereal grain crops and green pasture at the Wapato Lake Unit

Prior to initiating restoration activities in the Wapato Lake lake bed and surrounding areas, use small grain croplands and green pastures as an interim measure to provide wildlife habitat while controlling weeds on acquired lands. Benefitting species include migrating and wintering waterfowl (e.g., tundra swan, northern pintail), raptors (e.g., northern harrier, red-tailed hawk), and landbirds (e.g., western meadowlark, savanna sparrow).

Small grain croplands are characterized by the following:

- Crops such as corn, wheat, barley, and oats
- 70% harvested, 30% left standing
- May have standing water or be completely flooded during rainy season

Green pastures are characterized by the following:

- Green forage crops such as clover and grass hay
- Tall grasses during spring
- Short grasses during fall and winter
- May have standing water or be completely flooded during rainy season

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	837	0-871	0-871
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, water management, cultural, and biological methods, to control invasive species (Appendix G).	✓	✓	✓
Conduct cooperative farming to grow and harvest small grain crops.	✓	✓	✓
Leave 30% of small grain crops standing for winter waterfowl forage.	✓	✓	✓
Conduct cooperative farming to grow and harvest green pasture.	✓	✓	✓
Harvest 100% of green pasture during spring/summer.	✓	✓	✓
Mow green pasture to <4 inches during late summer/early fall to provide forage for migrating and wintering waterfowl.	✓	✓	✓
Explore the feasibility of refuge staff conducting farming operations on part or all refuge lands in a temporary cropping program.		✓	✓

Rationale: Growing cereal grains and green pasture on refuge lands as an interim measure helps reduce invasive plant species infestations prior to initiating restoration measures and provides benefits for migrating and wintering waterfowl, and other species. Selecting cereal grains versus green pasture is usually a decision based on market economics—which crops are most valuable to local farmers. Cooperative farming should benefit both the refuge in terms of wildlife value and the farmer in terms of economic value.

Maintaining crops on the land prior to restoration helps control nonnative invasive plant species such as reed canarygrass and Himalayan blackberry. Farming activities may include mowing, discing, application of approved herbicide, and planting of small grain crops, clover, or grass. Cooperative farming would be phased out in Alternatives 2 and 3 as restoration efforts continue throughout the refuge. Acreage numbers presented in Alternatives 2 and 3 (0-804 acres) reflect the uncertainty of restoring the entire lake basin during the 15-year life span of the CCP. The range of acres suggested for restoration is due to the uncertainty of the direction of the Wapato Lake Unit restoration. Restoration would be dependent on the outcome of a hydrology study currently being conducted by the USGS.

Conversion of croplands to native habitat types should benefit native species in the long term. Species using this area would likely transition as restoration is completed and new native habitats mature. Native fish species such as steelhead, coho, and lamprey would benefit from reconnecting the Wapato Lake lake bed with the Tualatin River and nearby tributary streams, while a host of waterfowl would benefit from restoration of herbaceous wetlands, and marsh birds and songbirds would use restored scrub-shrub wetlands.

Cooperative farming is conducted by local growers who incur all costs associated with growing and harvesting crops. The cooperator is responsible for all aspects of farming including site preparation, seeding, application of any fertilizers or herbicides, harvesting, and any follow-up work necessary to remove the crop or prepare the field for the following year. Cooperators are required to leave a share of crops as determined by a cooperative agreement. For additional information see the compatibility determination in Appendix B.

Harvesting green pasture is usually conducted during spring, and a follow-up cutting is conducted in fall to provide forage for wintering geese.

Refuge staff may also conduct farming operations; however, all costs would be incurred by the refuge and all crops would be left for the benefit of wildlife.

Objective 7.2 Cultivate small cereal grain crops and green pasture at the Onion Flats Unit

Until the refuge acquires an interest in portions of the Onion Flats Unit that are sufficient to conduct restoration activities without impacting neighboring landowners, use small grain croplands and green pastures as an interim measure to provide wildlife habitat while controlling weeds on acquired lands. Benefitting species include migrating and wintering waterfowl (e.g., Canada goose, northern pintail), raptors (e.g., northern harrier, red-tailed hawk), and landbirds (e.g., western meadowlark, savanna sparrow).

Small grain croplands are characterized by the following:

- Crops such as corn, wheat, barley, and oats
- 70% harvested, 30% left standing
- May have standing water or be completely flooded during rainy season

Green pastures are characterized by the following:

- Green forage crops such as clover and grass hay
- Tall grasses during spring
- Short grasses during fall and winter
- May have standing water or be completely flooded during rainy season

Alternatives	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Acres	105	0-105	0-105
Strategies Applied to Achieve Objective:	**Alt 1**	**Alt 2**	**Alt 3**
Use IPM techniques, including mechanical/physical (e.g., mowing), chemical, water management, cultural, and biological methods, to control invasive species (see Appendix G).	✓	✓	✓
Conduct cooperative farming to grow and harvest small grain crops.	✓	✓	✓
Leave 30% of small grain crops standing for winter waterfowl forage.	✓	✓	✓
Conduct cooperative farming to grow and harvest green pasture.	✓	✓	✓

Harvest 100% of green pasture during spring/summer.	✓	✓	✓
Mow green pasture to <4 inches during late summer/early fall to provide forage for migrating and wintering waterfowl.	✓	✓	✓
Explore the feasibility of refuge staff conducting farming operations on part or all refuge lands in a temporary cropping program.		✓	✓

Rationale: Growing cereal grains and green pasture on refuge lands as an interim measure helps reduce invasive plant species infestations prior to initiating restoration measures and provides benefits for migrating and wintering waterfowl, and other species. Due to the nature of the Onion Flats basin, restoration of Rock Creek (see Objective 6.2) and restoration of scrub-shrub wetland (see Objective 5.3) cannot proceed until sufficient interest in land (e.g., fee title, easement, or management agreement) is secured so that neighboring landowners are not impacted by refuge actions. The acreage numbers presented in Alternatives 2 and 3 (0-105 acres) reflect the uncertainty of acquiring an interest in land and restoring the basin during the 15-year life span of the CCP.

Conversion of croplands to native habitat types should benefit native species in the long term. Species using this area would likely transition as restoration is completed and new native habitats mature. Native fish species such as cutthroat trout and lamprey would benefit from restoration of Rock Creek, while a host of marsh birds and songbirds would use restored scrub-shrub wetlands.

Selecting cereal grains versus green pasture is usually a decision based on market economics—which crops are most valuable to local farmers. Cooperative farming should benefit both the refuge, in terms of wildlife value, and the farmer, in terms of economic value.

Maintaining crops on the land prior to restoration helps control nonnative invasive plant species such as reed canarygrass and Himalayan blackberry. Farming activities may include mowing, discing, application of approved herbicide, and planting of small grain crops, clover, or grass. Cooperative farming would be phased out in Alternatives 2 and 3 as restoration efforts continue throughout the refuge.

Cooperative farming is conducted by local growers who incur all costs associated with growing and harvesting crops. The cooperator is responsible for all aspects of farming including site preparation, seeding, application of any fertilizers or herbicides, harvesting, and any follow-up work necessary to remove the crop or prepare the field for the following year. Cooperators are required to leave a share of crops as determined by a cooperative agreement. For additional information see the compatibility determination in Appendix B.

Harvesting green pasture is usually conducted during spring, and a follow-up cutting is conducted in fall to provide forage for wintering geese.

Refuge staff may also conduct farming operations; however, all costs would be incurred by the refuge and all crops would be left for the benefit of wildlife.

Goal 8: Collect scientific information (surveys, scientific assessments, and research) necessary to support adaptive management decisions that are associated with Goals 1-7.

Objective 8.1 Inventory and monitoring surveys

Throughout the life of the CCP, conduct high-priority inventory and monitoring surveys that evaluate resource management and public use activities to facilitate adaptive management as well as provide baseline data. These surveys contribute to the protection, enhancement, restoration, use, and management of wildlife populations and their habitats on and off refuge lands. Specifically, they can be used to evaluate achievement of resource management objectives identified under Goals 1-7 in the CCP. These surveys would have the following attributes:

- Data collection techniques would likely have minimal animal mortality or disturbance and minimal habitat destruction
- Scale and accuracy of assessments would be appropriate for development and implementation of refuge habitat and wildlife management actions
- Minimum number of samples to meet statistical analysis requirements would be used to minimize long-term or cumulative impacts
- Proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary, would be required to minimize the potential spread or introduction of invasive species
- Projects would adhere to scientifically sound protocols for data collection, where available and applicable

Strategies Applied to Achieve Objective:	Alt 1 (no action)	Alt 2 (proposed action)	Alt 3
The following is a list of survey activities to support resource management decisions on the refuge. This list is not in order of priority.			
Work with the Friends of the Refuge and other volunteers to conduct inventory and monitoring surveys.	✓	✓	✓
Map invasive plant distributions throughout the refuge.	✓	✓	✓
Monitor water levels in managed wetland basins.	✓	✓	✓
Monitor survival and growth of planted woody species to evaluate restoration success as needed.	✓	✓	✓
Conduct forest monitoring to assess snag density every 5 years.	✓	✓	✓
Inventory and monitor restored wet prairies to gather baseline life history data and evaluate changes over time.	✓	✓	✓
Monitor wetland and other vegetation types to determine management effectiveness as needed.	✓	✓	✓
Monitor wintering waterfowl weekly from September 15 to March 15.	✓	✓	✓
Monitor shorebirds weekly from April 1 to September 30.	✓	✓	✓
Conduct monthly point count surveys for songbirds from April 1 to June 30.	✓	✓	✓
Conduct songbird banding from May 1 to August 15 following Monitoring Avian Productivity and Survivorship (MAPS)	✓	✓	✓

protocol.			
Monitor reptiles and amphibians (e.g., frogs, salamanders, turtles) as needed.	✓	✓	✓
Monitor mammals as appropriate.	✓	✓	✓
Inventory freshwater mussels in streams.	✓	✓	✓
Monitor for listed fish species as appropriate (e.g., salmonids, lamprey).	✓	✓	✓
Monitor water quality entering, within, and at discharge points of refuge wetlands.	✓	✓	✓
Conduct periodic assessments to evaluate current habitat conditions.	✓	✓	✓
Rationale: The Improvement Act requires the Service to "monitor the status and trends of fish, wildlife, and plants in each refuge." Surveys would be used primarily to evaluate resource response to assess progress toward achieving refuge management objectives (under Goals 1-7 in this CCP) derived from the Refuge System mission, refuge purposes, and maintenance of BIDEH. Determining resource status and evaluating progress toward achieving objectives is essential to implementing adaptive management on Department of Interior lands. Specifically, results of surveys would be used to refine management strategies, where necessary, over time in order to achieve resource objectives. Surveys would provide the best available scientific information to promote transparent decision-making processes for resource management.			

Objective 8.2 Research

Conduct high-priority research projects that provide the best science for habitat and wildlife management on and off refuge lands. Scientific findings gained through these projects would expand knowledge regarding the life history needs of species and species groups as well as identify or refine habitat and wildlife management actions. Research also would reduce uncertainty regarding wildlife and habitat responses to refuge management actions, which would help achieve desired outcomes reflected in resource management objectives and facilitate adaptive management. These research projects would have the following attributes:

- Data collection would adhere to scientifically defensible protocols, where available and applicable, in order to develop the best science for resource management
- Data collection techniques would likely have minimal animal mortality or disturbance and minimal habitat destruction
- The minimum number of samples would be collected to meet statistical analysis requirements for identification and/or experimentation to minimize long-term or cumulative impacts
- Proper cleaning methods would be used on investigator equipment and clothing, as well as quarantine methods, where necessary, to minimize the potential spread or introduction of invasive species
- Research projects would produce a summary report containing methods, results, and discussion of findings
- Projects would often result in peer-reviewed articles in scientific journals and publications and/or symposiums

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
The following is a list of research projects to support resource management decisions on the refuge. This			

list is not comprehensive and is not in order of priority.			
Conduct soil and topographic surveys and hydrological modeling to determine surface water interactions between river levels and floodplain elevations, with an outcome of frequency and duration of flooding within the Tualatin River floodplain to support saturation requirements for Objectives 4.1, 4.2, 5.3, 5.4, 6.1, and 6.2.	✓	✓	✓
Conduct detailed topographic survey of Wapato Lake and surrounding areas to use in restoration planning and evaluation.		✓	✓
Conduct hydrologic survey of Wapato Lake and the surrounding watershed to use in restoration planning and evaluation.		✓	✓
Conduct studies to determine water quality parameters within refuge impoundments, and the effects to water quality on streams and the Tualatin River.	✓	✓	✓
Conduct study to evaluate timing of prescribed fire to best promote native herbaceous cover and control invasive plants.		✓	✓
Conduct studies to determine practical techniques (grazing, haying, mowing, herbicide application) for habitat management.		✓	✓
Conduct studies to determine BMPs for eradicating or controlling nonnative invasive species.	✓	✓	✓
Conduct studies of disturbance to wildlife from public use activities to determine compatibility and recommend any necessary modifications to reduce disturbance.		✓	✓
Investigate methods for reducing competition from nonnative fish species in stream and floodplain habitat types.	✓	✓	✓
Investigate species and habitat sensitivity to changing climate trends and climate vulnerability assessments; monitor results of climate modeling by University of Washington and others.	✓	✓	✓
Partner with universities and other academic institutions to conduct scientific research.	✓	✓	✓
Partner with USGS, other Federal and state agencies, and nongovernmental organizations to conduct research studies.	✓	✓	✓
Rationale: Research projects on refuge lands would address a wide range of natural and cultural resource as well as public use management issues. Examples of research projects include habitat use and life history requirements for specific species/species groups, practical methods for habitat management and restoration, extent and severity of environmental contaminants, techniques to control or eradicate pest species, effects of climate change on environmental conditions and associated habitat/wildlife response, identification and analyses of paleontological specimens, modeling of wildlife populations, and assessing response of habitat/wildlife to disturbance from public uses. Projects may be species-specific or refuge-specific, or they may evaluate the relative contribution of the refuge to issues and trends affecting the larger landscape (e.g., ecoregion, region, flyway, national, international). Like monitoring, results of research projects would expand the best available scientific information and potentially reduce uncertainties to promote transparent decision-making processes for resource management over time on refuge lands. In combination with results of surveys, research would promote adaptive management on refuge lands. Scientific publications resulting from research on refuge lands would help increase the visibility of the Refuge System as a leader in the development of the best science for resource conservation and management.			

Goal 9: Protect and manage the refuge's unique cultural resources for their cultural, scientific, and educational values, while consulting with appropriate Native American groups and preservation organizations and complying with historic preservation legislation.

Objective 9.1 Inventory, evaluate, monitor, and protect cultural resources to improve cultural resource management			
Continue and improve cultural resource management that meets the requirements of the NHPA, including consultation, identification, inventorying, monitoring, and protection of cultural resources.			
Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Through partnerships, expand on current cultural resource inventories in high probability areas on existing lands and newly acquired lands.	✓	✓	✓
Develop partnership with the Tribes for cultural resource inventory, evaluation, and project monitoring, consistent with the regulations of the NHPA. Protect all identifiable archaeological sites by avoiding disturbance within the area.	✓	✓	✓
Evaluate sites for eligibility for the National Register of Historic Places (NRHP).		✓	✓
Continue to identify cultural resources that coincide with existing and planned roads, facilities, public use areas, habitat projects, and research projects. Plan and implement activities to avoid or mitigate impacts as necessary.	✓	✓	✓
Complete a comprehensive cultural review of the refuge and compile all site surveys, work requests, and reports for easy access by managers.		✓	✓
When funding is limited, low priority and unsafe buildings should be cataloged and considered for removal.		✓	✓
Monitor known archaeological and historical sites, as needed.		✓	✓
Provide refuge staff with training on managing historic, archaeological, and cultural resources.		✓	✓
Develop and implement a museum management plan (including inventory, storage, and use) for existing and new property.		✓	✓
Collect and catalog oral histories from local community members.		✓	✓
Rationale: Various Federal historic preservation laws and regulations, such as the Archaeological Resources Protection Act of 1979 and the NHPA, require the Service to implement the kind of program described under this objective. The refuge has currently identified numerous historic structures and archaeological sites throughout the refuge related to pioneer agriculture. The refuge has also been identified as a long-term occupation area of the Kalapuyan Tribe, and several prehistoric sites have also been discovered. This objective would serve to protect these important cultural resources. Developing a partnership with the Tribes would foster greater understanding of not only the refuge's cultural heritage, but the greater Willamette Valley region as well.			

Objective 9.2 Provide interpretive and educational programs on the refuge's cultural resources			
Expand education and interpretation for cultural resources through programs and materials that highlight the rich cultural heritage of the Tualatin River watershed and the Willamette Valley. Encourage understanding and appreciation of the relationships of past and present human interactions with wildlife and their habitats.			
Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Develop and strengthen partnership with the Tribes in order to provide high-quality educational and interpretive programs with a focus on natural and cultural resources of the refuge and the Tualatin River watershed.	✓	✓	✓
Consult with the Tribes and other preservation partners to identify the type of cultural resources information appropriate for public interpretation.	✓	✓	✓
Expand the Wildlife Center exhibits to include exhibits highlighting Native American history and Euro-American land use.		✓	✓
Develop interpretive media (e.g., pamphlets, signs, and exhibits) that relate to cultural resources and the refuge.		✓	✓
Rationale: Preservation and protection of our cultural resources requires attention not only from the refuge but the public as well. Interpretation of these resources can raise public interest and appreciation for the rich history of the peoples who lived in the valley in earlier times and how they shaped the landscape the refuge now manages. This appreciation can lead to public support for the conservation, maintenance, identification, and protection of archaeological and historic sites.			

Goal 10: Provide visitors, local residents, volunteers, and partners with opportunities to understand and appreciate fish and wildlife conservation as well as the purpose, ecology, and management of the refuge and the Refuge System.

Objective 10.1 Provide visitors with clear and accurate information			
Visitors would be provided with clear and accurate information that would: • Describe what areas are open to the public • Articulate activities that are allowed and those that are prohibited and why • Describe how to safely and ethically experience the refuge • Be presented in a variety of graphic and written formats			
Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Provide informational signs and brochures, regulatory information, and trail maps.	✓	✓	✓
Partner with others to keep the refuge Wildlife Center open a minimum of 5 days a week.	✓	✓	✓
Maintain a refuge website that meets Service web standards.	✓	✓	✓

Provide at least annual training for Wildlife Center volunteers and volunteer rovers to ensure they provide quality service and are well informed about the refuge, its resources, and rules and regulations.	✓	✓	✓
Maintain all existing public use facilities.	✓	✓	✓
Explore opportunities for one or two informational kiosks at or near the Wapato Lake Unit.		✓	✓
Hire a full-time, permanent law enforcement officer to provide both visitor and resource protection.		✓	✓
Rationale: Kiosks, signs, publications, and contact with refuge staff and volunteers are effective communication tools to welcome and orient visitors. These steps are necessary to provide a safe and enjoyable visit that both meets visitor needs and communicates what public use opportunities and facilities are available at the refuge. In addition, clear regulations and guidance promotes protection of refuge resources, reduces law enforcement violations, and maintains compatibility. A full-time law enforcement officer would provide greater protection of visitors and natural and cultural resources.			

Objective 10.2 Conduct outreach and special events

Conduct outreach and special events that:

- Describe the refuge and its place as part of the Refuge System
- Promote understanding of the refuge's role in enhancing natural resources, protecting habitats and water quality, and providing educational and economic benefits to the community
- Describe how the refuge is different from local parks
- Focus on local residents, with an emphasis on serving urban and underserved populations, and families and youth that may not otherwise have opportunities to engage in programs about or activities on national wildlife refuges

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Partner with Friends of the Refuge and others to offer special programs and events to draw neighbors, area residents, and community partners to the refuge. Examples of events include Tualatin River Bird Festival, National Wildlife Refuge Week, and Spring Break Exploration Days.	✓	✓	✓
Maintain a presence at community events where there is a high potential for delivering refuge messages. Examples include local county fairs, nature festivals, city events, and farmers' markets.		✓	✓
Develop a volunteer speakers' bureau to deliver presentations to local groups.		✓	✓
By 2015, investigate and develop a plan to use new/social media to expand refuge outreach.		✓	✓
Regularly use media like newspapers, television, magazines, and radio. Focus on news venues, as well as specialty outdoor, commerce, and travel venues.	✓	✓	✓
Rationale: The area surrounding the refuge is becoming increasingly developed, and the population is expanding. The refuge opened to the public in 2006 and is still relatively unknown to many area residents and businesses. Outreach is needed for these new and growing audiences, in order to build interest in the			

refuge, bring visitors to the refuge, and build support for refuge programs and fish and wildlife conservation.

Objective 10.3 Plan for continuing and new public use opportunities

Plan for continuing and new public use opportunities that:

- Emphasize the role that national wildlife refuges have in the conservation of fish and wildlife and their habitats
- Prescribe a wide range of techniques and media that appeal to culturally and ethnically diverse audiences and can adapt to changing trends
- Allow visitors to experience a variety of refuge habitats and associated wildlife
- Ensure that public uses are accessible and adhere to the guidelines set forth in the Architectural Barriers Act

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
By 2016, develop primary refuge interpretive, outreach, and educational themes.		✓	✓
By 2016, identify target audiences through a variety of means including demographic studies.		✓	✓
Use the Refuge System's visitor survey (USFWS and USGS, OMB #1018-0145) or other valid and approved method to gather information about visitors and their expectations and experiences. Use data to identify areas of growing public interests and to provide the information necessary to exercise adaptive management.		✓	✓
Use the Refuge System Visitor Estimation Workbook (USFWS 2005a), traffic counters, and program attendance to estimate numbers of visitors participating in public use activities.		✓	✓
At least every 5 years, conduct an evaluation using *Visitor Services Standards: A Handbook for Evaluating Visitor Service Programs* (USFWS 2009b) for all visitor services programs of the refuge. Conduct evaluations of new programs within 1 year of implementation.		✓	✓
Every 3 years, invite an organization such as Access Recreation in Portland to conduct a courtesy accessibility evaluation of public use facilities. Develop and implement a plan to make needed corrections or improvements based on this evaluation.		✓	✓
By 2017, develop a comprehensive visitor services plan that prescribes all public use facilities and programs at both the Sherwood Units and the Wapato Lake Unit. Complete all relevant appropriateness and compatibility determinations.		✓	✓

Rationale: Established under the Urban Refuge Policy, the Tualatin River National Wildlife Refuge has a special role in sharing the mission of the Refuge System, how refuges are managed throughout the Refuge System, and how citizens can learn more about and support the Refuge System as a whole. Public use opportunities need to be designed and planned in a way that that is aligned with primary messages. Opportunities that do not support primary messages should be eliminated from consideration. A

comprehensive visitor services plan would use primary refuge messages and themes to prescribe long-term wildlife-dependent public use programs and the facilities that would support those programs. Examples of programs could include, but may not be limited to, wildlife observation areas, trails, interpretive exhibits, signs, photography blinds, auto tour routes, education study sites, and hunting and fishing facilities.

Objective 10.4 Improve and enhance public access to, from, and within the refuge

Improve and enhance public access to, from, and within the refuge in a manner that:

- Is safe, well marked, and accessible where feasible
- Promotes the use of alternative transportation to visit the refuge, thereby helping to reduce the refuge's carbon footprint
- Poses minimal conflict with wildlife and habitat objectives
- Promotes stewardship and conservation
- Is coordinated with local communities and agencies planning transportation corridors near the refuge

Strategies Applied to Achieve Objective:	Alt 1 (no action)	Alt 2 (proposed action)	Alt 3
Continue to work with regional and local organizations to connect the refuge to existing and proposed land-based and water-based trail systems, such as Sherwood's Cedar Creek Trail (Otak 2009), Metro's Tonquin Trail, and Tualatin Riverkeepers' Tualatin River Water Trail, where feasible and compatible.	✓	✓	✓
Partner with interested parties/organizations to identify potential locations for one public river access for nonmotorized boats in or near the refuge.		✓	✓
By 2015, partner with Oregon Department of Transportation (ODOT), local counties, TriMet, and the Western Federal Lands Highway Division of the Federal Highway Administration to conduct transportation access and safety studies for the existing refuge access from Highway 99W and Roy Rogers Road and any proposed new access points to the Sherwood Units.		✓	✓
If determined necessary, partner with transportation agencies to improve safety of existing access points.		✓	✓

Rationale: The demand for increased, enhanced, and improved public access to the refuge was a common theme of many public comments during scoping for the CCP. These comments also reflect a desire for improved public access within the refuge and for connectivity with existing and proposed land and water trails.

At present, public access to the refuge is primarily by automobile along Highway 99W and Roy Rogers Road, and by TriMet bus along Highway 99W. Of particular concern, the Highway 99W entrance was constructed in 2006 without a deceleration lane. This current entrance design was required by ODOT specifications and permit conditions, and the entrance resides within ODOT's right-of-way. Refuge visitors continue to express concern that the Highway 99W entrance is unsafe. This entrance warrants further evaluation and potential remedy.

Objective 10.5 Maintain a volunteer and internship program

Maintain a volunteer and internship program that:

- Assists with the habitat, biological, public use, maintenance, and administrative programs of the refuge
- Provides opportunities for citizens to engage in, learn about, and conduct the work of conservation
- Builds capacity to recruit, train, manage, and retain volunteers over the long term
- Fosters the development of conservation professionals

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Hire a full-time, permanent volunteer coordinator to manage current and expanding refuge-wide volunteer program.		✓	✓
Develop and conduct an annual refuge-wide volunteer needs assessment.		✓	✓
Develop a package of position descriptions that clearly define the responsibilities and roles of volunteers in all relevant refuge programs.		✓	✓
Continue to provide opportunities for young adults to gain work experience in natural and cultural resources planning and management, as well as visitor services management, and to explore career options in conservation fields. These opportunities may include programs such as internships, AmeriCorps placements, student employment and work/study programs, Youth Conservation Corps, and other youth employment initiatives.	✓	✓	✓
Develop written training programs, manuals, and other resource training for volunteers.		✓	✓
Establish an advisory committee of volunteers that helps the refuge with oversight and day-to-day management of volunteer activities.		✓	✓
Construct a new bunkhouse and two recreational vehicle (RV) pads (with hookups) on the Tualatin River Unit near the maintenance facility to house volunteers.		✓	✓
Host annual volunteer appreciation event.	✓	✓	✓

Rationale: Volunteers are necessary to meet the operational needs of the refuge. In fiscal year 2010, a total of 205 volunteers contributed 15,065 hours. This contribution is the equivalent of 7.2 full-time staff, at a value of $327,000, calculated at $21.79/hour (Independent Sector 2011). Expansion of the current volunteer program to fully meet the needs of the refuge over the life of the CCP would require a full-time volunteer coordinator. This need could be met through direct hiring of USFWS staff or by partnering with Friends of the Refuge to hire personnel.

It is critical for the Service to attract and nurture the future workforce in natural resource conservation. This priority is also reflected in the Department of Interior's Youth in the Great Outdoors initiative.

Objective 10.6 Maintain a close working relationship with the Friends of the Refuge			
Maintain a relationship in which the Friends of the Refuge: • Assist with the refuge's habitat, biological, public use, and maintenance programs • Seek grants, funding, and sponsorships to support refuge programs			
Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Work with the Friends of the Refuge to establish a chapter that would provide support for the developing Wapato Lake Unit.		✓	✓
Continue to provide the Friends of the Refuge with office and storage space to successfully conduct their activities.	✓	✓	✓
Maintain the current memorandum of understanding between the Service and the Friends of the Refuge.	✓	✓	✓
Rationale: The Friends of Tualatin River National Wildlife Refuge is a nonprofit 501(c)(3) organization whose mission is to "support the Tualatin River National Wildlife Refuge." It is "dedicated to the protection and restoration of the refuge for the benefit of fish and wildlife, and for public education and recreation" (Friends of the Tualatin Refuge 2011). The Friends provide critical support to the refuge, supporting programs and activities that would otherwise not be feasible to conduct. The refuge maintains a memorandum of understanding with the Friends of the Refuge, partially under the authority of the Refuge System Volunteer and Community Partnership Enhancement Act of 1998.			

Goal 11: Provide students and educators from the greater Portland area with compatible and high-quality opportunities to participate in environmental education.

Objective 11.1 Increase participation in the refuge's environmental education program			
The goals for the refuge's environmental education program are to: • Remain of high quality • Not exceed capacity of refuge public use facilities • Coordinate with other regional natural areas and organizations that offer environmental education			
Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Hire a permanent, full-time environmental education specialist to manage all refuge education and interpretation programs.		✓	
Throughout the life of the CCP, increase the number of students participating in educator-led field trips from an average of 1,900 to at least 5,000 per year.		✓	
Throughout the life of the CCP, increase the number of students reached at off-site activities and events from an average of 700 to at least 1,750 per year.		✓	
Throughout the life of the CCP, increase the number of volunteers trained in support of the environmental education program from an average of 10 to at least 25 per year.		✓	✓

Offer programs that are tailored to youth outside of the traditional classroom (e.g., scouts, clubs). Increase the numbers of youth participating in these programs from an average of 800 to at least 2,000 per year.		✓	
Increase outreach about the refuge's environmental education program to teachers and administrators at schools within a 10-mile radius of Sherwood and of Gaston.		✓	
Continue to require teacher workshops prior to educators bringing class field trips to the refuge. Offer a minimum of two teacher workshops annually.	✓	✓	✓
By 2013, identify one off-trail area that students can use, when approved as part of a field trip registration and supervised by volunteers, to conduct educational activities.		✓	
By 2018, design and construct one off-trail nature exploration area that engages young children to experience unstructured outdoor play.		✓	
Rationale: Environmental education activities promote appreciation and knowledge of natural resources, foster a conservation ethic, and aid in understanding the important role people have in the environment. Ultimately, the highest goal of environmental education is to foster an aware and involved citizenry that takes an active role in conservation efforts. As such, environmental education is identified as one of the priority public uses of the Refuge System and, as an urban national wildlife refuge, is one of the top goals for the Tualatin River National Wildlife Refuge. Expanding the current environmental education program would reach more students and educators and foster integration into local school curricula. The current education program is carried primarily through internships, grants, and volunteers, and maintaining its current capacity is dependent on soft funding, which is funding that may or may not be available each year. Permanent maintenance of the current program and future increase in participation (as proposed in Alternative 2) is dependent on the hiring of a full-time professional environmental education coordinator. Nature explore areas provide opportunities for children to experience nature first-hand through unstructured outdoor play. Richard Louv identified the importance of first-hand unstructured experience in nature and the prevalence of "nature deficit disorder" as a serious issue in his book *Last Child in the Woods* (Louv 2005). Research supports Louv's arguments demonstrating that children's positive encounters with nature can lead to development of an environmental ethic (Chawla 1988; Palmberg and Kuru 2000; Wilson 1997).			

Objective 11.2 Expand the environmental education program to include the Wapato Lake Unit			
Same as Objective 13.1.			
Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
By 2013, provide teacher training and curricula to educators within the schools and communities surrounding Wapato Lake Unit.		✓	✓
By 2013, provide environmental education materials to educators in schools and communities surrounding the Wapato Lake Unit.		✓	✓
Explore the potential to partner with the City of Gaston to provide space and/or facilities for environmental education programs to occur at Brown Park.		✓	✓

By 2014, annually host at least two environmental education programs with the Tribes at the Wapato Lake Unit, both for tribal students and surrounding communities.		✓	✓
Rationale: Schools close to the Wapato Lake Unit offer a new audience that has yet to participate in refuge environmental education programs. The community, especially Gaston, has expressed a desire to have students learn about and experience the refuge. Although there are currently no public use facilities at the Wapato Lake Unit, the refuge can offer high-quality environmental education activities at schools, within the local community, and at the Atfálat'i Unit of the refuge.			

Objective 11.3 Ensure that the environmental education program is high quality

The environmental education program should:

- Align with grade-level curricula and be age appropriate
- Correlate with national and state educational standards
- Use current and widely accepted techniques
- Appeal to a broad range of learning styles and provide interdisciplinary opportunities that link natural resources through all academic subject areas
- Serve students across a range of economic, social, cultural, and ethnic diversity
- Be conducted to minimize impacts to fish, wildlife, plants, and their habitats; other compatible public uses; and refuge management programs and facilities
- Involve local communities, Friends of the Refuge, volunteers, and other partners
- Incorporate the importance of the Refuge System and the purposes, goals, and objectives of the refuge
- Incorporate current conservation issues and concerns
- Provide experiences that are hands-on and integrate the resources of the refuge

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Conduct at least one training per year to ensure volunteers use high-quality and appropriate educational methods, techniques, and tools.	✓	✓	✓
Loan educators and schools relevant supplies and materials such as binoculars, field guides, lesson kits, and water testing kits to support on-site field activities for environmental education.	✓	✓	✓
Develop a training program for parent chaperones who accompany student field trips to the refuge.		✓	✓
Align refuge education materials, curricula, and techniques with the Oregon Environmental Literacy Plan, as appropriate. (Oregon Environmental Literacy Task Force 2010)		✓	✓
At least every 5 years, conduct a comprehensive evaluation of the environmental education program using the Guidelines for Excellence established by North American Association for Environmental Education ([NAAEE] 2004).		✓	✓
Explore the potential to extend the teacher-training program from 1-day workshops to long-term, one-on-one coaching with individual teachers.		✓	✓
Maintain memberships in organizations such as NAAEE, Environmental Education Association of Oregon, Portland's	✓	✓	✓

Regional Environmental Education Network, and Metro's Intertwine.			
Rationale: Environmental education opportunities in the greater Portland area are plentiful, although few areas provide natural areas with facilities that accommodate student field trips (with shelter, classroom, and study areas) while also providing quality wildlife-oriented education opportunities. In addition, the past and projected population boom in proximity to the refuge may continue to create a larger demand for nature-based education programs within a short bus trip from local schools. However, several key factors limit schools' abilities to offer environmental education without the assistance of outside resources such as the refuge. At this time, environmental education is not mandated by the State of Oregon; teachers are increasingly pressured to meet current mandates and may not have the time to build skills, learn curricula, and seek out environmental education activities. Declining school budgets often limit teachers in their ability to provide transportation, cover substitute fees, purchase materials, and defray other costs associated with off-site field trips. By maintaining a high-quality education program, the refuge can offset these limitations in order to meet our environmental education goal. Education programs would be effective and offered in a way that would both attract educators and meet the learning mandates and objectives that schools are responsible for providing. The refuge can provide environmental education teaching materials (binoculars, field guides, water test kits, study skins, etc.) that schools would likely not have access to. In addition, the refuge can offer programs for youth outside the formal classroom (such as scouts and after-school clubs) that are more affordable and not subject to daily limitations of the school day. Ensuring the long-term quality of the environmental education program, through evaluation and adaptive management (as proposed in Alternative 2), is dependent on the hiring of a full-time professional environmental education coordinator.			

Goal 12: Provide refuge visitors with diverse, compatible, and high-quality opportunities to participate in wildlife-dependent recreation and interpretation.

Objective 12.1 Provide high-quality wildlife observation and wildlife photography opportunities

Provide high-quality wildlife observation and photography opportunities that:

- Focus on major wildlife species and groups of wildlife species, including migratory birds
- Incorporate a diversity of habitats found on the refuge
- Use various types of facilities to view/photograph wildlife and their habitats
- Are emphasized on a year-round basis
- Satisfy a range of skill sets, from casual and beginning observers/photographers, to advanced and expert observers/photographers

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Enhance and maintain the existing seven wildlife observation structures, 1.1 miles of year-round trails, 3.1 miles of seasonal trails, one wildlife photography blind, and two restrooms.	✓	✓	✓
Maintain seasonal trail closure from October 1 to April 30 on the Atfálat'i Unit to provide sanctuary for wintering waterfowl and maintain quality viewing opportunities.	✓	✓	✓
Improve habitat conditions and maintain viewing "lanes" in close proximity to wildlife observation/photography facilities. These improvements could include items such as snag/log		✓	✓

placements; removal of branches, trees, or other encroaching vegetation; and control of nonnative vegetation within wetlands.			
Explore the possibility of adding a material or substance to trail surfaces to both reduce the sound of footsteps on the trail and reduce weed encroachment.		✓	✓
Improve 400 feet of existing year-round trail to avoid winter flooding.		✓	✓
Explore adding trees and/or other vegetation along busy road corridors to reduce noise and create a more natural setting.		✓	✓
By 2016, construct and maintain one to three additional wildlife photography blinds and associated access trails on the Atfálat'i Unit of the refuge. Manage use through a reservation system.		✓	
Partner with the Friends of the Refuge, Tualatin River Photographic Society, and local wildlife organizations to assist with the funding, design, construction, maintenance, and management of new and existing wildlife observation and photography facilities.		✓	✓
Explore the desirability of user fees to help operate the wildlife observation and photography program, and maintain and repair associated facilities.		✓	✓
Maintain wildlife "Discovery Packs" for visitors to check out at the Wildlife Center. Packs would contain binoculars, field guides, and activities for outdoor nature exploration.	✓	✓	✓
Maintain an up-to-date and accurate Watchable Wildlife leaflet and checklist of birds, mammals, reptiles, and amphibians.	✓	✓	✓
Partner with Friends of the Refuge, Tualatin River Photographic Society, local wildlife organizations, agencies, and/or universities to offer regular programs on the Refuge oriented to increasing the knowledge and skills of wildlife observers and photographers. Evaluate the potential for revenue from a modest program-specific fee to support such programs.		✓	✓
At least every 5 years, conduct an evaluation of the wildlife observation and photography program using the Refuge System Birder Friendly Refuge criteria (USFWS 2008a).		✓	✓
Rationale: Opportunities to participate in wildlife observation and photography in the greater Portland area are plentiful. However, many areas lack the diversity and abundance of wildlife and the expanses that the refuge offers. The refuge also provides a relatively unique location for high-quality wildlife observation and photography by limiting nonwildlife-dependent activities such as biking, jogging, dog walking, and other activities that may otherwise conflict with and disturb wildlife. Wildlife observation and photography programs are designed to provide a diversity of wildlife viewing opportunities in a manner that minimizes disturbance to wildlife. Many of the various wildlife observation facilities provide excellent photography opportunities. In addition, the refuge has one existing photography blind that can be reserved on a first-come, first-served basis, on Wednesdays, Saturdays, and Sundays throughout the year. The 0.2-mile spur trail to the photography blind is closed to all other users during the winter seasonal trail closure period. Demand for the blind is growing. Wildlife photographers have expressed concern that the blind does not offer a consistent quality experience because it faces south and			

photographs must be taken toward the sun at all times during the day. Opportunities may exist to offer additional photography blinds that do not face the sun.

A 400-foot section of the year-round trail, located between the River Overlook and the riparian forest, floods during most winters—sometimes with puddles up to 16 inches deep. Pedestrians are forced to walk around the puddles and cause substantial trampling of vegetation. This section is impassable by strollers or wheelchairs when flooded. The trail section could be improved by relocating the trail farther toward the river, by building a boardwalk, or by raising the trail surface.

Maintaining the existing public use seasonal trail closures from October 1 to April 30 would help provide needed sanctuary for wintering waterfowl, and other wildlife such as the bald eagles, in support of refuge purposes.

Objective 12.2 Provide high-quality interpretive programs

Provide high-quality interpretive programs that:

- Follow the basic tenets of interpretation as defined in the Interpretive Process Model (Larsen 2003)
- Incorporate a variety of materials and technology into interpretive materials, such as signs, publications, exhibits, and direct contact with staff and volunteers
- Appeal to a variety of learning styles and facilitate self-discovery
- Convey the key messages and purposes of the refuge
- Explore interconnection of the natural and human environments
- Empower individuals to adopt conservation-minded lifestyles
- Emphasize first-hand experiences on the refuge

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Maintain existing interpretive facilities, including signs, exhibits, overlooks, and kiosks.	✓	✓	✓
Annually, provide interpretive training for volunteer naturalists and participating refuge staff and partners.	✓	✓	✓
By 2018, develop a partnership with the National Association for Interpretation to train refuge staff and long-term volunteers as Certified Interpretive Trainers and/or Certified Interpretive Guides.		✓	✓
Develop and publish an annual calendar of refuge presentations, special programs, and events. This would include volunteers and guest speakers who conduct a variety of interpretive programs on topics that support refuge messages and themes.		✓	✓
Partner with the Tribes to provide interpretive programs at the refuge that focus on Native Americans' traditional uses of the refuge and surrounding areas; uses of native fish, wildlife, and plants; and other indigenous knowledge.		✓	✓
Every 10 years, partner with Certified Interpretive Trainer(s) to conduct an audit or review of the refuge's interpretive programs to measure adherence to the Interpretive Process Model (Larsen 2003).		✓	✓

Rationale: Interpretation is a communication method whereby visitors and program participants forge emotional and intellectual connections between their own interests and the significance of refuge resources, and management of the refuge and the Refuge System. Interpretation differs from formal education in that participants are self-motivated, have a choice as to whether or not to participate, and are not part of a formal class seeking an educational objective. The refuge currently documents 90,000 annual visitors, only 4,000 of whom participate in formal education programs. Most of the remaining visitors come in small groups, with their families, or alone. Interpretation is a key method to connect the public with the primary messages of the refuge.

Objective 12.3 Provide opportunities for youth to participate in high-quality waterfowl hunting on the Riverboat Unit of the refuge

Waterfowl hunting on the Riverboat Unit should:

- Place a priority on safety (hunters are spaced appropriately, spatial separation exists between hunt areas and areas open to other recreational use, law enforcement presence is adequate, etc.)
- Include clear and concise regulations that are readily available
- Pose minimal conflict with wildlife and habitat objectives
- Pose minimal conflict with other priority public use activities
- Pose minimal conflict with neighboring lands
- Promote stewardship and conservation
- Provide youth with quality hunting experiences that include hunter education and mentorships in coordination with ODFW
- Promote understanding and appreciation of natural resources
- Provide reliable/reasonable opportunity to experience wildlife
- Use accessible facilities that blend into the landscape

Strategies Applied to Achieve Objective:	Alt 1 (no action)	Alt 2 (proposed action)	Alt 3
By 2015, complete all requirements to open the Riverboat Unit of the refuge to waterfowl hunting for youth.		✓	
Work closely with ODFW, local sporting organizations, and local hunters to develop a waterfowl youth hunt plan that includes hunter safety and mentorships.		✓	
By 2016, construct and maintain two to five hunting blinds and associated access trails on the Riverboat Unit. Manage use through a reservation and/or lottery system.		✓	
Explore the potential for local sporting organizations to provide volunteers, funding, and other resources needed to operate the youth hunting program, and maintain and repair associated facilities.		✓	

Rationale: Opportunities to hunt in the greater Portland area are increasingly scarce due to an ever-growing population, urbanization, and a relative lack of public lands open to these uses. Hunting (both for and against) was the subject of more letters and e-mails received during scoping for the CCP than any other topic. In particular, the community has expressed a very strong interest in sharing hunting traditions with youth.

Opening the refuge to waterfowl hunting would provide youth an opportunity to hunt in proximity to the

urban area, in uncrowded and in relatively natural environments. In addition, youth hunts would reinforce ODFW programs that expose young people to hunting heritage, education, and mentorships. Refuge hunting opportunities would be consistent with relevant state hunting regulations, and with management plans for applicable game species and the PFC's plans for cackling Canada geese (PFC 1999) and dusky Canada geese (PFC 2008).

Objective 12.4 Provide opportunities for high-quality fishing in the Tualatin River

Fishing opportunities in the Tualatin River should:

- Include clear and concise regulations that are readily available
- Pose minimal conflict with wildlife and habitat objectives
- Pose minimal conflict with other "big six" priority public uses
- Pose minimal conflict with neighboring lands
- Promote stewardship and conservation
- Focus on youth, families, and disabled persons
- Promote understanding and appreciation of natural resources
- Provide reliable and reasonable opportunities to experience wildlife
- Use the existing River Overlook on the Atfálat'i Unit of the refuge

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
By 2016, complete all requirements to open the refuge to fishing on the Atfálat'i Unit.		✓	
Work closely with ODFW, local sporting organizations, and local anglers to develop a fishing plan.		✓	
Explore the desirability of user fees to help operate the fishing program, and maintain and repair associated facilities.		✓	
Explore the potential for local sporting organizations to provide volunteers, funding, and other resources needed to operate the fishing program, and maintain and repair associated facilities in lieu of or to offset user fees.		✓	
By 2017, offer at least one special fishing event annually on the refuge and/or elsewhere in the local community. This could be a Take Me Fishing event, could coincide with Oregon's free fishing day(s) or National Fishing and Boating Week, and/or could be a separate local event at an area such as Henry Hagg Lake.		✓	✓
Work with partners to support and/or promote other fishing opportunities that are not on but near the refuge and/or within the Tualatin River watershed.		✓	✓

Rationale: Fishing opportunities on the Tualatin River, especially for families and disabled persons, are scarce. Opening the refuge to fishing would provide the public an opportunity to fish in proximity to the urban area, in an uncrowded and natural environment, and at a reasonable cost. Special emphasis would be placed on family-oriented and accessible fishing opportunities in order to introduce fishing to urban audiences who may otherwise not regularly experience this high-priority wildlife-dependent activity.

As part of an earlier planning and evaluation effort, fishing was determined compatible on the Atfálat'i

Unit (USFWS 2003a). Refuge fishing opportunities would be consistent with relevant state fishing regulations.

Objective 12.5 As land acquisition progresses and habitat restoration is completed on the Wapato Lake Unit of the Refuge, explore opportunities to offer high-quality waterfowl hunting

As land acquisition progresses and habitat restoration is completed on the Wapato Lake Unit of the refuge, explore opportunities to offer high-quality waterfowl hunting that:

- Place a priority on safety (hunters are spaced appropriately, spatial separation exists between hunt areas and areas open to other recreational use, law enforcement presence is adequate, etc.)
- Include clear and concise regulations that are readily available
- Pose minimal conflict with wildlife and habitat objectives
- Pose minimal conflict with other priority public use activities
- Pose minimal conflict with neighboring lands
- Promote stewardship and conservation
- Provide the public with quality hunting experiences that include hunter education and mentorship in coordination with ODFW
- Promote understanding and appreciation of natural resources
- Provide reliable/reasonable opportunity to experience wildlife
- Use accessible facilities that blend into the landscape and are compatible with and do not interfere with habitat restoration facilities and programs at Wapato Lake Unit

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Concurrent with habitat restoration research and planning (see Objective 8.2), explore the feasibility of providing safe parking and access to hunting facilities, such as blinds and associated trails.		✓	✓
If hunting is determined feasible, complete all requirements to open the Wapato Lake Unit of the refuge to waterfowl hunting within 2 years after restoration planning is completed.		✓	✓
Work closely with ODFW, local sporting organizations, and local hunters to develop a waterfowl hunt plan.		✓	✓
Concurrent with restoration, construct hunting blinds and associated access trails on the Wapato Lake Unit. Implement and maintain a hunting program. Manage use through a reservation and/or lottery system. Explore the desirability of user fees to help operate the hunting program, and maintain and repair associated facilities.		✓	✓
Explore the potential for local sporting organizations to provide volunteers, funding, and other resources needed to operate the hunting program, and maintain and repair associated facilities in lieu of or to offset user fees.		✓	✓

Rationale: Opportunities to hunt in the greater Portland area are increasingly scarce due to an ever-growing population, urbanization, and a relative lack of public lands open to these uses. Hunting was the subject of more letters and e-mails received (both for and against) during scoping for the CCP than any other topic.

Opening the refuge to waterfowl hunting would provide the public an opportunity to hunt in proximity to

the urban area, in uncrowded and relatively natural environments, and at a reasonable cost. The habitat and wildlife objectives for Wapato Lake Unit are very likely to support quality waterfowl hunts. Refuge hunting opportunities would be consistent with relevant state hunting regulations, and with management plans for applicable game species and the PFC's plans for cackling Canada geese (PFC 1999) and dusky Canada geese (PFC 2008).

Goal 13: Build a broad-based natural resource conservation constituency with a focus on urban audiences to create a conservation ethic within urban communities; increase relevance of habitat conservation, wildlife heritage, and the Refuge System in the eyes of urban citizens; and instill a sense of empowerment for urban communities to work together to actively support conservation, in both local and global settings.

Objective 13.1 Serve as a gathering place and clearinghouse for natural resource conservation–related information and resources to be shared among community organizations, agencies, educators, businesses, urban planners and builders, and other stakeholders

Serve as a gathering place and clearinghouse for natural resource conservation–related information and resources to be shared among community organizations, agencies, educators, businesses, urban planners and builders, and other stakeholders that:

- Provides an information exchange location for conservation partner resources as well as Refuge System information
- Encourages a collaborative approach to information sharing
- Is accurate, current, scientific, credible, and responsive to public requests and needs

Strategies Applied to Achieve Objective:	Alt 1 (no action)	Alt 2 (proposed action)	Alt 3
Develop a guide to the sustainable land management and construction practices employed by the refuge, and share with interested partners such as urban planners, developers, and individuals.		✓	✓
Develop a self-guided walking tour of the refuge's sustainability features. This may include leaflets, exhibits, and/or technology-based information such as podcasts and QR codes.		✓	✓
Develop a reference library of natural resource/conservation education curricula, techniques, and materials. Provide access to formal and informal educators, parents, schools, and youth clubs.		✓	✓
Provide a resource library of land conservation incentives, and cost-sharing and financial assistance opportunities through organizations such as UFSWS Partners for Fish and Wildlife; Natural Resources Conservation Service; ODFW; Oregon Watersheds Enhancement Board; soil and water conservation districts; and watershed councils.		✓	✓
Engage refuge staff and Friends of the Refuge leadership in urban land use and open space planning in communities surrounding the refuge to encourage development that favors	✓	✓	✓

wildlife corridors, watershed protection, and high-quality nature-based recreation.			
Provide technical assistance and/or subject matter experts to local communities for both wildlife and habitat restoration and management, and nature-based recreation and education.		✓	✓
Host one open house per year that highlights urban refuge–related conservation challenges, progress, opportunities, research, and initiatives.		✓	✓
In cooperation with Intertwine, use the refuge's Wildlife Center to host and facilitate dialogue regarding conservation-related urban planning efforts.		✓	✓
Establish a conservation leadership program that encourages urban youth aged 18 to 25 to contribute to community conservation needs.		✓	✓
In cooperation with the Service Natural Resources Program Center's Branch of Social Science, collect scientific literature, research, and materials supporting social values of connecting people with nature. Provide this information to partners and the public.		✓	✓
Rationale: As an urban refuge, Tualatin River National Wildlife Refuge can be a catalyst for building a natural resource conservation constituency among urban dwellers. The refuge is strategically located near more than 2 million people in the Portland-Salem metropolitan area and is accessible to countless local and regional jurisdictions, schools, agencies, nonprofit organizations, and commercial organizations. Conservation information is plentiful, but there are few places where information is centrally accessible. While the refuge cannot provide comprehensive conservation information, the refuge can partner with entities such as the Intertwine Alliance (www.theintertwine.org), ODFW, USFWS Partners for Wildlife Program, and others to leverage collective resources. In addition, the refuge can serve as an example of wildlife habitat restoration and sound land management techniques, as well as high-quality nature-based recreation and education. The USFWS "Conserving the Future" vision document (USFWS 2011e) states that "As leaders, partners, and role models in conservation efforts, we can seek to inspire others to work with us …."			

Objective 13.2 Provide urban people tangible opportunities to experience nature and actively participate in the work of conservation

Provide urban people tangible opportunities to experience nature and actively participate in the work of conservation in a way that:

- Appeals to and reflects the diverse communities and people of the Portland-Salem metropolitan area. (Diversity may be measured in economic, educational, cultural, ethnic, and language terms)
- Builds comfort for those unfamiliar with or lacking experience in nature
- Focuses on urban citizens, with an emphasis on families and children
- Incorporates standards of excellence for urban refuges as defined in recommendation 13 of the USFWS "Conserving the Future" vision document (USWFS 2011e)
- Uses the refuge's land base to connect people with nature

Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**
Incorporate objectives and strategies for public activities as defined for Goals 10, 11, and 12.	✓	✓	✓

Become a partner in national and regional outreach organizations such as Children in Nature Network, Nature Rocks, Intertwine Alliance, and other similar groups.	✓	✓	✓
Hire urban youth (ages 18-25) through direct hires or through partnerships with organizations such as Northwest Youth Corps, Confluence Environmental Center, and Youth Conservation Corps of Oregon. Youth would participate in the work of habitat conservation on the refuge and in the community.	✓	✓	✓
By researching literature and relevant publications, identify barriers to connecting the Portland-Salem metropolitan area's urban population with nature. Use results to adapt refuge outreach, education, and interpretation programs as appropriate.		✓	✓
Use the refuge's nature explore area (see Objective 11.1) to promote development of similar play areas in urban communities.		✓	
Develop a transportation outreach strategy for letting urban audiences know how to access the refuge using existing and future planned infrastructure (bus stop, bike lanes, and regional trail systems).		✓	✓
Rationale: Many organizations are recognizing an increasing disconnect between people (especially children) and the natural world. In addition, our society is more ethnically and socially diverse and increasingly more urban, with 80% of Americans living in urban or suburban areas. Nature therefore seems to be, or is, farther away from the majority of Americans than ever before. As urban dwellers have competing priorities, technology is replacing place-based opportunities, and nature places may be harder to access, people have fewer experiences in nature (USFWS 2011e). The Oregon Parks and Recreation Department (OPRD) recognizes several demographic and social changes, including fewer youth learning outdoor skills, a (lack of) physical activity crisis, and an increasingly diverse Oregon population (OPRD 2008). These types of changes have led to an increased disconnect between people and the natural world, to the detriment of physical and mental health, as well as decreasing understanding, awareness, and support of conservation efforts. It is critical to provide nature-based facilities and programs to provide opportunities for diverse urban publics to reconnect with their natural environment, for the benefit of both wildlife and people. Key to the effort is providing nature-based experiences starting in childhood to prepare youth with a foundation for facing future environmental challenges (Chawla 1988; Palmberg and Kuru 2000).			

Objective 13.3 Share how the conservation of natural resources is relevant to urban communities			
Share how the conservation of natural resources is relevant to urban communities in a way that: • Builds support for conservation of the refuge and other natural spaces • Reaches a demographic that mirrors the diversity of the Portland-Salem metropolitan area • Promotes dialogue and partnerships to further identify connections between the value of the natural world and the well-being of people • Increases environmental literacy of citizens (see Rationale for definition of environmental literacy)			
Strategies Applied to Achieve Objective:	**Alt 1 (no action)**	**Alt 2 (proposed action)**	**Alt 3**

Complete an economic benefits study demonstrating the refuge's economic contribution to local community, and share with local jurisdictions, tourism organizations, city planners, and community leaders.		✓	✓
Partner with local health care providers and organizations to promote the value of nature-based activities in support of mental and physical health for community members.		✓	✓
Identify and/or develop projects in and near the refuge, such as a water quality monitoring station or bioswale, to measure and demonstrate the value of natural systems to improving watershed health.		✓	✓
Develop outreach and interpretive materials to address landscape-level conservation issues/challenges that affect habitats and wildlife, as well as agriculture areas and communities. Examples of topics may include: the value of pollinators for native landscapes and for agricultural crops and urban gardens; the threats of nonnative and invasive species; the ever-increasing interaction with wildlife in urban neighborhoods; and the effect of climate change.		✓	✓
Seek partner(s) to develop traveling exhibit and/or outreach materials demonstrating the value of natural spaces for improved mental and physical health. Display at local libraries, museums, schools, hospitals, other urban refuges or natural areas, and other urban community centers.		✓	✓
Rationale: Increasing the relevance of natural systems to urban people would build increased awareness of and support for conservation and, therefore, human well-being. The National Park Service (NPS), through its "Healthy Parks Healthy People US" strategic plan states that "human health is dependent upon the health of all species and the planet we share" (NPS 2011). Even more traditional nonprofit organizations such as The Nature Conservancy and Trust for Public Lands recognize the need for an increasing urban focus to stay viable in the minds of citizens (Grist.org 2012; Trust for Public Lands 2003). The Nature Conservancy's chief scientist is quoted as saying "Conservation is facing a crisis of irrelevance—it is an enterprise that is not urgent to most people…. If conservation is to build the support it needs, it must energize young urban dwellers, who now make up most of the world. The best way to get city people to care about conservation is to do conservation where they live, so that nature is seen as relevant and connected to modern life" (Grist.org 2012). Also critical to gaining this support is an increased need for people to understand the interrelationship between environment, society, and economy. In 2009, the State of Oregon passed into law the "No Oregon Child Left Inside Act" (HB2544), which created a task force that, in 2010, defined environmental literacy as "an individual's understanding, skills and motivation to make responsible decisions that consider his or her relationships to natural systems, communities and future generations" (Oregon Environmental Literacy Task Force 2010). Through the strategies listed above, the refuge can increase relevance to people's everyday lives through their food sources, water sources, and personal health, as well as increase environmental literacy of citizens to behave in a way that contributes to conservation.			

Chapter 3
Physical Environment

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Chapter 3 Physical Environment

3.1 Climate

3.1.1 General Climate

Tualatin River National Wildlife Refuge (the refuge) is located in Washington and Yamhill Counties in northwestern Oregon (see Appendix P, Map 3). The refuge is located at the northern end of the Willamette Valley in the Tualatin River watershed, between the Coast Range mountains and the Willamette River (see Appendix P, Map 1). Much of the refuge lies within the Tualatin River floodplain. Major tributaries that drain into the refuge include Chicken and South Rock Creeks in the Sherwood Units (see Appendix P, Map 6), and Wapato, Hill, Ayers, Harris, and Scoggins Creeks at the Wapato Lake Unit (see Appendix P, Map 7). Many smaller perennial and ephemeral streams also drain into the basin. Elevation within the Sherwood Units ranges from about 105 feet to 300 feet. Elevation at the Wapato Lake Unit varies from about 160 to 240 feet, with the majority of the lake bed at about 170 feet. The Tualatin River Valley consists of low foothills, terraces, alluvial fans, and floodplains. The floodplains are subject to frequent flooding during winter and spring. However, changes due to agriculture, urbanization, and flood control projects have altered historic flooding patterns.

Photo 3-1. Frozen wetlands on the Atfálat'i Unit, January 2008. Peter Schmidt/ USFWS.

The northern Willamette Valley exhibits a general maritime climate with cool, wet winters and warm, dry summers. Temporal patterns of climate variability in Oregon are primarily influenced by the Pacific Ocean, namely the El Niño/Southern Oscillation (Oregon Climate Change Research Institute [OCCRI] 2010). Precipitation averages about 42 inches per year (Table 3-1) and occurs mainly from November through March. Average temperatures are lowest from December through February and highest on average during July and August (Table 3-1). Severe weather events are rare

but may include summer temperatures above 100°Fahrenheit (F), winter snow and ice storms, flooding of the Tualatin River and tributaries, high winds, and periods of subfreezing weather. Flooding of the river and tributaries typically occurs during December and January when the ground has become saturated and rainfall increases (Figure 3-1).

Table 3-1. Monthly High, Low, and Average Temperatures; Monthly Rainfall April 2008-March 2009

Month	Average Temperature*	Average Precipitation**
January	40.0	6.74
February	41.3	3.63
March	45.3	4.36
April	48.5	2.95
May	58.9	2.59
June	61.8	1.15
July	68.8	0.21
August	69.6	0.74
September	65.2	1.01
October	53.5	3.62
November	49.2	7.12
December	37.5	8.23
Total		42.35

* National Oceanic and Atmospheric Administration (NOAA) National Weather Service for Portland, Oregon.

**Average from refuge rain gauge 2003-2010.

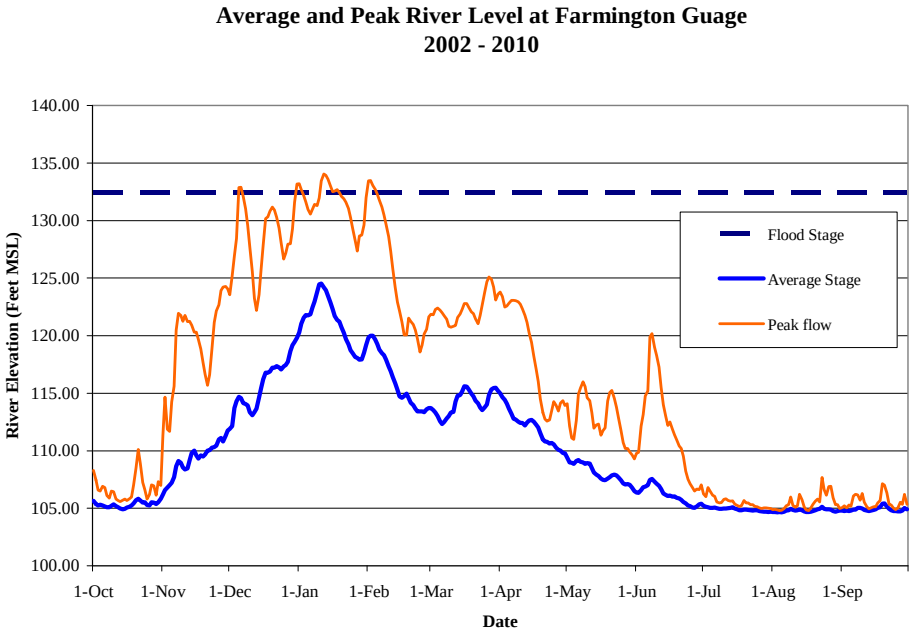

Figure 3-1. Average and peak river levels measured in feet above mean sea level (MSL) at Farmington gauge approximately 8 miles upstream from the westernmost parcel in the Sherwood Units.

3.1.2 Climate Change

As stated in U.S. Department of the Interior (USDOI) Secretarial Order 3226 (USDOI 2009) and the Service's climate change strategic plan (USFWS 2010c), the Service considers and analyzes climate change in its decisions, long-range plans, and other activities. Also, refuge efforts contribute to carbon sequestration through habitat restoration and protection efforts. A 1999 U.S. Department of Energy report, *Carbon Sequestration Research and Development* (U.S. Department of Energy 1999), concluded that ecosystem protection is important to carbon sequestration and may reduce or prevent loss of carbon currently stored in the terrestrial biosphere. The report defines carbon sequestration as "the capture and secure storage of carbon that would otherwise be emitted to or remain in the atmosphere."

Greenhouse gases (GHG) occur naturally in the Earth's atmosphere, but are also added by human activities. This happens primarily through the burning of fossil fuels, such as coal, oil, and natural gas, which releases carbon dioxide into the atmosphere. Over the past century, atmospheric carbon dioxide (as measured from ice cores) has increased due to human activities, and the average Earth temperature has increased approximately 0.7°Celcius (C) or about 1.3°F (NOAA 2011a; OCCRI 2010) (Figure 3-2), and it continues to increase.

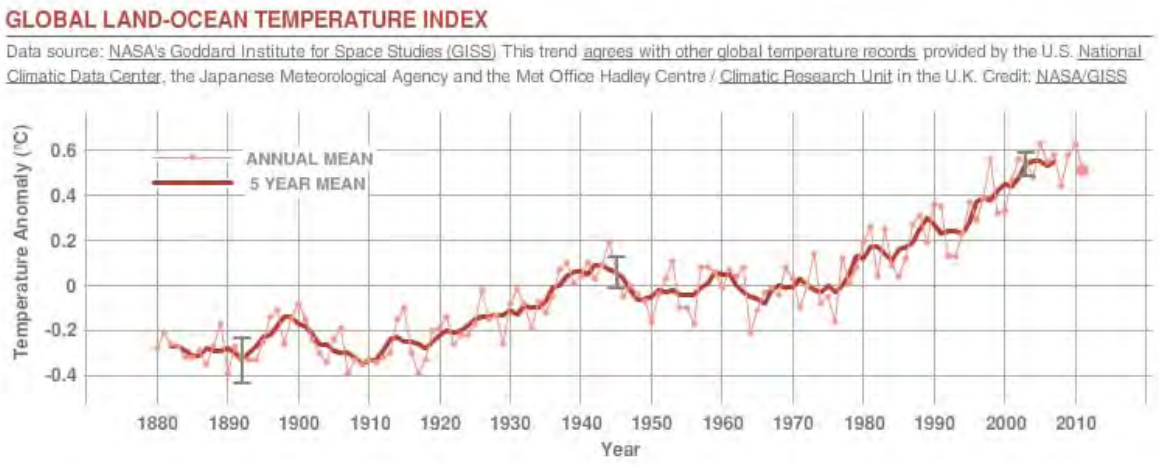

Figure 3-2. Global surface temperature (NASA 2012).

The greenhouse effect is a natural phenomenon that assists in regulating and warming the temperature of our planet. Just as a glass ceiling traps heat inside a greenhouse, certain gases in the atmosphere, called greenhouse gases, absorb heat from sunlight. The primary GHGs occurring in the atmosphere include carbon dioxide, water vapor, methane, and nitrous oxide. Carbon dioxide is produced in the largest quantities, accounting for more than half of the current impact on the Earth's climate.

The terms "climate" and "climate change" are defined by the Intergovernmental Panel on Climate Change (IPCC). "Climate" refers to the mean and variability of different types of weather conditions over time, with 30 years being a typical period for such measurements, although shorter or longer periods also may be used (IPCC 2007b:78). The term "climate change" thus refers to a change in the mean or variability of one or more measures of climate (e.g., temperature or precipitation) that persists for an extended period, typically decades or longer, whether the change is due to natural variability, human activity, or both (IPCC 2007b:78).

Scientific measurements spanning several decades demonstrate that changes in climate are occurring, and that the rate of change has been faster since the 1950s. Examples include warming of the global climate system, and substantial increases in precipitation in some regions of the world and decreases in other regions. (For these and other examples, see *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* [IPCC 2007a:30] and *Technical Summary* [Solomon et al. 2007:35-54, 82-85].) In the Pacific Northwest, increased GHGs and warmer temperatures have resulted in a number of physical and chemical impacts. These include changes in snowpack, stream flow timing and volume, flooding and landslides, sea levels, ocean temperatures and acidity, and disturbance regimes such as wildfires, insects, and disease outbreaks (United States Global Change Research Program [USGCRP] 2009). All of these changes will cause major perturbations to ecosystem conditions, possibly imperiling species that evolved in response to local conditions.

Results of scientific analyses presented by the IPCC show that most of the observed increase in global average temperature since the mid-twentieth century cannot be explained by natural variability in climate, and is "very likely" (defined by the IPCC as 90 percent or higher probability) due to the observed increase in GHG concentrations in the atmosphere as a result of human activities,

particularly carbon dioxide emissions from use of fossil fuels (IPCC 2007b:5-6, Figures SPM.3 and SPM.4; Solomon et al. 2007:21-35). Further confirmation of the role of GHGs comes from analyses by Huber and Knutti (2011:4), who concluded it is extremely likely that approximately 75 percent of global warming since 1950 has been caused by human activities.

Looking toward the future, the University of Washington Climate Impacts Group (CIG) has projected changes in mean annual temperature and precipitation for the Pacific Northwest based on "statistical downscaling" an ensemble of 20 global climate models and two carbon emissions scenarios for each model run (Mote and Salathé 2009, 2010). The CIG also performed projections using two regional climate simulations with the same two emissions scenarios (Salathé et al. 2010). These two approaches provide the projected changes described below.

3.1.2.1 Temperature: Historical Trends and Projections

The Pacific Northwest experiences wide temperature variability based on geography (for example, the Olympic, Coast, and Cascade mountain ranges enhance a moderating maritime influence west of the Cascades) and seasonal and year-to-year variability (e.g., associated with the El Niño-Southern Oscillation) (Salathé et al. 2010). In the Pacific Northwest, regionally averaged temperature rose 1.5°F between 1920 and 2000, slightly more than the global average. Warming was largest for the winter months of January through March. Minimum daily temperatures have increased faster than maximum daily temperatures (Mote et al. 2005).

Historical climate data for Tualatin River National Wildlife Refuge are available from the United States Historical Climatology Network (USHCN), a high-quality data set of daily and monthly records of basic meteorological variables from 1,218 observing stations across the 48 conterminous states. The data have been corrected to remove biases or heterogeneities from nonclimatic effects such as urbanization or other landscape changes, station moves, and instrument and time-of-observation changes.

The USHCN Forest Grove, Oregon, station is the station closest to the refuge, and temperature data are shown in Figure 3-3. There has been a statistically significant increase of 1.36°F ($p = 0.001$) in average annual temperature from 1925 to 2010 at the Forest Grove station, similar to the regional average. Much of the increase is due to the increase in minimum temperature (increase of 1.53°F, $p = 0.000$) rather than maximum temperature (increase of 1.1°F, $p = 0.025$). In the past 30 years, temperature increases have been particularly pronounced during summer months (Table 3-2).

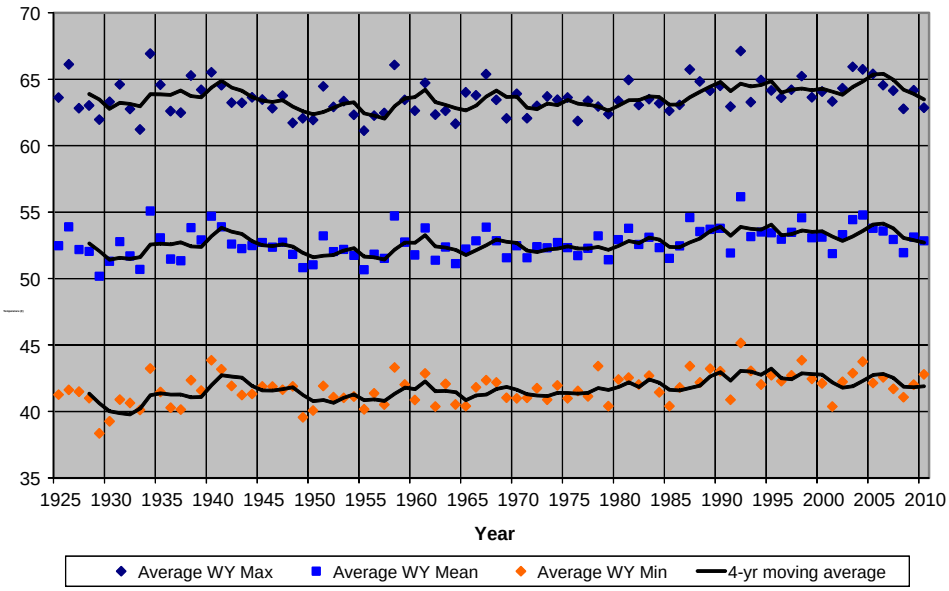

Figure 3-3. Water year temperature 1925-2010. USHCN Station: Forest Grove, Oregon (352997).

Table 3-2. Seasonal Temperature Trends, 1981-2010 (Monthly Records)

	Monthly Absolute Change		
	Temp. Max	**Temp. Avg**	**Temp. Min.**
Winter (Dec-Feb)	+0.54°F	+0.18°F	−0.21°F
Spring (march-May)	−0.23°F	−0.44°F	−0.64°F
Summer (Jun-Aug)	+1.36°F	+1.07°F	+0.79°F
Fall (Sept-Nov)	−0.36°F	−0.41°F	−0.48°F

* Forest Grove, Oregon United States Historical Climatology Network Observation Station

Looking to future projections, researchers have refined global circulation models so that they are useful at a regional scale, in our case, for the Pacific Northwest. One approach involves statistical downscaling of 20 global climate models, which projects that average annual temperature would increase by 2.0°F by the decade of the 2020s for the Pacific Northwest, 3.2°F by the decade of the 2040s, and 5.3°F by the decade of the 2080s, relative to the 1970-1999 average temperature (Mote and Salathé 2009, 2010). This is substantially greater than the 1.5°F increase in average annual temperature observed in the Pacific Northwest during the twentieth century. Seasonally, summer temperatures are projected to increase the most. One important note is that actual global emissions of GHGs in the past decade have exceeded even the highest emissions scenario (the A2 scenario), a scenario that was not modeled by Mote and Salathé in 2009 and 2010, or Salathé et al. in 2010 (discussed below). The authors used more moderate emissions scenarios. If these emission trends continue, temperature increases could turn out to be much greater than projected.

Another approach involves two regional climate simulations (Salathé et al. 2010). These findings support the warming increases described above, with small variations. West of the Cascades, both regional climate change models predict warming in all seasons (when compared to current average air temperatures) (Salathé et al. 2010). Increases in air temperature are forecasted to be the greatest in summer and spring (including increased frequency of heat waves, which are three or more consecutive days with a daily heat index of over 89.6°F or 32°C), while increased marine cloudiness in fall and winter may dampen temperature increases during those seasons (Salathé et al. 2010).

It should be noted that these projections are not intended to be predictions of actual conditions on any given date. Models represent the average response over climatological timescales (i.e., on a multi-decadal timescales) rather than precise behavior at exact dates. As discussed above, the Pacific Northwest's long-term climate includes a high degree of interannual and decadal variability, and this is projected to continue. However, long-term trends and projections indicate that overall temperatures are increasing and will continue to do so.

3.1.2.2 Precipitation: Historical Trends and Projections

Longer-term precipitation trends in the Pacific Northwest are more variable than temperature and vary with the period of record selected for analysis (Mote et al. 2005). The Pacific Northwest experiences this wide precipitation variability due to geography (e.g., the Olympic, Coast, and Cascade mountain ranges cause orographic, or upward, lift of air masses and precipitation) and seasonal and year-to-year variability (e.g., variation associated the El Niño Southern Oscillation and other longer-term oscillations) (Salathé et al. 2010). Looking at the period 1920 to 2000, precipitation has increased almost everywhere in the region, though not in a uniform fashion. Most of that increase occurred during the first part of the record (Mote et al. 2005).

The Forest Grove USHCN station (the closest station to the refuge) provides historical precipitation data, shown in Figure 3-4. There is no statistically significant trend, but note the year-to-year variability, such as flood risk during El Niño years in the late 1990s, which can provide management challenges for the refuge.

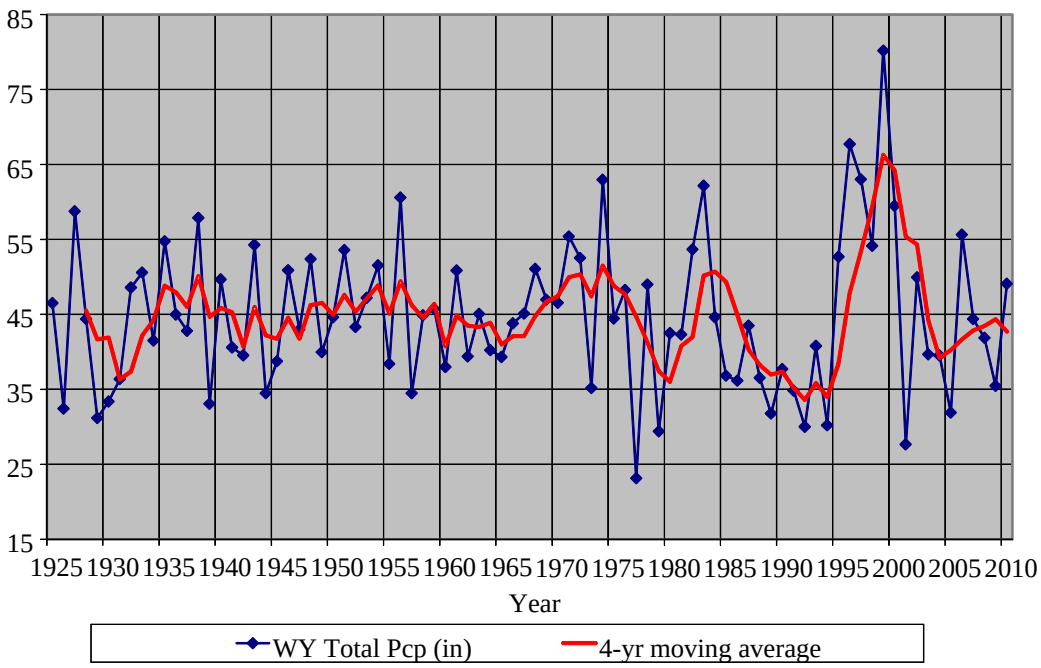

Figure 3-4. Water year total precipitation 1925-2010. USHCN Station: Forest Grove, Oregon.

The other significant trend found from the Forest Grove USHCN observation station is a 37 percent decline in summer precipitation in the last 30 years (Figure 3-5).

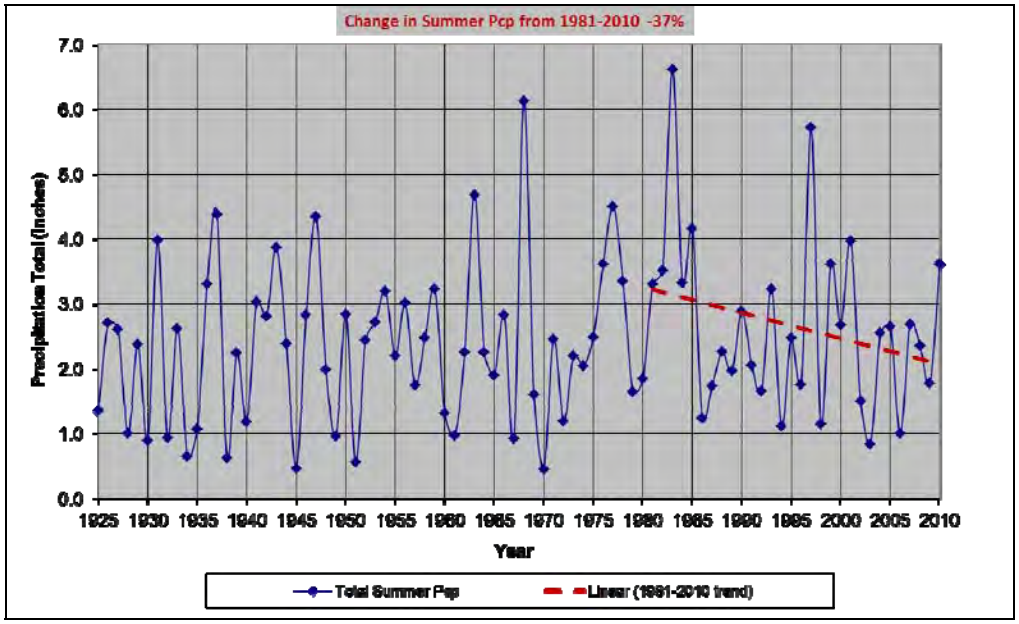

Figure 3-5. Summer (Jun-Aug) total precipitation, 1925-2010. USHCN Station: Forest Grove, Oregon (352997).

West of the Cascades, projections of future precipitation levels vary by model, with a majority of models projecting an annual increase in precipitation (Mote and Salathé 2010) and some models projecting a decrease relative to current observations (Leung et al. 2004). A strong seasonal pattern in altered precipitation relative to current levels is foreseen, as well as increases in the number of extreme precipitation events (daily precipitation exceeding the twentieth-century 95th percentile) (Salathé et al. 2010). Seasonal increases in precipitation are projected for fall, winter, and spring, and little change or a slight decline in precipitation for summer (Salathé et al. 2010). Regional climate change models project conflicting results for the spring season, with one model showing a substantial decline in precipitation while the second shows increases in precipitation (Salathé et al. 2010).

3.1.2.3 Stream Flow Changes

In addition to changes in the amount of precipitation, a major concern in the Pacific Northwest is change in the form of winter precipitation expected due to warmer temperatures. The CIG has modeled changes in current and future peak snowpack versus October through March precipitation for watersheds in the Columbia River Basin and the coastal watersheds of Oregon and Washington. Generally, there is a large shift in the form of winter precipitation from snow to rain, with lower elevation basins affected before upper elevation basins (Elsner et al. 2010). As these changes occur, there would likely be a tendency for higher winter flows and possible increased risk of flooding in transition watersheds (those not dominated by snow processes and those not rain-dominant), earlier snowmelt and runoff from peaks, and lower summer stream flows (Hamlet and Lettenmaier 2007). The Tualatin River watershed is a rain-dominant system, and these changes may not be significant to the refuge.

3.2 Hydrology

3.2.1 Regional Hydrology

The refuge lies within the Tualatin River watershed, which is a part of the Willamette River Basin (see Appendix P, Map 3). The Tualatin River is one of the most northern tributaries in the Willamette River watershed and is about 80 miles long (Tualatin River Watershed Council [TRWC] 1998). The river flows roughly eastward from the Coast Range mountains in Washington County, Oregon, to its confluence with the Willamette River in Clackamas County, Oregon, near the City of West Linn. The elevation at the headwaters of the Tualatin River is approximately 1,980 feet, and there are four large elevation drops in the river before it enters the Tualatin Valley plain at an elevation of 240 feet. Where the Tualatin River meets Wapato Lake, the elevation is about 170 feet, and where the Tualatin River meets the Willamette River, it is 58 feet in elevation. The Tualatin River drainage basin is approximately 43 miles long and 29 miles wide, covering an area of 712 square miles (TRWC 1998). Annually, more than 1.1 million acre-feet of water flow out of this watershed into the Willamette River. Nearly 85 percent of this flow is discharged during November through March.

The river can be characterized in four distinct reaches with varying degrees of flows and gradients (Table 3-3).

Table 3-3. Approximate Reaches of the Tualatin River As it Flows from the Coast Range Mountains (rivermile 80) to its Confluence with the Willamette River (rivermile 0)

Reach	Description	Rivermile	Elevation Gradient (feet/mile)	Description
1	Mountain	80-58	80.4	Forested, fast-moving mountain streams, rock channels
2	Meander	58-33	2.8	Transition from timberland to farmland, major floodplain storage, logjams
3	Reservoir	33-3.4	0.2	Flat, “reservoir like” flow with heavy sedimentation, recreational use
4	Riffle	3.4-0.0	10.1	Steep gradient, short series of shallow pools and riffles

The first reach of the river starts in the mountains and is characterized by forested, fast-moving mountain streams with rock channels. As the river flows through the basin, it slowly transitions from forested areas into more open habitat, and the flow changes from fast to slow flowing. The Tualatin River has five major and numerous minor tributary streams. Streams entering the river within the refuge include Wapato, Ayers, Hill, Harris, and Scoggins Creeks in the Wapato Lake Unit, and Chicken and Rock Creeks in the Sherwood Units. Average daily flow rate in the Tualatin River measured at the West Linn gauging station, approximately 1.7 miles from the confluence with the Willamette River, ranged from a low of 80 cubic feet per second (cfs) to a high of 4,150 cfs between 1928 and 2010 (Figure 3-6). These figures do not include water that is diverted upstream of this gauging station into Oswego Lake.

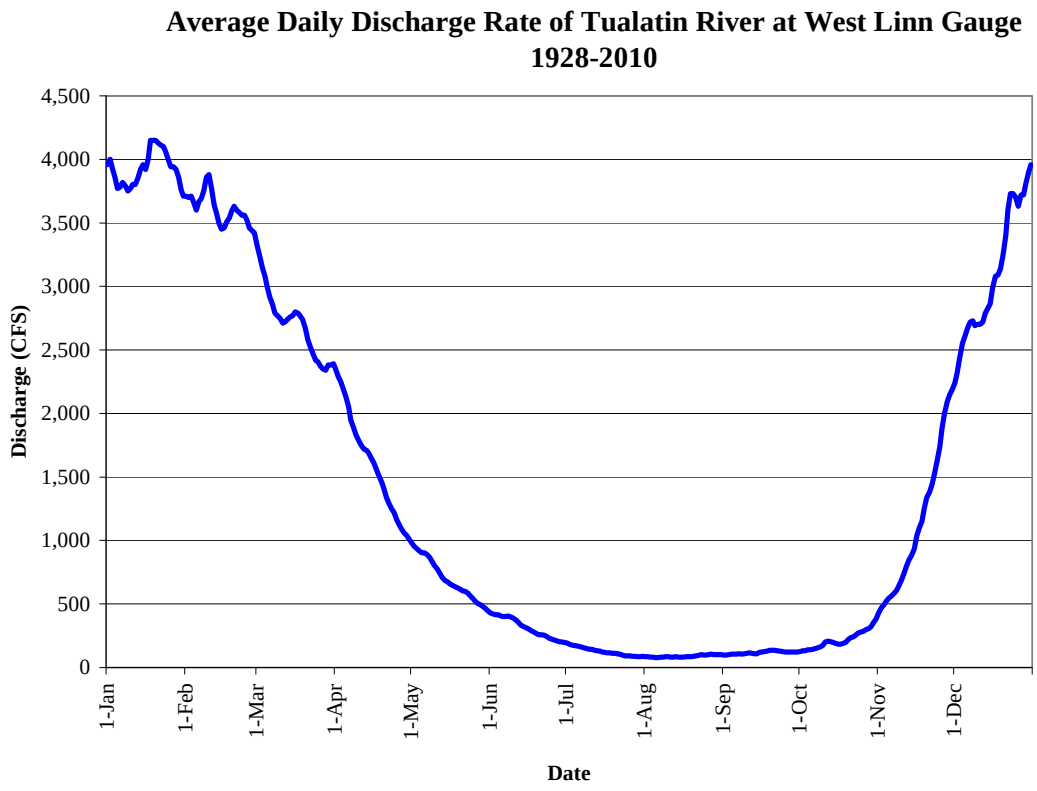

Figure 3-6. Average daily discharge rate (cfs) measured on the Tualatin River at the West Linn gauging station.

In general, stream flow in the Tualatin River Basin reflects patterns of precipitation with high winter and low summer flows (Figure 3-6. River elevation measured at the Farmington gauge is typically at summer flows (<110 feet) from late April to early May until late October when precipitation begins to fill the river basin. Flooding in tributary streams is typically more prevalent during short-term heavy rainfall after the surrounding watershed is saturated by early season rainfall. In particular, the Chicken Creek watershed, which includes Cedar Creek, flows from the City of Sherwood and experiences heavy flooding. The population of Sherwood has increased from about 3,000 in 1990 to over 18,000 in 2010, and this has led to an increase in urban development (U.S. Census Bureau 2011). This change has created increased impervious surfaces (e.g., roads, rooftops) and has led to an increase in runoff and higher peak flows in Chicken Creek that flow into the refuge.

Photo 3-2. Chicken Creek flooding. Peter Schmidt/USFWS.

There are two dams affecting water flows within the basin: Scoggins dam on Scoggins Creek, creating Henry Hagg Lake, and the Lake Oswego diversion dam, which shunts water to Oswego Lake. In addition, Barney Reservoir on the Trask River diverts water to the Tualatin River during summer to augment flows. Henry Hagg Lake has a capacity of 53,600 acre-feet of water and is managed by the Bureau of Reclamation (USDOI 2011). A large part of refuge lands, both in the Sherwood Units and the Wapato Lake Unit, lie within the jurisdictional boundary of the Tualatin Valley Irrigation District. This district was formed to deliver irrigation water associated with the Henry Hagg Lake project. As members of the district with attached water rights, the refuge is required to pay for irrigation on lands that fall within the district.

3.2.2 Refuge-specific Hydrology

Water Rights: The refuge has a complex system of irrigation ditches, springs, creeks, wetland cells, and water control structures for moving water within the refuge to fill the various wetland cells and for irrigation purposes in the cooperative farming program. The refuge has 51 water rights with priority dates ranging from 1890 to 2000. Sources of water include wells, ditches, unnamed creeks, springs, overland flow and runoff, Chicken Creek, Hill Creek, Rock Creek, Scoggins Creek, and the Tualatin River. The purposes of the water rights are primarily for irrigation and wildlife use, and to ensure that water is diverted for use on approximately 1,157 acres of wet prairie, scrub-shrub, and herbaceous wetlands at the Sherwood Units and the lake bed at the Wapato Lake Unit. In addition, the Service voluntarily selected 15 irrigation water rights for in-stream leases, which aids in restoration and protection of over 4 cfs of stream flow in Rock Creek and the Tualatin River.

Table 3-4 summarizes the water rights of the refuge.

Table 3-4. Summary of Water Rights for the Refuge

Priority Date	Application No.	Certificate No.	Source Name	Flow Rate (cfs)	Place of Use/Storage (Acres/Acre-Feet)
Groundwater					
25-Jul-50	G-2325	33116	Well	0.026	2.9
30-Sep-68	G-4614	45012	Sump well	0.07	
27-Oct-88	G-11863	72443	Well	0.35	
19-Oct-06	G-16740		Three wells	0.13	
Instream Lease					
02-Mar-51	IL-809	20149	Rock Creek	0.34	
05-Dec-28	IL-867	8117	Rock Creek	0.38	
05-Dec-28	IL-867	8117	Rock Creek	0.38	
1-01-1890	IL-869	29185	Cummings ditch	0.1	
16-Jun-50	IL-868	22918	Tualatin River	0.35	
1-01-1890	IL-870	29186	Rock Creek and unnamed ditches	0.338	
1-01-1890	IL-871	29191	Rock Creek	0.044	
1-01-1890	IL-872	29192	Unnamed ditches	0.037	
1-01-1890	IL-873	29193	Rock Creek	0.1	
1-01-1890	IL-874	29195	Springs and ditch	0.044	
1-01-1890	IL-875	29202	Cummings Ditch and unnamed ditches	0.231	
1-01-1890	IL-876	29282	Rock Creek	0.063	
25-May-53	IL-890	81965	Tualatin River	0.97	
Reservoir					
23-Jun-97	R-83470		Chicken Creek		579 Acre-Feet
01-Jul-97	R-83496		Runoff		180 Acre-Feet
12-Aug-97	R-83529		Runoff and Chicken Creek		40 Acre-Feet
08-Aug-00	R-84503		Tualatin River, overland flow		100 Acre-Feet

Table 3-4. Summary of Water Rights for the Refuge

Priority Date	Application No.	Certificate No.	Source Name	Flow Rate (cfs)	Place of Use/Storage (Acres/Acre-Feet)
25-Jul-01	R-84813		Runoff		10 Acre-Feet
24-Apr-03	R-85570	84056	Overland flow/runoff		1.6 Acre-Feet
24-Apr-03	R-85571	84055	Overland flow/runoff		2.9 Acre-Feet
24-Apr-03	R-85572	84054	Overland flow/runoff		2 Acre-Feet
24-Apr-03	R-85573	84053	Overland flow/runoff		1.8 Acre-Feet
06-May-05	R-86279		Runoff		60 Acre-Feet
Surface Water					
29-Dec-28	S-12500	14092	Tualatin River	6.93	553.8 Acres
29-Dec-28	S-12500	14093	Tualatin River	2.03	162.3 Acres
29-Aug-30	S-13702	14096	Chicken Creek (Cedar Creek)	1.8	143.3 Acres
19-Nov-35	S-16153	24368	Chicken Creek	1.01	80.8 Acres
04-Sep-36	S-16568	45451	Hill Creek	0.06	4 Acres
04-Sep-36	S-16568	45451	Tualatin River	.44	36 Acres
01-Aug-39	S-18312	19761	Tualatin River	1.08	21 Acres
26-Feb-40	S-18591	15099	Tualatin River	0.21	2.1 Acres
14-Nov-49	S-24270	22317	Rock Creek	0.044	3.5 Acres
25-Jul-50	S-25034	23148	Drainage ditch and unnamed stream	0.16	7 Acres
25-Jul-50	S-25035	20132	Unnamed drainage	0.024	2.9 Acres
12-Mar-51	S-25704	40860	Tualatin River	0.38	30 Acres
02-Jun-65	S-40957	40726	Tualatin River	0.6	50 Acres
31-Mar-71	S-48082	43946	Tualatin River	0.96	77.1 Acres
28-Jun-82	S-63714	64950	Chicken Creek	1.08	86.2 Acres
25-May-53	T-10246	81965	Tualatin River	0.13	
02-Jan-00		29187	Rock Creek		

Source: USFWS 2012.

The main season of water use is usually between November until May at select locations. This varies with water conditions as determined by annual precipitation. Adequate water is important to provide habitat for migratory birds and for irrigation of habitat restoration sites. During the winter, most wetland cells (including the Wapato Lake Unit lake bed) are kept full to provide water for both resident and wintering species.

Photo 3-3. Tualatin River flooding at the Tualatin River Unit, December 2007.
Peter Schmidt/USFWS.

Sherwood Units: The floodplain of the Tualatin River is the dominant feature within the Sherwood Units (see Appendix P, Map 6). The Atfálat'i Unit is bordered by the Tualatin River, but water for wetlands in much of this unit comes from a diversion on Chicken Creek. The diversion allows gravity flow to fill five managed wetland cells in the unit. One additional wetland cell is filled by rain water and is managed as a permanent wetland with no outlet structure. Another wetland cell is also filled with rain water and overland runoff, but is managed as a seasonal wetland with a water control structure at the outlet.

On the Tualatin River Unit there are five wetland impoundments that normally fill with rain and overland runoff, but the largest wetland also has a pump with a fish screen in the Tualatin River that may be used to conduct early season flood-up or to augment rainfall during periods of drought. On the Riverboat Unit there are four impoundments, with a seasonal wetland filled using a water control structure to back up overland flow from springs and rainfall and, frequently, floods from high water in the Tualatin River. In addition, the seasonal wetland has a series of three low-capacity wells that are sometimes used to augment overland flow in early fall. There is also a scrub-shrub wetland, which is a closed water body and is filled by rainfall alone. During extreme flooding of the Tualatin River, the scrub-shrub wetland becomes a flow channel for river water. This unit has extensive floodplain connections to the river and is often saturated through the winter.

The Onion Flats Unit is a low-lying basin bisected by Rock Creek. The creek is channelized and straightened through this unit and is deeply incised. This area floods frequently as the Tualatin River water backs up Rock Creek, and also during periods of heavy rain. The Rock Creek Unit features its

namesake creek and is also largely channelized. This is a relatively small creek through this unit and rarely causes any major flooding. During winter as the Tualatin River begins to reach bankfull stage (elevation 128 above mean sea level), many backwater areas in riparian forest and wetland habitats begin to flood. Vegetation communities in these areas are adapted to frequent winter flooding, and fish and wildlife species use these areas for foraging and sanctuary. Inundation in these areas is typically intermittent and of short duration

Wapato Lake Unit: The Tualatin River bisects the Wapato Lake Unit acquisition boundary. Inputs to Wapato Lake proper were historically from Wapato, Ayers, and Hill Creeks, and from the river backing up into the lake (see Appendix P, Map 7). The historical Wapato Lake lake bed was severely altered during the 1920s with the formation of the Wapato Improvement District (WID), a state-sponsored irrigation and drainage district. This district supported onion farming that took place on the lake bed itself. The WID installed 5.5 miles of levees around the lake, a lift pump station, and interior ditches to facilitate drainage of the lake for historical farming. Wapato, Ayers, and Hill Creeks were diverted around the outside of the levees to connect with the Tualatin River later. During fall and winter, the lake was allowed to fill with rain water, and it was pumped out in early spring for farming. Currently the refuge has a cooperative farming program that uses much of the same infrastructure. In the northern part of the acquisition boundary, Scoggins and Harris Creeks are tributaries to the Tualatin River.

3.3 Topography and Bathymetry

The refuge area lies in the northwestern corner of the Willamette Valley, southwest of Portland, Oregon (see Appendix P, Map 1). Elevations on the refuge range from about 105 feet to 300 feet. The Tualatin River floodplain is relatively flat, with gradually sloping sides leading to upland forest types, agricultural lands, and developed areas. Major mountain features include the Coast Range to the west of the Wapato Lake Unit and Chehalem Ridge rising to 1,629 feet (Oregon Parks and Recreation Department 2011) between the Wapato Lake and Sherwood Units. The Tualatin River channel is deeply incised with steep banks throughout most of its length. Henry Hagg Lake is a 1,110-acre reservoir (ODFW 2011a) approximately 3 miles west of the Wapato Lake Unit.

Many refuge land parcels have had detailed topographic surveys completed prior to initiation of restoration projects. In the Sherwood Units, surveys were conducted on the Atfálat'i, Tualatin River, and Riverboat Units. The refuge is currently working with U.S. Geological Survey (USGS) and other partners to conduct a hydrogeomorphic survey at the Wapato Lake Unit that will provide a digital elevation model for the lake bed and surrounding area, as well as a water budget for future restoration planning.

3.4 Geology and Geomorphology

3.4.1 Origins and Development

During the Oligocene epoch roughly 35 million years ago (MYA), a line of sea floor subduction, which had run in a northeast direction from west of the Klamath Mountains to the Blue Mountains, moved to its current position several hundred miles to the west on its northern end. This change left a slab of what had been subducting sea floor attached to the continental margin and also moved the line of volcanic activity associated with remelting oceanic crust. Part of this slab, covered by shallow

seas, ultimately became the floor of the Willamette River basin. Although volcanic eruptions had started building the southern Cascade Mountains millions of years earlier in the Eocene epoch, the northern Cascades lie on top of the slab and arose as volcanoes. Volcanic rocks in the western Cascades date from two principal periods of volcanic activity, one occurring 20 to 30 MYA and the other in the Miocene, 10 to 15 MYA; both periods included the entire length of the Cascades (Branscomb 2002). The Tualatin River Basin is underlain by 9,000-12,500 feet of sedimentary and volcanic rock (Popowski 1996; Wilson 1998). On top of this layer lie up to 900 feet of Columbia River basalt and another 1,200 feet of sediments from the late Miocene to Pleistocene.

The Coast Range arose as continental sediments carried eastward by the subducting oceanic plate were forced under the western edge of the slab, pushing it upward. The rise proceeded from south to north, the northern Coast Range not appearing until roughly 15 MYA. During this process, the area of the future Willamette Valley also rose, becoming dry land and draining its embayment by about 20 MYA. Although the direction of sea floor spread is southeastward toward the Oregon coast, the entire Pacific plate, including the spreading and subduction zones, is moving northward. The net effect for the Oregon Coast Range appears to be a slow movement north, evidence for which may be seen in the roughly 50-mile northward offset of the Columbia River at Portland and the sharply curved Olympic Mountains in western Washington State, where movement of the Coast Range encountered the more deeply rooted Vancouver Island. This northward tearing of the Coast Range may also have contributed to the formation of the Willamette Valley, the floor of which is now composed of multiple fault blocks. In contrast to its south end, the valley is spreading more in the north, possibly due to the thinner crust and reduced linkage with the subducting sea floor present there (Branscomb 2002).

3.4.2 Recent Geologic Events

Defining the northern limit of the Willamette River Basin, the Columbia River has reestablished its course through multiple dammings by slides, basalt flows, and ice. Reaching their maximum 13 MYA, basalt floods from the enormous Grande Ronde volcano in northeast Oregon flowed down the Columbia channel all the way to the river’s mouth and into the Willamette Valley. In the Pliocene (3 to 11 MYA), western Oregon was a desert, and gravels produced during that time eroded into and covered the spreading valley floor.

Work performed by J. Harlan Bretz in the 1920s revealed that between 15,500 and 13,000 years ago, ice periodically dammed the Clark Fork in Idaho east of Spokane, Washington, forming a lake in the present-day Missoula Valley of Montana covering some 3,100 square miles and containing 500 cubic miles of water. In a typical release occurring over less than two weeks, a quantity of water equal to half the present volume of Lake Michigan, more than the modern annual volume of all the world’s rivers, poured down the Columbia channel. These floods were known as the Missoula Floods. Backwater from these floods carried ice-rafted “erratic” rocks from Montana repeatedly into the Willamette Valley, filling it to about 400 feet above current sea level. Evidence in the geologic record suggests that these floods entered the Tualatin River Valley at least 22 times during this time period (Wilson 1998). This vigorous overflow southward across the divide between the Willamette River and Tualatin River Basins scoured multiple channels in the basaltic bedrock, dug small rock-bound basins, and left rock knobs barren of soil, forming a topography in the Rock Creek area just east of the City of Sherwood that is a miniature replica of the well-known scablands in eastern Washington. The sediments left by these floods form much of the present valley floor (Branscomb 2002). In the Tualatin River Basin, these overlying sediments have been classified as the Hillsboro

Formation (Wilson 1998) and consist of about 900 feet of fluvial and lacustrine sediment overlying 95 feet of lateritic soil and weathered basalt of the Columbia River Basalt Group. This area is still geologically active as evidenced by the 1980 eruption of Mount Saint Helens 65 miles to the northeast.

3.5 Soils

Within the refuge boundaries there are 64 soil types described (U.S. Department of Agriculture [USDA] 1982). These can roughly be broken down into the following six categories: 1) clay, 2) loam, 3) silt loam, 4) silty clay loam, 5) stony silt loam, and 6) Xerochrepts. A majority of refuge lands in the floodplain contain clays, silty clay loams, and silty loams. Most of these lands were in agricultural production prior to purchase by the Service. On areas outside the floodplain, most of the soils are loams and silty loams that are well drained and primarily support mixed upland forest types.

There are two areas of particular historical interest—Onion Flats and Wapato Lake. These areas contain Labish Mucky Clay, a rare organic peat soil type that historically supported scrub-shrub and other wetland types. It is heavy, poorly drained soil, usually associated with old concave lake beds. These areas were drained for farming in the early twentieth century and continue to be cooperatively farmed by the refuge at present. The major crop in these areas was onion, but with a shift in economics, these areas now support small grains such as oats, corn, wheat, barley, and grass and clover crops.

Another area of interest is the Tonquin scablands along the Rock Creek drainage. This area contains soils of stony loam to Xerochrepts deposited by the ancient Missoula Floods, and is an area of rocky basalt outcrops and deep gravel. This soil varies greatly from highly porous, well-drained soil to highly impermeable rock creating perched wetlands. Much of the area surrounding refuge lands in the Rock Creek area is extensively mined for rock and gravel. Any organic soil existing within this area is relatively shallow, but still supports abundant native plant growth.

3.6 Fire

3.6.1 Historic Activity

For thousands of years prior to European settlement, fire played an important role in maintaining various habitat types within the Willamette Valley and in Oregon as a whole. Whether ignited by lightning or set by Native Americans, fire helped to maintain native habitat types by preventing woody species from encroaching into prairie habitat types, preventing build-up of volatile fuels in forested areas, creating a mosaic of habitat types and successional stages, and recycling nutrients (ODFW 2006). Since at least the 1850s, fire suppression actions began to change the landscape of the Willamette Valley, and have resulted in a host of unintended consequences for ecological health, wildlife populations, and people.

In more open habitat types such as prairies and oak savanna, fires were essential for removing encroaching woody species (especially conifers), reducing thatch left by annual and perennial grasses and forbs, and providing habitat for wildlife, such as elk, acorn woodpeckers, and white-breasted nutchatch, dependent on open habitat types. Native Americans often burned open habitat types to promote food plants such as camas and tarweed, provide for more open travel corridors, and provide

forage for elk, deer, and other game species that they hunted (ODFW 2005). Due to fire suppression, less than 1 percent of these habitats remain in the valley, as woody species, such as Douglas-fir, have moved in and changed the landscape.

Photo 3-4. Kalapuya people ignited fires to manage habitats for their needs.
USFWS.

In forested areas, fires played an important role in maintaining a diversity of habitat structure. Drier forests historically experienced frequent fires (usually at less than 25-year intervals) that mainly burned understory plants, but left larger trees undamaged. In wetter forests such as those in the Coast Range, fires were less frequent (on the order of once every 100 years), but often burned the entire stand, setting the stage for early successional plant growth.

3.6.2 Recent Activity

In forested areas, fire suppression has increased the likelihood of wildfires that are unusually large and severe (ODFW 2005). In the late nineteenth and early twentieth centuries, logging operations combined with fire suppression throughout the Pacific Northwest created conditions for catastrophic fires. Vegetation composition within forests has also changed as a result of fire suppression. Historically, conifer-dominated forests had little undergrowth because of the shade imposed by the closed canopy and frequent fires that cleared brush and downed woody debris. However, with the onset of widespread fire-suppression activities, debris was allowed to accumulate, and brush and eventually understory trees began to grow and provide “ladder” fuels that led to canopy fires when a fire did occur.

In prairie and savanna habitat types, fire suppression often led to a complete change in vegetation structure as woody species such as shrubs and conifers invaded and shaded out other species. In addition to fire suppression, these open habitat types were often the first to be converted to agriculture or developed as home and town sites, thus exacerbating their decline.

Photo 3-5. Prescribed fire can be used to manage native habitats. Scott Swanson/ USFWS.

3.6.3 Current Conditions

The refuge currently has a fire management plan (USFWS 2002b) in place that covers wildland fire events and pile burning, but does not address prescribed fire. This plan states that all wildland fires, whether human-caused or lightning-induced, will be suppressed. Brush and debris piles that result from management activities will be burned by fully trained and equipped Service fire crews in accordance with national and regional policies. The refuge is updating the fire management plan, which will propose prescribed fire; this information can be found in Appendix O of the Comprehensive Conservation Plan/Environmental Assessment (CCP/EA).

Many of the habitat types on the refuge are fire-dependent vegetation communities. In the absence of prescribed fire, these habitat types are maintained with surrogates for fire such as mowing and discing. The introduction of nonnative and invasive plant species such as reed canarygrass, velvetgrass, cocklebur, and Bermuda grass during the past century have complicated maintenance of these native habitat types. Use of prescribed fire to maintain native habitat types may or may not address some of these issues.

3.7 Environmental Contaminants

In 1992, prior to formal establishment of the refuge, the Service conducted a pre-acquisition contaminant survey (USFWS 1992b) to assess possible contaminants affecting proposed refuge lands. The survey found that there were " …a variety of contaminant sources on and adjacent to the refuge including container nurseries, a tannery, a potato processing plant, an abandoned town dump, nonpoint source pollution from highways and industrial areas, agricultural runoff, dairy farms, auto wrecking yards, electrical power lines, and possible hazardous wastes from farming and industrial operations."

In the Rock Creek drainage within the refuge acquisition boundary, but on lands not owned by the refuge, is the 33-acre site of a former tannery and battery company. The Frontier Leather Company

(Frontier) began operating a tannery at the site in 1947. Two 3-acre sedimentation lagoons were constructed, and placed in service in 1965. Frontier discharged wastewater to the sedimentation lagoons intermittently between 1965 and 1982. Between 1971 and 1974, chromium-treated hides were both stockpiled and buried at the facility. Frontier landfilled an estimated 21,000 cubic yards of chromium-containing wastes including chromium-treated hides and chromium-containing vacuum filter sludge. Some of the hides were later covered with approximately 2 feet of soil, but a large percentage of the landfill was not adequately consolidated and capped to control possible direct contact or surface water runoff. Landfilling of hides was discontinued in 1973 after analytical results from hide samples collected by the Department of Environmental Quality (DEQ) suggested that the hides could adversely impact soil, groundwater, or surface water quality (DEQ 2011c). Additionally, contaminants found in surface soil samples included antimony, trivalent chromium, lead, and mercury (DEQ 2011b). In addition to contaminants from the tannery, there are also contaminants from lead acid batteries at the tannery site, including lead, sulfuric acid, and battery casings (DEQ 2011b).

DEQ uncovered records from the former tannery indicating that tannery wastes were land-applied to pasture land at Ken Foster Farm (KFF) during the 1960s. The former KFF 40-acre farm site is on Murdock Road, in Sherwood, outside the refuge acquisition boundary, but adjacent to and upslope of the Rock Creek Unit. Investigations of the KFF confirmed the presence of high concentrations of chromium in surface soils consistent with land application of the tannery wastes. These contaminants could have migrated into the Rock Creek drainage, which flows through the refuge. In 2007, the U.S. Environmental Protection Agency (EPA) published findings from their assessment of the former KFF site confirming that several heavy metals, primarily chromium, lead, and mercury were present at elevated concentrations in site soils. Sampling performed to date indicates lead and chromium in site soils are attributable to historical land application of tannery wastes at the site (DEQ 2011a). Additional work at the KFF site is warranted, including completion of a comprehensive remedial investigation and risk assessment, feasibility study, and implementation of remedial action as necessary (DEQ 2011b).

3.8 Air Quality

The EPA has lead responsibility for the quality of air in the United States; through the 1990 Clean Air Act, the agency sets limits on the amount of pollutants that can be discharged into the air. More than 170 million tons of pollution are emitted annually into the air within the United States, through either stationary sources (such as industrial or power plants) or mobile source (such as automobiles, airplanes, trucks, buses, and trains). There are also natural sources of air pollution such as fires, dust storms, volcanic activity, and other processes. The EPA has identified six principal pollutants that are the focus of its national regulatory program: carbon monoxide, lead, nitrogen dioxide, ozone, particulate matter, and sulfur dioxide.

The Oregon DEQ is responsible for protecting Oregon’s air quality. DEQ monitors air pollution to ensure that communities meet national ambient air quality health standards (DEQ 2011c). There are three main pollutants that are of greatest concern in Oregon. These are:

- Ground-level ozone, commonly known as smog;
- Fine particulate matter (mostly from wood smoke, other combustion sources, cars, and dust) known as PM2.5 (2.5 micrometers and smaller in diameter); and
- Hazardous air pollutants (also called air toxics).

According to a 2010 DEQ report (DEQ 2011c), the PM2.5 level was below the Federal health level throughout Oregon. Ground-level ozone (smog) exceeded the Federal standards twice in Portland and once in Salem. They did not violate the standard, which requires four exceedance days. Forest fire smoke was light in 2010 and did not exceed the Federal health standard anywhere DEQ monitored. Air toxins, such as benzene and acetaldehyde, remain near or above the health benchmarks. The health benchmarks are concentration levels at which, if exposed over a lifetime, an individual's risk of getting cancer is increased by one in one million. Carbon monoxide and PM10 (particulate matter 10 micrometers in diameter and smaller) remained far below the Federal health standard. The pollutants have been trending down in the past 10 to 15 years.

According to Creative Methods (2011), Washington and Yamhill Counties received poor grades for air quality based on tons of emissions per square mile of the following pollutants (Table 3-5): carbon monoxide, lead and lead compounds, nitrogen oxides, volatile organic compounds, PM10, PM2.5, ammonia, sulfur dioxide, total hazardous air pollutants, and two particular hazardous air pollutants, diesel emissions and acrolein emissions.

Table 3-5. Letter Grades* of Selected Air Quality Measures Based on Tons Emission per Square Mile

County	CO	Pb	NOx	VOC	PM10	PM2.5	NH_3	SO_2	HAP	Diesel	Acrolein
Washington	F	C	D	D	D	F	C	D	D	F	D
Yamhill	D	D	C	D	D	D	C	C	C	C	D

*The grade "A" represents the best/cleanest emission densities in the United States, and "F" the worst/dirtiest in the United States.

CO: Carbon dioxide
Pb: Lead
NOx: Nitrogen oxides
VOC: Volatile organic compounds
PM10: Particulate matter less than or equal to 10 micrometers
PM2.5: Particulate matter less than or equal to 2.5 micrometers
NH_3: Ammonia
SO_2: Sulfur dioxide
HAP: Hazardous air pollutants

However, in actual tests of ambient air quality, only Yamhill County exceeded any air quality parameters. Based on these tests, EPA levels for quarterly levels of lead were exceeded (Creative Methods 2011).

As discussed in Section 3.6 above, prescribed fire can be a useful management tool, but smoke management is a concern and is governed in part by Oregon Administrative Rules (OARs) (OAR 2011).

3.9 Water Quality

3.9.1 Overview—Tualatin River and Basin

The Tualatin River watershed lies almost completely within Washington County but also crosses Multnomah, Clackamas, Yamhill, Tillamook, and Columbia Counties. This watershed, or subbasin, is part of the larger Willamette River Basin. The Tualatin River drains more than 700 square miles of land on the west side of Portland's metropolitan area; its headwaters are in the Coast Range and it flows in an easterly direction to the confluence with the Willamette River. The Tualatin River Basin supports a growing population of more than 450,000 people and a wide range of urban, agricultural, and forest-derived activities (DEQ 2011d). The discharge of the river reflects seasonal rainfall, and most precipitation occurs between November and March. Seasonal stream flow is typically highest from December through April and lowest from July through October (USGS 2008). The low flow period occurs during the summer from May through October. Streams entering the river within the refuge include Wapato, Ayers, Hill, Harris, and Scoggins Creeks in the Wapato Lake Unit, and Chicken and Rock Creeks in the Sherwood Units.

The Oregon DEQ is the agency responsible for ensuring that the streams and rivers of Oregon are within standards set forth by the Federal Clean Water Act of 1972. In the past, as human activity increased in the subbasin, the Tualatin River experienced many water quality problems including algal blooms. Many streams in the Tualatin River subbasin do not meet Oregon water quality standards as these streams have high water temperatures and low dissolved oxygen levels that can harm fish and other aquatic life. Some water bodies have bacteria counts that are higher than Oregon's water quality standards recommend (DEQ 2011d). In response to these streams not meeting water quality standards, DEQ listed the Tualatin River as a "water-quality limited" stream. The term "water-quality limited" is used in the Clean Water Act to define streams that do not meet established water quality standards even after the implementation of standard controls. In 1984 and 1986, Tualatin River was listed due to low dissolved oxygen concentrations and nuisance levels of algae. Once a river has been designated as water-quality limited, the Clean Water Act requires that the DEQ develop thresholds for the amount of pollutants to be released in the river (USGS 2008).

Since the 1970s, DEQ has worked with other agencies and organizations to ensure actions are taken to improve water quality in the Tualatin River. These actions include closure of several water treatment plants that historically discharged high concentrations of ammonia and phosphorous, upgrades at remaining treatment facilities, implementation of management plans by agencies that address potential sources of pollutants, tree plantings along streams to facilitate cooler water temperatures, and the release of water from Henry Hagg Lake by Clean Water Services (CWS) during the critical summer months when water flow is low. All of these actions have contributed to improvement in the water quality of the Tualatin River.

CWS has worked further with DEQ to improve water quality in the Tualatin River. Water is released by CWS from Scoggins and Barney Reservoirs to improve the river's water quality. In 2004, CWS received a watershed-based permit from DEQ that provided a mechanism to offset a portion of the thermal loads from their wastewater treatment facilities with releases of stored water from the reservoirs. Reservoir releases during July and August are used to mitigate part of the thermal impacts from wastewater treatment facilities. CWS offsets the remainder of its thermal impact by planting riparian areas along tributaries, either directly within its service area or through a partnership with the Tualatin Soil and Water Conservation District on rural lands. During the rest of the summer, the

water is released to offset the effect of sediment oxygen demand on the dissolved oxygen levels in the river. Dissolved oxygen levels in the river downstream of the wastewater treatment facilities determine the ammonia limits for wastewater treatment facilities. The higher the dissolved oxygen levels, the more operational flexibility the wastewater treatment facilities have (CWS 2011).

Low dissolved oxygen levels can be a water quality issue in the lower Tualatin River. During the early parts of the summer, photosynthetic production of oxygen by algae effectively offsets the oxygen consumed by the decaying substances in the sediment of the river (sediment oxygen demand). In the fall, however, oxygen production by algae is reduced as the days become shorter and it no longer offsets the oxygen consumption by sediment oxygen demand. This can lead to low dissolved oxygen levels. Increasing stream flow reduces oxygen consumption by sediment oxygen demand because it shortens the contact time between the river water and the river sediments (CWS 2011).

In addition to the above actions, DEQ developed total maximum daily loads (TMDLs) as required by the Clean Water Act. The TMDLs are developed to meet established water quality standards. They define the amount of heat, bacteria, phosphorous, and ammonia that can be added while still being protective of the river (DEQ 2011d). DEQ first released TMDL loads (or amounts) in the 1980s for various sources in the Tualatin River Basin. There has been a revision of these TMDLs, and they are currently undergoing public review at the time of this writing. The establishment of TMDLs in the Tualatin River Basin prompted many management agencies to take actions to meet the load allocations set forth by the TMDLs.

3.9.2 Refuge-specific Water Quality

There are some data available on several creeks that enter the Tualatin River through the refuge. Chicken Creek, which supplies most of the water to the managed wetlands on the Atfálat'i Unit, enters the refuge through a diversion point from which water is then diverted to several different ponds using an irrigation canal. Over the years, as more urban development occurs upstream, the refuge has observed higher stream flows at the diversion. Higher flows have caused extra management responsibility and burden on the refuge to divert the water to the river to avoid flooding or damage to refuge infrastructure. In response to the increases in high flows, the refuge has installed some new infrastructure, including an emergency spillway to facilitate water reaching the river. In addition to high water flows, another concern of the refuge is the water quality of Chicken Creek, due to the runoff from urban development that occurs in the watershed. However, CWS has been monitoring the water quality for upper and lower Chicken Creek and as of date, all standards of temperature, dissolved oxygen, pH, and toxics are below applicable water quality criteria.

3.10 Visual Quality

The scenic beauty of the refuge plays in sharp contrast to the surrounding urban development of homes and roads. All features of visitor and administrative facilities have been designed and constructed to complement the natural refuge environment. Buildings are placed to welcome visitors at the entry point of the refuge, but not detract from wildlife observation. Where possible, structures are set into the landscape and/or provide views through or around the structure itself. Overlooks, kiosks, benches, signs, and railings are all low profile and colored to match the environment. This careful planning allows the visitor to experience the refuge without distractions.

3.11 Surrounding Land Use

The region surrounding the refuge is primarily a mix of urban and agricultural lands (see Appendix P, Map 2). The City of Sherwood in Oregon (population 17,930) abuts the southern and western boundaries of the Sherwood Units (U.S. Census Bureau 2011), the City of Tualatin (population 26,745) is to the east, and King City (population 2,965) is northeast of the refuge. The City of Gaston, Oregon (population 792), is adjacent to the west boundary of Wapato Lake Unit, and Forest Grove (population 21,448) is north of the refuge boundary by approximately 2 miles. Oregon's largest metropolitan center with Portland at its core is approximately 12 miles from the Sherwood Units and 23 miles from the Wapato Lake Unit. The population of Portland is 566,143; the population including its surrounding metropolitan area is approximately 2,260,000 (Portland Business Journal 2011). The population of Sherwood has increased by more than five times from 3,093 in 1990 (U.S. Census Bureau 2011) to the current level, and other cities in the surrounding area are also experiencing rapid population growth. In fact, some areas within the refuge acquisition boundary have already been developed with housing and businesses.

The western part of the Sherwood Units and Wapato Lake Unit are characterized by a more rural nature, with active agriculture as well as scattered patches of potential wildlife habitat. Dominant agricultural practices include growing of nursery and greenhouse stock; field crops such as winter wheat, corn, grass hay, and clover and grass seed; orchards of fruit and nuts; berry crops; and row crops such as potatoes and onions. In 2009, Washington County produced $4,106,865 in agricultural products (Oregon State University 2011). Yamhill County is a more rural county with high production of both agricultural commodities and timber products. Yamhill County is the nation's leader in production of hazelnuts and the fifth-largest producer of grass seed; it has the third-largest acreage of rhubarb, and is number five nationally for llama production (Oregon Department of Agriculture 2012). Active timber harvest occurs both east and west of the Wapato Lake Unit in the Chehalem Ridge area and in the Coast Range, respectively.

Within the Tualatin River Basin there are a number of public and private lands managed as wildlife. The regional Metro government has an active greenspaces program and has acquired and restored several land parcels. CWS maintains several land parcels that benefit wildlife, and other county and public entities maintain suitable wildlife habitat within the basin. In addition, private landowners maintain waterfowl hunting clubs throughout the area that benefit fish and wildlife. Other private landowners maintain habitat in a natural condition that also benefits fish and wildlife.

The lower reaches of the Tualatin River are navigable with small boats, and many recreationists take advantage of the river using canoes and kayaks. Fishing opportunities are limited; however, a few people use motor boats to fish for warm-water species during summer, and at least one person fishes for crayfish commercially on the river.

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Chapter 4
Biological Environment

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Chapter 4 Biological Environment

4.1 Overview

4.1.1 Historic Land Use and Conditions

The Willamette Valley is an area of extremely fertile and rich soils that when mixed with the abundant rainfall and relatively mild temperatures of the region provide an ideal system for healthy natural ecosystems (see Appendix P, Map 1). With the presence of people, these natural ecosystems changed (see Appendix P, Map 2). Prior to European settlement in the 1850s, the Kalapuya were the first people of the valley, and one band, the Atfálat'i, made their home here. At that time, much of the valley was covered by native grasses and forbs, with riparian forests and wet prairies along the rivers. The Atfálat'i observed the benefits of lightning-strike fires and emulated those benefits by manually setting fires to serve their needs. Each year, they burned different parts of the valley to control insect pests and to keep woody plants from moving into uplands of grasslands and oak savannas. Fire also cleared foraging ground for elk and deer. This method of prescribed burning added nutrients into the soil and stimulated plant growth. However, with European settlement, fire ceased to exist on a consistent and rotational basis, thereby allowing woody plant species to invade the grasslands and resulting in less than 1 percent of this habitat remaining in the valley.

Historically, the Willamette Valley was home to large ungulates such as deer and elk. However, by 1898 elk populations had diminished to the point that the Oregon Legislature prohibited elk hunting until 1910 (a ban that was later extended to 1933). Bears and wolves were present, and bighorn sheep lived nearby in the Columbia River Gorge.

Sturgeon, steelhead, salmon, and other native fish were numerous in most rivers and streams; however, by 1898 fish stocks were declining and hatchery operations were underway (Oregon Department of Fish and Wildlife [ODFW] 2011b). Beaver, mink, and other wetland-dependent mammals found an abundant food source in the riparian forest of the Tualatin River. Trapping was in high demand here in the early 1800s, but declined as the demand for farmland increased. In 1899, a moratorium on beaver trapping was imposed, but it was lifted 20 years later. In 1931 beaver season was again closed as habitat conditions declined, and fish and wildlife resources continued to take a downward turn.

By the 1850s, the grasslands and prairies had been claimed by settlers for grazing and town sites. This left riparian forest for farmers who were beginning to move west. To use the land, the farmers cut, burned, and plowed riparian forest for farmlands. Widespread burning of habitats was eliminated to protect infrastructure and farmlands. Lack of periodic fire allowed succession of shrubs and trees into remaining prairie, woodland, and savanna habitat types, which eventually changed many of them to Douglas-fir-dominated forest.

Other habitats also saw modifications. Wetlands were drained for farming, and rivers and streams were channelized as flood control measures. Some areas were frequently flooded and were too wet to farm or develop and therefore were left as intact habitats. The flora and fauna of the valley began to change and support different species. This change continues as exotic species invade and once common native species decline. Christy et al. (2006) reported 1,404 plant species in the Portland area in 2006, and noted "today there are about half as many common native taxa as there were in 1925, and the number of rare natives has increased eleven-fold. Since 1925, the number of common exotic

taxa has nearly tripled, while the number of rare exotics has increased by 71. This trend is to be expected in an urbanizing environment, and as time goes on, more native species will become rare while the ranks of common exotic species will continue to increase."

Currently the Tualatin River Basin is a highly altered system with almost all the land within the watershed affected, at least to some degree, by timber harvest, agriculture, urbanization, dams, diversions, and stream channel alteration. However, many organizations and individuals are working to restore natural processes and habitats. Many species of native plants, fish, and wildlife still thrive in the basin, and opportunities exist to enhance and restore additional habitat for greater resource enrichment.

4.1.2 Biological Integrity, Diversity, and Environmental Health

The National Wildlife Refuge System Improvement Act of 1997 directs the U.S. Fish and Wildlife Service (Service; USFWS) to ensure that the biological integrity, diversity, and environmental health of the National Wildlife Refuge System (Refuge System) are maintained for the benefit of present and future generations of Americans. To meet this mandate, the Service developed a Biological Integrity, Diversity, and Environmental Health (BIDEH) Policy to provide implementation guidance. Elements of BIDEH are represented by native fish, wildlife, plants, and their habitats as well as those ecological processes that support them. The Refuge System policy on BIDEH provides guidance on consideration and protection of the broad spectrum of fish, wildlife, and habitat resources that represent BIDEH on refuges and in associated ecosystems. This policy provides refuges with a process for evaluating the best management direction to prevent the additional degradation of environmental conditions and to restore lost or severely degraded environmental components. It also provides guidelines for dealing with external threats to the BIDEH of a refuge and its ecosystems.

Maintaining and perpetuating the ecological integrity of the Tualatin River National Wildlife Refuge (the refuge) fits well within this policy. By providing for the full range of natural processes and native floral and faunal diversity, the refuge will be implementing this policy.

To preserve BIDEH, we examined priority habitat types and determined the species that were the best indicators of the health of those plant communities.

4.2 Selection of Priority Resources of Concern

4.2.1 Analysis of Priority Resources of Concern

Wildlife and habitat goals and objectives were designed directly around the habitat requirements of species designated as "priority resources of concern" (ROC). ROCs are called conservation targets in conservation planning methodologies used by other agencies and nongovernmental organizations (NGOs). In developing objectives, the comprehensive conservation plan (CCP) planning team followed the process outlined in the Service's *Writing Refuge Management Goals and Objectives: A Handbook* (Handbook) (Adamcik et al. 2004).

As defined in the Service's policy on habitat management plans, ROCs are "all plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), System Mission, or international, national, regional, state, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect

‘migrating waterfowl and shorebirds.’ Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts (620 FW 1.4G).” The Handbook goes on to say that “Habitats or plant communities are resources of concern when they are specifically identified in refuge purposes, when they support species or species groups identified in refuge purposes, when they support NWRS [Refuge System] resources of concern, and/or when they are important in the maintenance or restoration of biological integrity, diversity, and environmental health.” Therefore, ROCs for a refuge may be a species or species group, or the habitat/plant community that supports a priority species/species group.

In developing a list of ROCs, the planning team selected not only species mentioned in establishing documents for the refuge, but also species that captured the ecological attributes of habitat types required by larger suites of species (see Appendix E, Biological Resources Of Concern). The ecological attributes of habitats were analyzed with regard to the life history requirements of ROCs and are critical to sustaining the long-term viability of the ROC and other benefitting species. Ecological attributes of habitats include vegetation structure, species composition, age class, and patch size and/or connectivity with other habitat types; hydrologic regime; and disturbance events (e.g., flooding, fire). From the ROC list, we developed a list of focal species to represent each habitat type on the refuge. These provide measurable indicators that strongly correlate with the ability of a plant community to support a given species or group. The descriptions of habitat types on the refuge incorporate “desired” conditions that are based on scientific literature review and team members’ professional judgment. These desired conditions for specific ecological attributes were used to help design habitat objectives, as presented in Chapter 2.

Limiting factors were also considered in developing objectives. A limiting factor is a threat to, or degradation of, the natural processes responsible for creating and maintaining plant and animal communities. In developing objectives and strategies, the team gave priority to mitigating limiting factors that presented a high risk to ROCs. In many cases, limiting factors occur on a regional or landscape scale and are beyond the control of individual refuges. Therefore, objectives and strategies may seek to mimic, rather than restore, natural processes. For example, pumps and water control structures may be used to control water levels in wetlands in areas where natural hydrology has been altered. Also, the structure of plant communities used by ROCs can be created, rather than restoring the original native species composition. For example, mowing and/or grazing may be used to maintain a desirable vegetation structure in restoring native grassland communities when prescribed fire is impractical. With the consideration of BIDEH, the refuge will maintain all appropriate native habitat types and species. Table 4-1 lists the focal and benefitting species that were considered using the following criteria:

- The resource must be reflective of the refuge’s establishing purposes and the Refuge System mission;
- The resource must include the main natural habitat types found at the refuge;
- The resource must be recommended as a conservation priority during preplanning efforts; and
- The resource must be federally or state listed, be a candidate for listing, or be a species of concern.

Other criteria that were considered in the selection of the ROCs included:

- Species groups and/or refuge features of special management concern; or

- Species contributing to the biological diversity, integrity, and environmental health of the ecosystem or community.

Table 4-1. Focal Species and Other Benefitting Species for Each Priority Habitat Type

Habitat Type	Focal Species	Other Benefitting Species
Bottomland riparian forest	Pacific slope flycatcher	Yellow warbler, song sparrow, willow flycatcher, and rufous hummingbird
	Swainson's thrush	Beaver, northern red-legged frog, anadromous fish, yellow-breasted chat, and black-capped chickadee
	Brown creeper	Chestnut-backed chickadee, anadromous fish, downy woodpecker, and pileated woodpecker
	Western wood pewee	Wood duck, yellow warbler, warbling vireo, western screech owl, spring Chinook, winter steelhead, chorus frog, and hooded merganser
Mixed coniferous/deciduous forest	Orange-crowned warbler	Bewick's wren, spotted towhee, downy woodpecker, olive-sided flycatcher, and pileated woodpecker
Oak savanna	Western bluebird	Chipping sparrow, coyote, grasshopper sparrow, mourning dove, rufous hummingbird, and western meadowlark
	White-breasted nuthatch	Western gray squirrel, acorn woodpecker, black-tailed deer, and lesser goldfinch
Wet prairie	Wilson's snipe	American bittern, savanna sparrow, western meadowlark, northern harrier, dusky Canada goose, migrating and wintering waterfowl, and Nelson's checker-mallow
Herbaceous wetland	Northern pintail	Tundra swan, cackling Canada goose, wintering waterfowl, river otter, mink, northwestern pond turtle, bald eagle, and peregrine falcon (foraging)
	Greater yellowlegs	Least sandpiper, dunlin, killdeer, lesser yellowlegs, long-billed dowitcher, spotted sandpiper, tree swallow, and great blue heron
	Virginia rail	Wintering waterfowl, American bittern, sora, common yellowthroat, common garter snake, and chorus frog
Shrub-scrub wetland	Willow flycatcher	American bittern, sora, Virginia rail, red-winged blackbird, common yellowthroat, northern red-legged frog, and northwestern salamander
Rivers, streams, and backwater sloughs	Coastal cutthroat trout, winter steelhead	Northwestern pond turtle, mink, beaver, belted kingfisher, spring Chinook, and Pacific lamprey

Table 4-1. Focal Species and Other Benefitting Species for Each Priority Habitat Type

Habitat Type	Focal Species	Other Benefitting Species
Cropland	Cackling Canada goose	Tundra swan, dusky Canada goose, northern pintail, American wigeon, northern harrier, and western meadowlark

4.3 Habitat Types

4.3.1 Bottomland Riparian Forest

4.3.1.1 Overview

There are currently about 388 acres of riparian forest on the refuge supporting a myriad of breeding and migrating songbirds, amphibians and reptiles, resident mammals, and anadromous fish. Mature bottomland riparian forests are characterized by Oregon ash, bigleaf maple, scattered grand and Douglas-fir, and western red cedar in the overstory, with swordfern, snowberry, and willow in the understory. There are many acres of this habitat type on the refuge that have been recently restored and would not have all these attributes yet. This forest type typically occurs in floodplains and other areas with moist soils. Plants here are adapted to winter and spring flooding and may be inundated or have wet feet for several months of the year.

Photo 4-1. Riparian forest during winter flooding. Peter Schmidt/USFWS.

4.3.1.2 Regional Distribution, Conditions, and Trends of Bottomland Riparian Forest

Bottomland riparian forest in the greater Willamette Valley has been severely reduced since historic times due to draining and timber harvest, conversion to agricultural and urban uses, and stream alterations. Riparian forest within the Tualatin River Basin is highly fragmented. Metro, Clean Water

Services, and others are working to restore riparian forest on many of their land holdings within the basin. The refuge has also engaged in restoration of bottomland riparian forest on several sites within the Sherwood Units.

4.3.1.3 Key Species Supported

Bottomland riparian forest supports a host of bird species and guilds including warblers, woodpeckers, raptors, flycatchers, and hummingbirds. Amphibians such as northern red-legged frogs, salamanders, and rough-skinned newts may spend part of their life cycles in riparian forests. Reptiles such as northwestern pond turtles and garter snakes frequently use these habitats to aestivate over winter or to escape the hot summer sun. Mammals such as beaver, mink, black-tailed deer, and bats use this habitat type for foraging, resting, and finding escape cover. Anadromous fish such as steelhead and Pacific lamprey migrate up rivers and creeks shaded by riparian forest. In winter, juvenile salmonids may benefit from riparian forests for foraging and escape during flood events.

4.3.1.4 Refuge Management Activities

In existing stands of riparian forest, management activities are typically limited to controlling nonnative invasive plant species. Plants such as English ivy, nightshade, and Himalayan blackberry crowd out native plants, to which native wildlife are adapted. Nonnative trees such as cherry, English hawthorn, and English holly are removed or girdled and treated with herbicide following integrated pest management (IPM) methods, to create snags.

In areas of new riparian forest restoration, native trees and shrubs are planted and maintained for several years to ensure successful establishment. Trees are typically planted and protected with tubes to prevent browsing by deer and other herbivores, and girdling by voles and other rodents. Grasses and nonnative plants are mowed and/or sprayed with Service-approved herbicide between shrubs and trees to reduce competition and shading until the desired plants are of sufficient size to compete on their own. After 5 to 10 years, once the trees have reached sufficient size and girth to resist damage from herbivores, tree tubes are removed.

In some areas where natural recruitment of native plants is strong, management activities include placing tubes on naturally established trees and mowing nonnative plants and grasses until the trees are tall enough to compete on their own.

4.3.2 Mixed Coniferous/Deciduous Forest

4.3.2.1 Overview

There are currently about 49 acres designated as mixed coniferous/deciduous forest on the refuge. This habitat type is typically above the floodplain on drier, well-drained soils. This forest type is dominated by Douglas-fir, with grand fir, western redcedar, western hemlock, bigleaf maple, red alder, Pacific yew, and Pacific dogwood. The understory contains swordfern, snowberry, hazel, cascara, vine maple, and various other shrubs and forbs. Snags are an important habitat component in a mature forest. Snags provide foraging substrate and nesting cavities for a variety of bird species. This upland forest type supports a host of bird species and other wildlife.

Photo 4-2. Mixed coniferous/deciduous forest in the Rock Creek Unit. Peter Schmidt/USFWS.

4.3.2.2 Regional Distribution, Conditions, and Trends of Mixed Coniferous/Deciduous Forest

Historically, upland forest was the dominant habitat type in the greater Portland area (Christy et al. 2006). By the time the General Land Office surveys were undertaken in the 1850s, much of this habitat type was already burned or logged. In the area surrounding the refuge, there is no old-growth forest remaining, but there are some tracts of mature second growth with intact native understory plants and few invasives. The forests surrounding the refuge were logged during the late nineteenth and early twentieth centuries to provide lumber for an expanding population and to provide more agricultural land. Currently, remaining forest tracts occur in areas too steep to farm or build effectively, or on land managed for timber production. Some tracts of remaining forest are found on conservation lands such as those recently purchased and protected by Metro and others. This forest type has also expanded into areas that were historically oak woodland, oak savanna, or prairie, as a result of fire suppression.

4.3.2.3 Key Species Supported

A myriad of species spend all or part of their life cycles in mixed forest habitat types. A host of resident and migratory birds such as woodpeckers, owls, wood warblers, and corvids use mixed forests for foraging, resting, and nesting. Small mammals such as squirrels, shrews, and mice are abundant in mixed forest habitat types, and bats often roost in cracks and cavities of larger trees. Larger mammals such as black-tailed deer and coyotes are also present in smaller numbers. Reptiles and amphibians such as chorus frogs and common garter snakes also use this habitat type.

4.3.2.4 Refuge Management Activities

Management activities for this habitat type are similar to activities carried out in riparian forest. In established forest, management of invasive species is the primary activity, while maintenance of

planted trees and shrubs would be the focus in restoration areas. In addition, prescribed fire may be a management tool employed to manage fuel and provide a diversity of habitat structure.

4.3.3 Oak Savanna

4.3.3.1 Overview

There are currently about 149 acres of oak savanna habitat on the refuge. This land is in various stages of restoration. Restored areas have been planted with oaks, native grasses, and other native species during the past 12 years. The oaks in these areas are in the sapling stage and range from 3 to 20 feet in height; they have not reached a mature stage. Only a few relic oaks over 100 years old remain on refuge lands. Mature oak savanna is characterized by large single or a very small cluster of Garry oaks, generally widely scattered throughout a grassland with few to no shrubs and abundant native wildflowers. Snags may be present in small numbers, and areas of bare ground may also be present. Native grass species may include California oatgrass, California brome, meadow barley, Roemer's fescue, and blue wildrye. Native forb species include blue-eyed grass, tiger lily, tarweed, and pearly everlasting. Overall grass height is usually less than 3 feet. Sites are typically dry, but may have saturated soils for a short duration during winter. This habitat type was historically maintained by frequent, low-intensity fire, which prevented shrubs and encroaching species, especially conifers, and maintained a low density of oaks. Currently the refuge manages this habitat type by annual mowing. However, mowing does not remove accumulated thatch, which may inhibit growth of some species of wildflowers. Spot spraying of herbicides is also employed to control invasive species such as blackberry and thistle.

Photo 4-3. Garry oaks. © Ed Bustya.

4.3.3.2 Regional Distribution, Conditions, and Trends of Oak Savanna

Oak savanna is a rare habitat type in the Willamette Valley. Noss et al. (1995) reported a loss of 99.5 percent of this habitat type in the Willamette Valley since Euro-American settlement. Metro and other organizations are conserving and restoring this habitat type; however, few large areas with mature oaks remain in the Tualatin River Valley and distribution is fragmented. Restoration efforts may take up to 100 years before the habitat can support a full range of species.

4.3.3.3 Key Species Supported

Oak savanna supports a variety of species, especially grassland bird species, oak specialists, invertebrates, and listed plant species. Grassland birds such as western meadowlark and savanna sparrow nest and forage in grassland communities. Oak specialists such as acorn woodpecker and Lewis' woodpecker, and white-breasted nuthatch use oaks for nesting and foraging. Invertebrates such as Fender's blue butterfly rely on native savanna and prairie plants for survival. Listed plant species native to oak savanna habitats include Kincaid's lupine, Willamette daisy, and golden paintbrush (USFWS 2010b).

4.3.3.4 Refuge Management Activities

The refuge has undertaken several oak savanna restoration projects and annually maintains these areas by mowing to reduce encroachment of woody species and applying Service-approved herbicides, following IPM practices, to control nonnative and invasive species. As land has been acquired, restoration activities have included cooperative farming as a means of purging weeds through tilling and application of herbicide. Further application of herbicide is usually necessary prior to planting of native seed. Native seed may be drilled in using a no-till drill or may be broadcast following discing. Typically, native grasses are planted first and allowed to become established while using a broad-leaved-specific herbicide to control invasive species. Once native grass is established, native forbs are seeded. Research is still needed to determine best management practices for establishing native oak savanna plants in this area because restoration of this habitat type is still in its infancy.

4.3.4 Wet Prairie

4.3.4.1 Overview

Wet prairie covers about 27 acres on the refuge. Wet prairie is dominated by native herbaceous plants such as sedges, rushes, grasses, and forbs that are generally less than 3 feet tall. There are few to no trees or shrubs. Wet prairie is characterized by generally poorly drained soils that may be saturated or have standing water from November through April. These habitat types on the refuge are typically inundated by either back flooding of the river onto floodplain areas or by ponding of rainwater in shallow basins. There are currently two areas of wet prairie restoration on the refuge. One was planted in 2001-2002 with native grasses, oaks, and ponderosa pine. Plants in this area are well established. The other area was restored in 2005, but is currently being rehabilitated to remove invasive reed canarygrass.

Photo 4-4. Wet meadow prairie habitat, Morand. Kim Strassburg/USFWS.

4.3.4.2 Regional Distribution, Conditions, and Trends of Wet Prairie

Similar to oak savanna, this habitat type has undergone a dramatic decline since Euro-American settlement due to conversion to other uses and lack of fire, which has allowed the encroachment of woody species, thus changing the vegetation community. Noss et al. (1995) state that 99.9 percent of all prairie habitats in the Willamette Valley have been lost. Much of the habitat that remains is in degraded condition due to the influence of invasive and nonnative species and lack of periodic fire to properly maintain function. Further, restored sites are confounded by a lack of available native seed types to foster adequate diversity. However, more native seed and plant varieties are becoming available as more entities embark on restoration of wet prairies. As with other rare habitat types, Metro, Natural Resources Conservation Service, and other organizations are conducting restoration and enhancement of this habitat type throughout the Tualatin River Valley. As these projects proceed, knowledge is gained and shared about methods and tools used to effectively manage wet prairie habitats.

4.3.4.3 Key Species Supported

Wet prairie supports a number of listed plant species (Bradshaw's lomatium, Willamette daisy, Nelson's checker-mallow) and species of concern (upland larkspur, peacock larkspur, Sierra horkelia, Columbian whitetop aster) (USFWS 2010b). A number of other species use wet prairies during all or part of their life cycles. Chorus frogs, northern red-legged frogs, northwestern and long-toed salamanders, and rough-skinned newts breed and lay eggs in shallow, vegetated wet areas in spring; wading birds such as great blue herons and great egrets also forage in the shallow pools or dry margins of wet prairies. Wilson's snipe nest in the wet grasses of the prairie. Black-tailed deer forage on grasses and forbs, while mink hunt for birds and rodents. In winter, large numbers of waterfowl rest and forage on the numerous seeds and plants in the flooded prairie.

4.3.4.4 Refuge Management Activities

Refuge management includes restoration, enhancement, and maintenance of wet meadow prairie. As with other habitat types, restoration usually begins with efforts to purge nonnative and invasive plant species using mechanical means (mowing and discing) and/or application of Service-approved herbicide, following IPM practices. Plants may be installed as pots or plugs, or seeded using a no-till drill or broadcast method. Areas requiring enhancement may have plants installed as mentioned above and invasive species removed using mechanical means or spot spraying with herbicide. Current maintenance includes annual mowing to prevent encroachment of woody species and/or spot spraying with herbicide to control nonnative and invasive species.

4.3.5 Herbaceous and Scrub-shrub Wetlands

4.3.5.1 Overview

There are currently about 294 acres of herbaceous wetland and 20 acres of scrub-shrub wetland habitat on the refuge. The herbaceous wetlands have all been restored, but the scrub-shrub wetlands are in various early stages of restoration. According to Christy et al. (2006), prior to Euro-American settlement, there were historically few wetlands in the vicinity of the refuge. Wetlands that existed at the time of Euro-American settlement were often drained by ditching, diversions, channelizing streams, and installing drain tiles to facilitate farming and development. The floodplain in the northern part of the Riverboat Unit had extensive scrub-shrub and herbaceous wetlands that were likely drained by the early twentieth century. Likewise, the majority of the Wapato Lake basin consisted of various wetland types. Even though they represent a small fraction of the landscape, wetlands play a vital role in the ecosystem, providing habitat for a variety of wetland-dependent plants and wildlife, and native resident and anadromous fish.

Herbaceous wetlands are characterized by areas with heavy, poorly drained clay soils. Wetlands may be saturated or flooded for a large part of the year, usually from the first fall rains until early to mid-summer. Water depths may range from just a few inches to 3 feet or more, with an average of 4 to 18 inches. The extent and depth of water is dynamic, changing throughout the season and year to year as periods of rain and flooding from creeks and rivers come and go. Plant composition includes perennial species such as sedges, rushes, wapato, common cattail, and softstem bulrush, and a large variety of annual plants such as smartweed, beggars tick, and wild millet.

Scrub-shrub wetlands are characterized by a somewhat more stable hydrological regime. Soils may range from heavy clay to organic peat soil, and water may be present year-round. Water is typically deeper than on herbaceous wetlands and may range from 1 foot or 2 to 10 feet deep at times. Plants include woody species dominated by willow, as well as Douglas spirea, swamp rose, redosier dogwood, and emergent species such as cattails and softstem bulrush. Fewer annual plants would be expected in this habitat type.

Photo 4-5. Seasonal wetland plants provide habitat and food for wintering waterfowl. Kim Strassburg/USFWS.

4.3.5.2 Regional Distribution, Conditions, and Trends of Herbaceous and Scrub-shrub Wetlands

As noted above, considerable effort was historically expended to convert wetlands to human-oriented uses. However, the value of wetlands for many beneficial uses, and their intrinsic value, has been recognized, and substantial work has been accomplished to restore or create wetlands throughout the Tualatin River Basin for the benefit of both human endeavors and wildlife needs. Wetlands currently exist on every unit of the refuge. Many of these wetlands are intensively managed to mimic historic conditions by using water control structures, diversions, pumps, canals, and levees. Managing and maintaining these systems is expensive and time consuming, but provides a level of certainty that habitat would be available no matter what the seasonal climate might provide. Other wetlands are not managed and depend on seasonal rain to fill and evaporation to naturally draw down in summer.

In addition to wetlands on the refuge, Metro, Clean Water Services, local duck hunting clubs, and others have worked to restore or create wetlands in the Tualatin River Basin. These wetlands provide a host of benefits such as groundwater recharge, water quality benefits, dissipation of flood waters, and habitat for fish and wildlife.

4.3.5.3 Key Species Supported

Wetlands support a number of fish and wildlife species throughout their annual cycle. Marsh birds such as sora and Virginia rail, and songbirds such as common yellowthroat and marsh wren nest in or near wetlands. Mammals such as mink, muskrat, and beaver use wetlands. Amphibians such chorus frogs, northern red-legged frogs, and salamanders use wetlands for breeding. Migratory shorebirds such as least and western sandpipers, greater yellowlegs, and black-bellied plovers forage on wetland mudflats and margins. Waterfowl such as northern pintails and cackling Canada geese forage and rest on wetlands. Raptors such as bald eagles and peregrine falcons prey on waterfowl that use wetlands.

4.3.5.4 Refuge Management Activities

Of all habitat types encountered on the refuge, wetlands require the most management and maintenance. During fall and winter, water is managed to fill and maintain wetlands. Fish screens are maintained to allow water passage and to prevent both native and nonnative fish from entering wetlands from diversions. Pumps are sometimes operated to begin filling wetlands prior to fall rains. Water control structures such as flashboard risers are managed to precisely control timing of water levels in some wetlands. Supplemental planting of woody species such as willow is conducted in newly restored scrub-shrub wetlands. During spring, water levels in managed wetland basins are drawn down to stimulate growth of desirable wetland plant species. Invasive species may be controlled by timing of flooding, mechanical means such as mowing or discing, or application of Service-approved herbicide. In late summer, some wetland basins are mowed to reduce vegetation height at the wetland margin to allow waterfowl access to adjacent uplands. Some wetlands are periodically disced to stimulate growth of annual plants dependent on a disturbance regime. In newly restored scrub-shrub wetlands, mowing is conducted around woody species to reduce competition with invasives such as reed canarygrass.

4.3.6 Rivers, Streams, and Backwater Sloughs

4.3.6.1 Overview

The Tualatin River and several tributary streams run through or are adjacent to refuge lands (see Appendix P, Maps 6 and 7). In addition, several areas back up with water during periods of flooding or high water. These waterways have been impacted by alterations since the time of Euro-American settlement. Streambanks were fortified to prevent flooding; adjacent lands were drained and ditched, causing increased runoff and erosion; vegetation along streambanks was removed, reducing the amount of shade and resulting in increased water temperatures, reducing woody input, and causing additional erosion; timber harvest, farming activities, and urbanization caused increased runoff, chemical and trash inputs, and reduced groundwater recharge; and water diversions for industrial, agricultural, and municipal uses caused a reduction in water flow.

Tributary streams such as Chicken Creek and South Rock Creek in the Sherwood Units were channelized in the early twentieth century to facilitate drainage and farming of adjacent lands. Under Alternatives 2 and 3, the refuge would restore at least parts of these creeks to their natural meandering channels. In addition, under these alternatives, construction and/or reconnection of backwater sloughs would be explored on some refuge units.

4.3.6.2 Regional Distribution, Conditions, and Trends of Rivers, Streams, and Backwater Sloughs

The Tualatin River and its tributaries have total maximum daily loads listed by the Oregon Department of Environmental Quality (DEQ) for several water quality parameters including temperature, dissolved oxygen, phosphorus, and bacteria (DEQ 2001). Efforts have been underway for several years in the Tualatin River Basin to reverse some of the negative effects that have taken place over the past 150 years. Many organizations have been promoting stewardship of the watershed and are engaged in restoration and enhancement projects that have greatly improved conditions in the river and local streams. The Service has partnered with the U.S. Geological Survey (USGS) and others to conduct a water quantity and quality study at Wapato Lake that will help inform and guide future refuge management activities at that unit. A few small backwater areas on the refuge have

been enhanced to provide benefits to anadromous fish during flood events and provide benefits to native wildlife.

Photo 4-6. Backwater flooding along the Tualatin River. Peter Schmidt/USFWS.

4.3.6.3 Key Species Supported

Rivers, streams, backwater sloughs, and their streamside vegetation support a vast array of fish, wildlife, and plant species. Native resident and anadromous, and nonnative fish species, may be found in local waters. Resident native fish include coastal cutthroat trout, rainbow trout, and three-spined stickleback. Native anadromous fish include steelhead and western brook and Pacific lamprey. Nonnative fish include a number of sunfish species, bass, catfish, mosquito fish, and carp. Coho salmon, which were not historically present in the Tualatin River system because they could not get over Willamette Falls during the fall when they migrate, were introduced into the system as mitigation for Scoggins Dam. The coho stocking program ended in 1998, but coho are still present and reproducing with help from fish ladders at the falls (ODFW 2011c).

Wildlife also abounds in and along waterways. Mammals such as beaver, mink, and muskrats are water-dependent furbearers. Birds of all types are associated with streams and rivers including mergansers, wood ducks, belted kingfishers, and ospreys. Many warblers and flycatchers are associated with streamside riparian habitats. Reptiles such as northwestern pond turtles and painted turtles use the slow-moving lower reaches of the Tualatin River, often basking on logs in spring and summer. Amphibians such as rough-skinned newts are abundant in all waters of the refuge.

Many plant species thrive in and around refuge streams. Submergent vegetation such as pondweeds and wigeon grass grow in the slow-moving waters of the river and adjacent sloughs. Trees and shrubs commonly associated with streams include willow, Oregon ash, redosier dogwood, Oregon grape, and Douglas spirea.

4.3.6.4 Refuge Management Activities

One of the major management activities related to streams is operation of a water diversion structure on Chicken Creek on the Atfálat'i Unit. A portion of the water in Chicken Creek is diverted year-round to supply water to managed wetlands. In summer, a small maintenance flow is diverted to maintain freshwater flow to a minimal number of wetland acres. In fall and winter, more water is diverted to fill and maintain approximately 226 acres of wetlands. There is a fish passage associated with the structure that was designed prior to listing of upper Willamette salmon and steelhead, and it may no longer be adequate based on current standards. There are fish screens on the structure to help prevent fish from entering the wetland system and becoming entrapped. Upstream and downstream of the diversion, the creek was channelized decades ago and runs straight to the Tualatin River. Under Alternatives 2 and 3, Chicken Creek would be at least partially returned to its historical channel and a new diversion structure would be constructed in a different location and built to current fish passage standards.

Similar to Chicken Creek, South Rock Creek is channelized through both the Rock Creek and Onion Flats Units.

Management of water in the Wapato Lake Unit is another important activity. Currently the refuge is maintaining cooperative farming operations in the lake bed and using the pumps in place to dewater the lake during spring. Until restoration begins, it is anticipated that this practice would continue.

Other management actions along streams include planting native vegetation, and controlling nonnative and invasive species including reed canarygrass, English holly, and Himalayan blackberry.

4.3.7 Croplands

4.3.7.1 Overview

Cropland management is used as a tool when lands are acquired to provide wildlife habitat and control invasive species until restoration of the property to native habitats can commence. Croplands are currently managed under cooperative farming agreements with local farmers who plant, maintain, and harvest select crops. A share of the crops is left for wildlife use. Crops grown include cereal grains, such as corn, wheat, barley, and oats. In the case of cereal grains the grower is required to leave 30 percent of crops standing as forage for wildlife. Another crop grown is green forage, such as pasture grass for hay or clover for seed. In this case, the grower harvests all the crop and then mows the area in late summer or early fall to provide green forage primarily for geese.

The refuge currently has cooperative farming agreements on the Onion Flats and Wapato Lake Units. Crops on the Onion Flats Unit are naturally flooded as fall rains begin and standing water accumulates or as the Tualatin River backs up into this area. Similarly, Wapato Lake starts to fill following fall and early winter rainy periods. Typically waterfowl will wait until rains begin before they begin foraging in grain fields, but they will begin to use green forage as soon as they arrive in fall. During periods of drought, when fields may not become flooded, waterfowl will begin to forage in grain fields after other sources of food in the vicinity have been depleted.

4.3.7.2 Regional Distribution, Conditions, and Trends of Croplands

The refuge is surrounded by a mixture of urban and rural land uses. There are many farms in the area supporting a variety of crop types including small grains and green forage. The primary difference in private management is that most small grains are tilled under after harvest in early fall to prepare for the next crop and green forage areas may also be tilled under if on a rotational schedule. However, many fields retain forage values for wildlife whether tilled or not. Many farmers rotate crops from year to year, and some crops may not be attractive to wildlife. Landowners may also convert field crops to orchards, berry crops, or nursery stock, which have different values for wildlife.

4.3.7.3 Key Species Supported

Croplands primarily support foraging for waterfowl such as dabbling ducks and grazers such as Canada geese and American wigeons. Other birds commonly observed in this habitat type include great blue herons, shorebirds, and grassland songbirds. Many small rodents such as Oregon voles reproduce here, providing a prey base for coyotes and raptors such as northern harriers, red-tailed hawks, and American kestrels.

4.3.7.4 Refuge Management Activities

Management activities are typically limited to overseeing cooperative farming activities and, in the case of the Wapato Lake Unit, managing water levels necessary for planting and irrigation.

4.3.8 Ruderal Lands

4.3.8.1 Overview

Currently there are approximately 181 acres of ruderal uplands and 68 acres of ruderal wetlands on the refuge. Ruderal uplands are lands that are typically above the annual floodplain but may experience occasional flooding from extreme events. These lands have been fallow for some time and typically are dominated by nonnative vegetation. Ruderal wetlands are lands typically within the annual floodplain, or they are saturated or inundated during some part of the year. These lands were often former pasture lands used for summer grazing.

4.3.8.2 Regional Distribution, Conditions, and Trends of Ruderal Lands

Ruderal lands in the surrounding area are usually limited to farm field edges or transitions between habitat types that remain unmanaged. Occasionally, growers will abandon a field or orchard and weeds will invade, creating a ruderal condition. If the field is left unmanaged for some time, native species may pioneer into the area and begin to transform the tract to a mix of native and nonnative species.

4.3.8.3 Key Species Supported

Ruderal lands may support a number of species such as great blue herons, sparrows, and grassland songbirds. Many small rodents such as Oregon voles reproduce here. Raptors such as red-tailed hawks and American kestrels may forage here.

4.3.8.4 Refuge Management Activities

Many of these lands have undergone pretreatment activities prior to restoration. Pretreatment activities may include removal of nonnative trees, mowing, discing, or application of herbicide. It is the refuge's intention to convert ruderal lands to native species habitat.

4.4 Major Species Groups

A wide variety of fish and wildlife use refuge habitats during all or part of their life. Appendix E contains a listing of ROCs that inhabit the refuge, and Appendix N is a listing of all known plants, fish, and wildlife that have been documented on the refuge. Large numbers of waterfowl use refuge wetlands during fall and winter, and some remain to breed during spring and summer. Shorebirds and marsh birds use the refuge to some extent year-round, but peak numbers typically occur during spring. Some species in these guilds breed on refuge lands or nearby, while others are migrants. Both resident and migrating songbirds use all refuge habitat types. Many species of neotropical migrant songbirds breed here during spring and summer, and many species of raptors use the refuge during most seasons of the year. Mammals, amphibians, and reptiles are present on the refuge year-round, but some of these species are secretive and may not be readily observed during most of the year. Many species of fish, some of which are migrants, inhabit waterways on and adjacent to the refuge.

4.4.1 Waterfowl

Providing high-quality habitat for waterfowl has been one of the priorities on the refuge since its establishment. Waterfowl are primarily associated with wetlands; however, they also use upland grasslands and croplands. Detailed weekly winter waterfowl surveys have been conducted on the refuge since 2000, and the area surveyed has increased over time as land has been acquired and/or restored. Surveys are conducted from September through at least February each year. Typically, few numbers and species of waterfowl breed and nest on the refuge and surrounding areas. A limited number of western Canada geese, mallards, gadwalls, cinnamon teal, hooded mergansers, and wood ducks annually raise a few broods. Buffleheads, northern shovelers, and blue-winged teal are rare breeders here. In early fall, waterfowl numbers remain low as migration begins (Figure 4-1); their numbers then increase sharply during November. Numbers remain relatively high to the end of January when waterfowl hunting season ends, and then birds tend to disperse to nearby private lands before migrating north near the end of March. The refuge lies in the Pacific Flyway, where birds migrate primarily from breeding grounds in Alaska, British Columbia, Alberta, the Yukon, and Northwest Territories, and to a lesser extent from Saskatchewan. For many of these birds, the refuge is an important stopover to wintering areas in California and Mexico, and for others it is their southern terminus, where they spend the winter.

Photo 4-7. Waterfowl. Gary Kramer/USFWS.

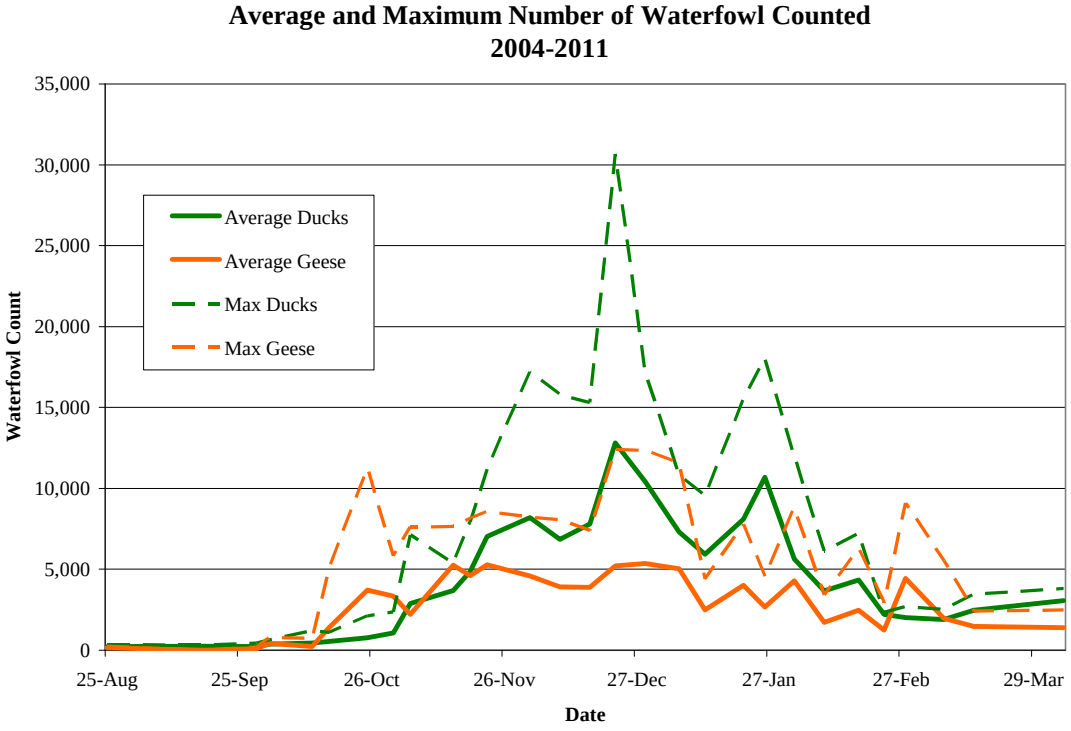

Figure 4-1. Average and maximum number of waterfowl counted on refuge lands during regular weekly surveys from 2004-2011.

Note: On December 16, 2010, a maximum of 71,601 ducks were counted, but this data point was removed to make the chart more readable.

4.4.2 Songbirds

The refuge supports a host of both resident and migratory songbirds that use all of the habitat types represented here. About 100 songbird species have been identified on the refuge and many of those species breed here. Point count surveys have been conducted to identify species using the refuge, and a bird banding program has been established under the Monitoring Avian Production and Survival protocol to assess productivity and survival of locally breeding birds. These surveys will help to determine long-term trends in songbird populations on both a local and regional scale.

4.4.3 Shorebirds

There are relatively few shorebirds that use the refuge, and species diversity is low. Twenty-one species have been recorded, but many of those are one-time or rare sightings. Killdeer, spotted sandpipers, and Wilson's snipe are among the most numerous; all of them breed at the refuge. Least and western sandpipers, dunlin, lesser yellowlegs, and long-billed dowitchers are also commonly sighted during migration. Regular weekly surveys are conducted from April through September on several of the Sherwood Units. Weekly counts average fewer than 50 individuals, but may number several hundred on rare occasions. Although some shorebirds do breed here, the majority of shorebirds are migrants, passing through during spring and late summer and fall. Typically, mudflats in wetland margins are available for shorebird foraging from early spring through summer as managed wetlands are drawn down on their annual cycle.

Photo 4-8. Long-billed dowitcher. © Ed Bustya.

4.4.4 Marsh Birds and Waders

Marsh birds use both herbaceous and scrub-shrub wetlands, and to a lesser extent adjacent uplands. Surveys for sora, Virginia rail, American bittern, American coot, and pied-billed grebe are conducted using recorded calls from April through June each year. Breeding has been verified on the refuge for each of these species, although they occur in relatively low numbers. Early spring drawdown of wetlands to meet other management objectives may have a negative effect on these species. The first

confirmed breeding of American bitterns on the refuge was observed at a recent scrub-shrub wetland restoration site.

Wading birds such as great blue herons, great egrets, and green herons are surveyed in conjunction with shorebird and waterfowl surveys. Great blue herons and great egrets are present nearly year-round on the refuge, while green herons are usually only observed during summer.

4.4.5 Raptors

At least 18 species of raptors have been recorded on the refuge including eagles, hawks, falcons, and owls. Bald eagles, red-tailed hawks, American kestrels, and great horned owls are year-round residents. Other species such as peregrine falcons are usually only present during winter when waterfowl populations are high. Some species are regular summertime visitors, such as ospreys that forage on fish as wetlands are drawn down. Raptors are specialized in the habitat types that they use and may be observed in most habitat types on the refuge. Eagles and peregrine falcons use wetlands for hunting waterfowl. Great horned owls hunt rodents in the forest at night while Cooper's hawks hunt in the forest during daylight in search of songbirds. Northern harriers hunt in the uplands, croplands, and wetlands during the day, while barn owls hunt open fields during the night and evening. The refuge has installed American kestrel nesting boxes and will monitor these from time to time to determine nesting success. There are no other surveys that specifically target raptors, although raptors are recorded during songbird point count surveys.

Photo 4-9. American kestrel. Robert Burton/USFWS.

4.4.6 Mammals

Many mammal species, large and small, use the various habitat types on the refuge. Large mammals such as black-tailed deer and the occasional elk are observed on the refuge. Smaller mammal species such as coyote, river otter, bobcat, raccoon, beaver, muskrat, and mink are present on the refuge, but

are less frequently observed. No regular surveys are conducted for the above-mentioned groups of mammals. Smaller, yet more numerous, are squirrels, voles, mice, and shrews. Bats are also known to use refuge lands, but no surveys have been conducted to determine species present. From 2003 to 2005, a small mammal survey was conducted, which identified 14 species on one parcel. By far the most numerous species in this study was deer mouse.

Photo 4-10. Black-tailed deer at Atfálat'i Unit. Peter Schmidt/USFWS.

4.4.7 Fish

Numerous fish species have been noted using the waters in and adjacent to refuge lands. The refuge has conducted fish trapping in refuge wetlands following river flood events to determine if salmonids were entering wetlands from the river and subsequently escaping as water levels receded. No salmonid species were detected during any surveys. Several species of both native and nonnative fish were detected during these surveys. Native species included western brook lamprey, three-spined stickleback, and sculpin. Nonnative species included carp, mosquito fish, and bluegill. From 1999 to 2001, ODFW conducted fish surveys in the Tualatin River Basin (Leader 2001) and recorded 16 species of fish from seven families. The survey noted that only 0.16 percent of the total sample were nonnative fish.

Upper Willamette River steelhead and Chinook salmon were both listed as threatened species in March 1999 (National Oceanic and Atmospheric Administration [NOAA] 2011d, 2011f), and critical habitat was designated in 2005 (Federal Register 2005) in the upper Tualatin River Basin (roughly defined as the Tualatin River and its tributaries upstream of Highway 219 near Hillsboro), excluding Rock Creek. Leader (2001) identified both rainbow trout (genetically identical to steelhead) and Chinook salmon in the Tualatin River system. Coho salmon, while not native to the Tualatin River system, were introduced and are now a self-sustaining population in the basin.

Nonnative fish such as carp, bass, catfish, and sunfishes are disruptive to and can outcompete native species. Carp uproot and consume submergent vegetation important to native species and cause

turbidity, thus inhibiting further growth of vegetation. Bass, catfish, and sunfishes directly consume native species, such as red-legged frogs, and also indirectly affect native species by consuming food such as invertebrates that native species forage upon.

Native fish species such as lampreys, sculpin, and three-spined sticklebacks have also been recorded in refuge waters and are an important part of the aquatic community. The presence of lampreys is a good indicator of water quality as they will not persist in poor-quality habitats. Three-spined sticklebacks, which were numerous in our sampling, may be beneficial in removing mosquito larvae from slow-moving waterways (Sharp 2000).

4.4.8 Reptiles

Reptiles observed on the refuge include northwestern, painted, and nonnative red slider turtles, and various varieties of garter snakes. Other species that are likely present, but have not been documented, are alligator lizards and rubber boa. Nonnative snapping turtles have been documented in the Tualatin River but have not been observed by refuge staff or volunteers. Turtles are commonly observed basking on logs in the river or on herbaceous wetlands. Garter snakes are observed in most open habitat types throughout spring and summer. No surveys for reptiles are currently being conducted.

Photo 4-11. Garter snake. © Ed Bustya

4.4.9 Amphibians

Many species of amphibians have been documented on the refuge including chorus frogs, red-legged frogs, and nonnative bullfrogs; long-toed and northwestern salamanders; and rough-skinned newts. These species breed in refuge wetlands and use adjacent uplands for part of their life cycles. Surveys for amphibian egg masses were conducted in late winter and spring during 2010 and 2011 on several refuge wetlands. Results showed red-legged frogs, chorus frogs, and long-toed salamanders were breeding in refuge wetlands.

4.5 Threatened, Endangered, and Sensitive Species

One goal of the Refuge System is "to conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered." In the policy clarifying the mission of the Refuge System, it is stated, "We protect and manage candidate and proposed species to enhance their status and help preclude the need for listing." In accordance with this policy, the CCP planning team considered species with Federal or state status, and other special-status species, in the planning process.

Currently there is one plant species (Nelson's checker-mallow) that is federally listed as threatened, and two fish species (upper Willamette River run Chinook, and upper Willamette River run steelhead) that are federally threatened and occur or could occur on the refuge. These three species are also state-listed as threatened. Meadow checker-mallow is a state-listed candidate plant species that occurs on several areas of the refuge. Bald eagles are listed as a state-threatened species, although they have been removed from the federally threatened list. Birds considered species of concern that have been observed on the refuge are olive-sided flycatcher, yellow-breasted chat, acorn woodpecker, Lewis' woodpecker, and band-tailed pigeon. Reptiles and amphibians considered species of concern include northwestern pond turtle and northern red-legged frog. Fish species considered species of concern that may occur in refuge waters are Pacific lamprey and coastal cutthroat trout.

Photo 4-12. Nelson's checker-mallow. Jeff Dillon/USFWS.

In February 2008, Nelson's checker-mallow was planted in seven plots on three of the Sherwood Units: Atfálat'i, Tualatin River, and Riverboat. Nelson's checker-mallow was known to occur on one parcel of the Atfálat'i Unit prior to this planting effort. In 2010, additional plants were added to the plots on the Atfálat'i and Riverboat Units. The plants have experienced good survival since installation and will continue to be monitored.

4.6 Invasive and Nuisance Species

Refuge personnel expend considerable resources in terms of funding and staff and volunteer time managing invasive and nuisance species each year to provide quality habitat for native species. Management of invasive and nonnative species follows the practices set forth and described in the IPM Plan in Appendix G. This plan describes priorities for response by the refuge and the various methods used to manage these species. The refuge has and will continue to follow the practice of "Early Detection and Rapid Response" (EDRR). Preventing the introduction of invasive species is the first line of defense in the battle against new invasions. However, it is inevitable that new introductions will occur. The next best line of defense is to manage these invasions through EDRR. EDRR is the principle of targeting noxious weed infestations when they first arrive in a given area, while their populations are small and localized. This effort greatly increases the likelihood that new invasions are addressed immediately, before the species can become established and widespread.

Table 4-2 lists the target nonnative and invasive species for the refuge; however, this list is not comprehensive. Plant species are by far the most problematic, but nonnative fish and wildlife species also have important direct and indirect impacts to native habitat types, native fish and wildlife, and refuge infrastructure.

Table 4-2. Common and Scientific Names of Target Nonnative Invasive Species on Refuge

Common Name	Scientific Name	State Noxious Weed*
Plant Species		
Bermuda grass	*Cynodon dactylon*	
Bull thistle	*Circium vulgare*	B
Canada thistle	*Circium arvense*	B
Cocklebur	*Xanthium strumarium*	B
Cutleaf teasel	*Dipsacus fullonum*	B
English holly	*Ilex aquifolium*	
English ivy	*Hedera helix*	B
Field bindweed	*Convolvulus arvensis*	B
Himalayan blackberry	*Rubus discolor*	B
Japanese knotweed	*Polygonum cuspidatum*	B
Poison hemlock	*Conium maculatum*	B
Purple loosestrife	*Lythrum salicaria*	B
Red hawthorn	*Crataegus monogyna*	
Reed canarygrass	*Phalaris arundinacea*	
Scotch broom	*Cytisus scoparius*	B
Tansy	*Tanacetum vulgare*	
Velvet grass	*Holcus lanatus*	
Velvetleaf	*Abutilon theophrasti*	B
Wildlife Species		
Bullfrog	*Rana catesbeiana*	
Nutria	*Myocastor coypus*	
Feral cat	*Felis catus*	
Red-eared slider (turtle)	*Trachemys scripta elegans*	
European starling	*Sturnus vulgaris*	

Table 4-2. Common and Scientific Names of Target Nonnative Invasive Species on Refuge

Common Name	Scientific Name	State Noxious Weed*
House sparrow	*Passer domesticus*	
Fish Species		
Bass	*Micropterus* sp.	
Catfish	*Ictalurus* sp.	
Common carp	*Cyprinus carpio*	
Mosquito fish	*Gambusia affinis*	
Sunfish	Family Centrarchidae	

*State B-listed plants are those defined as "a weed of economic importance which is regionally abundant, but which may have limited distribution in some counties" (ODA 2012).

There are species such as reed canarygrass listed in Table 4-2 that are not on the state's list of noxious weeds but are very problematic for the refuge because of their aggressive nature, difficulty of control, and abundant distribution. This list is not presented in priority order, and some plant species may be treated more aggressively in one season than another depending on staff availability, extent of distribution, or threat presented to native wildlife or habitats. The invasive plant species listed above often form a monoculture and compete with native plants. Many species of native wildlife have evolved with native plants and either cannot use nonnative plants or have reduced benefits from them. Many plants such as Himalayan blackberry form very dense thickets that may actually hinder wildlife movement. Reed canarygrass invades wetlands, forming dense monocultures and preventing beneficial native plants from growing. Both purple loosestrife and Japanese knotweed have been found on the refuge and have been vigorously removed before they could become established. Invasive tree species such as English holly and red hawthorn crowd out native species and spread prolifically by means of thousands of seeds annually per tree. These trees are removed as time allows in established habitat types and are vigorously controlled in new restoration areas.

Invasive wildlife regularly observed on the refuge include nutria and bullfrogs. Nutria, a native of South America, were introduced for fur farming and escaped or were released as fur prices dropped. They are well established in our area, and eradication efforts would only be successful if adopted on a regional basis. Climate change may contribute to their spread if winter climate becomes more favorable for breeding and survival. Nutria directly affect wetland and adjacent habitat types by foraging on native plants, and they also affect native wildlife such as muskrats by direct competition and displacement. They affect refuge infrastructure such as levees and water control structures by burrowing into levees, causing leakage through the levees and/or causing cave-ins of dens presenting safety hazards to vehicles traveling on levees; they also burrow along the side of culverts, causing a "piping" effect whereby water leaking along the outside of the pipe erodes the earthen material and causes a washout of the pipe. Lethal means such as shooting and trapping, wherever feasible, are used to attempt control of nutria.

Bullfrogs, which are native to the southeastern United States, eat native frogs and many other wildlife species such as ducklings. Bullfrogs thrive in wetlands that retain water year-round and can be at least partially controlled by completely drawing down wetlands during summer. The refuge contains managed wetlands that cannot be completely drawn down due to either incorrectly situated water control structures or incorrectly contoured basins that do not allow for complete drainage. European starlings are cavity nesters and displace and sometimes kill native cavity nesters such as Western bluebirds, American kestrels, and white-breasted nuthatches.

Photo 4-13. Nonnative nutria. Peter Schmidt/USFWS.

The Tualatin River watershed contains many species of nonnative fish. These species were either brought in for sport fishing, as commercial species, or were accidentally introduced. Nonnative fish displace and compete directly with native species by preying on native species, and/or disrupting native plant growth. Sunfish may eat larval amphibians and native fish, carp eat submergent vegetation important to wildlife species and cause turbidity, which further reduces plant growth, and bass eat native fish and wildlife species. Completely drawing down wetlands in summer may help reduce these species on a site-specific basis, but they likely will not be eradicated in the watershed as a whole. As mentioned above in the discussion on bullfrogs, drawing down the wetlands completely would help reduce nonnative fish on a localized basis but is not a likely scenario. Screening water diversions from creeks and the river would help reduce the presence of nonnative as well as native fish in wetland areas.

Nuisance species on the refuge may include such native animals as beavers, elk, Canada geese, and others, depending on circumstances. Beavers are native and are encouraged in most areas. However, they can become problematic by plugging up water control structures on a daily basis or cutting down trees in restoration areas. Sometimes it is necessary to control beavers using lethal means. Relocation is seldom successful as most suitable beaver habitat is already occupied and problem beavers are likely to return to their original capture site. Elk have not been a problem on the refuge to date, but with acquisition and restoration of large tracts of land in the Wapato Lake Unit this may be an issue in the future. ODFW considers the Willamette Valley an “elk de-emphasis zone” to prevent conflicts with agricultural interests. A population of elk residing on refuge lands and foraging on neighboring agricultural lands would cause conflict with neighboring landowners. In addition, elk crossing Highway 47 or Springhill Road to and from refuge property would create a safety hazard to vehicles.

4.7 Wildlife and Habitat Research, Inventory, and Monitoring

There are several regular inventory and monitoring surveys, and occasional research studies, conducted on the refuge. Table 4-3 lists the regular surveys that are conducted almost every year to determine habitat conditions, restoration/enhancement response to management activities, and wildlife response and population trends. In addition, research is conducted by refuge staff or outside organizations such as universities and USGS to help inform management decisions.

Table 4-3. Regular Surveys Conducted on Refuge Lands and Their Usual Timetables

Habitat Type or Guild	Survey Type	Timetable
American kestrel	Nest box	Spring/early summer
Amphibians	Egg mass	Late winter/spring
Western bluebird	Nest box	Spring/summer
Fish	Trapping/identification	Winter/flooding
Marsh birds	Recorded call-back	April-June
Nelson's checker-mallow	Inventory	June-July
Shorebirds	Instantaneous scan	April-September
Songbirds	Point count	April-June
Songbirds	Monitoring Avian Production and Survivorship mist netting	May-August
Tree and shrub	Fixed plots: survival and growth	Summer/early fall
Wading birds	Instantaneous scan	Year-round
Waterfowl	Instantaneous scan	September-February
Wetlands	Transects: plant species/density	Summer/early fall

In addition to surveys listed in Table 4-3, other surveys are conducted periodically by refuge staff and others:

- Mosquito larvae surveys were conducted during summer for several seasons and revealed very low numbers of larvae in refuge wetlands.
- A feasibility study was conducted in 2004 to determine if boxes for cavity nesting waterfowl would be beneficial. The study revealed adequate natural cavities existed on the refuge and brood water was limited.
- A survey for freshwater mussels was conducted in 2009 and revealed the presence of native western pearlshell mussels in Chicken Creek.
- USGS conducted a survey for nonnative crayfish and found none in waters in and adjacent to the refuge.
- University researchers conducted a study over a three-year period to inventory small mammals and determine prevalence of hanta virus.
- Extensive surveys have been conducted by qualified volunteers to identify, collect, and catalog plant species throughout the refuge.

- Refuge staff and volunteers have undertaken a project to map invasive plant species throughout the refuge using global positioning system (GPS)/geographic information system (GIS).
- In 2011 the refuge began a collaborative study with USGS and other partners to obtain a detailed topographic survey and water quantity/quality study at the Wapato Lake Unit to guide future restoration efforts.

Chapter 5
Human Environment

USFWS

Chapter 5 Human Environment

5.1 Cultural Resources

Archaeological and other cultural resources are important components of our nation's heritage. The U.S. Fish and Wildlife Service (Service; USFWS) is committed to protecting valuable evidence of plant, animal, and human interactions with each other and the landscape over time. An example of an interaction would be the importance of specific plants to Kalapuya Indians, or the use of fire to burn open spaces that then provided habitat for elk and deer. These interactions may include previously recorded or yet undocumented historic, cultural, archaeological, and paleontological resources as well as traditional cultural properties and the historic built environment. Protection of cultural resources is legally mandated under numerous Federal laws and regulations. Foremost among these are the National Historic Preservation Act (NHPA) as amended, the Antiquities Act, the Historic Sites Act, the Archaeological Resources Protection Act (ARPA) as amended, and the Native American Graves Protection and Repatriation Act (NAGPRA). The Service's Native American Policy of 1994 articulates the general principles guiding the Service's relationships with Tribal governments in the conservation of fish and wildlife resources (USFWS 1994). Additionally, the Tualatin River National Wildlife Refuge (the refuge) seeks to maintain a working relationship and consult on a regular basis with the Tribes that are or were traditionally tied to lands and waters within the refuge.

Since cultural resources encompass many elements and time periods, the following simple temporal divisions were used to distinguish and categorize this brief review of the following resources.

- Pre-recorded history
- Pre-contact Native American traditions
- Post-contact traditions (Native American, Early British, and United States)
- Recent U.S. settlement and economic development period
- Historic and prehistoric sites on the refuge

Cultural resources can be of significant cultural, scientific, and educational importance. It is essential that the Service look beyond compliance with cultural resource laws to ensure protection of these nonrenewable resources. Of critical importance is the development of close working relationships with those that express affinity with the refuge's cultural resources, such as Native Americans, historians, and educators.

There are seven recorded prehistoric sites and six recorded historic sites within the refuge boundaries. Other historic sites and features may exist on the refuge that have not been recorded. Several prehistoric and historic sites and/or features have been recorded within 1 mile of the refuge.

Two of the historic sites within refuge boundaries have been evaluated and determined ineligible to the National Register of Historic Places (NRHP). One site has been determined eligible to the NRHP. It is highly probable that additional archaeological sites will be exposed by human actions or natural causes in future.

5.1.1 Prehistoric and Ethnographic Resources

5.1.1.1 Prehistoric and Ethnographic Setting of the Refuge Region

The meandering Tualatin River and its banks are home to native fish, beaver, deer, raptors, songbirds, and plants, all of which are disappearing as their habitats are lost to urban development. Yet these resources were abundant when the Atfálat'i (At-fahl-a-ti) Tribe of Kalapuya Indians lived, hunted, and gathered food on the Tualatin River floodplain.

Archaeological research on the refuge has revealed a history of humans hunting and gathering that dates back over 2,000 years. Camas, tarweed, and wapato were some of the most important plant foods. Long before the Wapato Lake Unit of the refuge was turned into an irrigated agricultural area by settlers in the late nineteenth century, it was an important place where all the villages of Atfálat'i Kalapuya gathered in autumn to harvest wapato. The Kalapuya routinely burned the valley floor for a variety of benefits: to increase grazing for game animals such as elk and deer, to maintain and spread camas habitat, to increase production of acorns, and to prepare for tarweed harvest, to name a few.

As Zenk (1976:358) reported:

> … each Tualatin winter-village group had its own tarweed-producing area within which individuals (at least, we would presume, wealthy individuals) owned their own sub-plots. These areas were set on fire about August. Women then went out with rawhide buckets and paddles; the seeds were beaten from the plants into the buckets. It is stated that each "lot" (individually owned plot) might produce 10-20 bushels of seeds.

Understanding these past land uses by the valley's original inhabitants offers critical lessons and has important ramifications regarding habitat restoration and management decisions on the refuge today. What food or tools they could not obtain along the river and its environs, the Kalapuyans obtained via trade with their neighbors. Obsidian, a volcanic rock used to make arrow points, has been found from as far away as the east side of the Cascades. Historical accounts (Zenk 1976) suggest that the Tualatin River Valley, including the area of the refuge, supported at least 20 native winter villages.

Wapato Lake was a major habitation location for the Tualatin Indians, also known as the Wapato Lake Indians, one of approximately 13 groups of Kalapuya people. The territory of the Kalapuyans extended throughout most of the Willamette River Valley as far south as the Umpqua River. Named for the wapato plant that grew in and was harvested from it, Wapato Lake served as a seasonal community gathering place for the bands of Kalapuyans.

The first recorded contact between Euro-Americans and the Kalapuyans occurred in 1812, when the Kalapuyan population may have been as great as 10,000 people. From 1812 to the 1840s, Kalapuyans had many contacts with fur traders. Though it occurred even before recorded contact, the smallpox epidemic of 1782-1783 and the later malaria epidemic of the 1830s had dramatic impacts on the Kalapuyan population, and on other native groups. Other new illnesses soon followed. By the 1850s there were few Atfálat'i left to claim their traditional lands, and the survivors were ultimately removed to the Grand Ronde Reservation.

Euro-American settlers began arriving in the 1840s, displacing the native population and turning the fertile Tualatin River bottomlands to agricultural purposes. Land clearing and the construction of farming infrastructure such as dikes and ditches drained Wapato Lake and changed the landscape

from one of riparian forest to agricultural fields. Towns grew up around the homes of the earliest settlers, intensified by the development of a Portland-to-Corvallis railroad that begun in the late 1860s. Many towns bear the names of their founders or influential early landowners (e.g., Gaston, Seghers, Dilley).

Photo 5-1. For thousands of years, the Kalapuya people called Willamette Valley their home. Smithsonian Library (Wilkes 1845:223).

5.1.1.2 Known Prehistoric Sites

There are seven prehistoric archaeological sites recorded on the refuge. These sites are located throughout the refuge on both the Sherwood (three sites) and Wapato Lake (four sites) Units. In addition to the prehistoric sites, there is also a collection of artifacts donated to Portland State University by a private landowner. These artifacts came from property within and immediately adjacent to the refuge. Currently, the status and location of the collection is unknown. Table 5-1 summarizes the sites and surveys.

Table 5-1. Prehistoric Resources within Refuge Boundaries

Site#	Unit	Date Recorded	Site Type	Materials	NRHP Eligibility	Notes
35WN17	Wapato Lake	1977		Recorded based on informants' descriptions	Potentially eligible	State Historic Preservation Office (SHPO) report 11951 (testing)
35WN19	Wapato Lake	1977		Recorded based on informants' descriptions	Potentially eligible	SHPO report 9734 (survey)
35WN29	Wapato Lake	1982	Lithic scatter	Pestle, projectile points, fire-cracked rocks (FCR), charcoal	Potentially eligible	
35WN30	Wapato Lake	1982	Lithic scatter	Obsidian flake, FCR, basalt debitage	Potentially eligible	
34WN43	Atfálat'i	1997	Lithic scatter/FCR/artifact concentration	Period III (40000 BC-250 BC) and Period IV (250 BC-AD 1700)	Eligible	Tested
34WN44	Atfálat'i	1997	Lithic scatter/FCR/artifact concentration		Potentially eligible	
35WN46	Atfálat'i	2001	Lithic scatter		Eligible	Tested

5.1.2 Historic Resources

5.1.2.1 Known Historic Sites

Parcels acquired within the approved boundaries of the Tualatin River National Wildlife Refuge often come with standing structures associated with the area's agricultural history. After being acquired, several of these historic farm complexes and/or residential structures have been

documented and evaluated by the Service's Cultural Resources Branch (Table 5-2). Upon evaluation and determination of noneligibility to the NRHP, the subject buildings may be slated for removal through demolition and salvage if they pose a risk to humans or wildlife. In one case, a historic structure was determined eligible, and the necessary documentary steps were taken to mitigate its removal in compliance with the NHPA.

Photo 5-2. Onion barns are part of the historic structure of the refuge. Nick Valentine/USFWS.

Table 5-2. Historic Resources within Refuge Boundaries

Site Name	Site Type/Features/ Materials/Notes	Condition (integrity)	NRHP Eligibility
Cranfield Homestead	Estimated located as per 1852 General Land Office (GLO) map (GLO 1952)	Some brick/ceramic/glass observed	N/A
McKinney Field	Estimated located as per 1852 GLO map	No existing evidence	N/A
White-Ditmman Onion Barn	Onion barn reflecting agricultural function. A memorandum of agreement (MOA) was prepared to document it before demolition	Demolished	Eligible
Naujock House	Built in 1891 by emigrants from Germany who arrived in the area in 1876. Replaced earlier log house	In use, modified	Not eligible
Naujock Barn and	Gambrel roof barn, built in	Not in use	Not eligible

Table 5-2. Historic Resources within Refuge Boundaries

Site Name	Site Type/Features/ Materials/Notes	Condition (integrity)	NRHP Eligibility
Granary	1930s along with brick building (granary and potato cellar). SHPO recommended retaining or if necessary, salvaging site		
Cereghino Farm Complex	Onion drying barn, house, and outbuildings associated with onion farm complex. House is used for office space and other buildings are used for storage or are vacant		Not evaluated

5.2 Refuge Facilities

There are numerous refuge facilities that require upkeep and maintenance, which are performed by one maintenance employee and volunteers, as available. These facilities serve both the visitor services and biological programs, and range from boundary fencing to residences to public use facilities. In addition, there are structures that serve as offices for other Service programs, such as the Office of Law Enforcement and the Cultural Resources Office.

5.2.1 Boundary Fences and Markers

There are approximately 8.4 miles of boundary fence around various tracts of the refuge. The majority of the fencing is around tracts on the Riverboat Unit.

5.2.2 Entrance and Access Points

The primary public entrance to the refuge, opened in 2006, is from Oregon State Highway 99W, between Sherwood and King City. This entrance is allowed through a permit issued by the Oregon Department of Transportation (ODOT) and was constructed according to ODOT specifications, which do not include a deceleration lane from the highway to the refuge or an acceleration lane from the refuge to the highway. This has caused some safety concerns for visitors. Four state highway recreation signs direct visitors into the refuge. A secondary public entrance off of Washington County's Roy Rogers Road provides access to the west side of the Atfálat'i Unit and the Wayside Overlook (see Figure 5-1 and Appendix P, Map 11). There are no other public access points to the refuge. The refuge has provided input to a number of regional trail planning projects that have the potential of connecting to refuge access points. These include Tonquin Trail planning by Metro, a tri-county regional government that serves Multnomah, Clackamas, and Washington Counties; Cedar Creek Trail planning by the City of Sherwood; and West Bull Mountain Concept Plan by Washington County.

Figure 5-1. Public use facilities and regulations.

5.2.3 Administrative Facilities

Administrative facilities are located on the Atfálat'i Unit of the refuge. The 4,058-square-foot refuge headquarters, completed in 2007, includes staff offices and other work area amenities consisting of a documents work area, conference room, reception area, and space for volunteers. New facilities, including the refuge headquarters, Wildlife Center, environmental education shelter, fee collection booth, and parking lots have all been designed and constructed to meet sustainable design standards of the silver level of LEED (Leadership in Energy and Environmental Design). There is a fire suppression pump and a water storage building that serves the public use facilities and refuge headquarters.

There are other refuge buildings being used by Service Regional Office employees as offices. These include the Cultural Resources Office located at the Onion Flats Unit and the Office of Law Enforcement, located on the Tualatin River Unit.

The shop area on the Tualatin River Unit contains shop facilities that include a 3,750-square-foot shop containing the maintenance office, vehicle/equipment repair bays, and tool storage. There are another six buildings located at the shop area that support refuge maintenance functions. These include three pole barns used for equipment storage, a hazardous materials storage building, a wooden lean-to for equipment implement storage, and a storage shed for environmental education materials.

The refuge has numerous barns, outbuildings, and homes (houses and mobile homes) that came with the land when property was acquired. Many of these buildings are in poor condition and need to either be demolished or undergo a complete overhaul to be functional. There are seventeen barns and outbuildings scattered throughout the Sherwood Units and four at the Wapato Lake Unit. Along with the barns and outbuildings, there are two houses and one manufactured trailers on the Sherwood Units, and two homes and one manufactured trailer at the Wapato Lake Unit. Altogether, there are 31 buildings on the refuge.

5.2.4 Roads, Trails, and Parking Areas

Tualatin River National Wildlife Refuge opened its Atfálat'i Unit to the public in 2006 after two years of construction that provided safe access from adjacent highways and a variety of outdoor wildlife recreation and education features. Roads and parking features include: a 0.3-mile headquarters entrance road and bus turnaround with parking for 60 cars plus three buses/recreational vehicles (RVs); a 0.1-mile wayside entrance road with parking for six cars and one RV; and five bicycle racks. In the fall of 2010, both entry roads and parking lots were upgraded from gravel to a combination of pervious paver parking stalls and asphalted driving lanes—all stormwater flows into a bioswale in the center of the parking areas. The bioswale is designed to both slow the rate of stormwater runoff and provide natural filtration and water quality treatment.

Trail features include: a 1.1-mile year-round trail; a 0.2-mile photography blind spur trail; two foot bridges; a 3.1-mile seasonal trail, which is part of a gravel refuge road used by staff; a plaza overlook; a bioswale overlook; a wetland observation deck; a wayside overlook; a river overlook; a wildlife photography blind; and five environmental education study sites. All trail features were opened with the refuge in 2006, except for the bioswale overlook, which was completed in 2011. Numerous informational, regulatory, and directional signs are located throughout the refuge's public use areas. The refuge is open daily from dawn to dusk. To provide these high-quality facilities and

maintain compatible wildlife-dependent recreation, dense riparian vegetation plantings were planted in 2004 and 2005 along the planned trail corridor. These screens now provide “natural blinds” where visitors can observe wildlife while minimizing disturbance to the wildlife they are enjoying.

There are roads and parking areas that are not open to the public and serve solely administrative functions. Parking lots for the various residences and other structures include tracts on the Riverboat Unit (Harmon and Naujock tracts), Onion Flats Unit (Cereghino tract), Riverboat Unit (Dennis tract), and Wapato Lake Unit (Losey and Beecher tracts) and total 64,826 square feet of gravel and asphalt lots. Administrative roads throughout the refuge total 11.5 miles and are used to access areas for habitat management and maintenance. These roads are mostly gravel and require regular maintenance and upkeep. There is also a concrete road bridge that crosses Chicken Creek on the Atfálat’i Unit.

Photo 5-3. Wetland observation deck. USFWS.

5.2.5 Visitor Facilities

Outdoor facilities are complemented by a state-of-the-art, sustainably built Wildlife Center, which opened in 2008. The Wildlife Center encompasses 6,316 square feet, and includes an exhibit room, environmental education field laboratory, information desk, a Friends of the Refuge nature store, an indoor viewing area, and a multipurpose room. The center is currently open Tuesday through Sunday year-round. The center is typically closed on major holidays and for one to two weeks spanning the New Year holiday. Friends of the Refuge help staff the daily operation of the center by recruiting and training volunteers. The environmental education shelter, designed primarily to provide cover and education space for students visiting the refuge, was completed in the fall of 2010. The shelter can accommodate up to 65 students at a time. Approximately 25 percent of refuge visitors and students visit the Wildlife Center and/or environmental education shelter annually.

Photo 5-4. Wildlife Center. Kim Strassburg/USFWS.

5.2.6 Easements and Agreements

There is an intergovernmental agreement in place between the Service and Metro that has established a framework for the refuge to manage a portion of a property owned by Metro known as the Morand tract. The property is approximately 50 acres in size, and the Service is performing restoration of a mixture of bottomland riparian forest, herbaceous wetland, and wet prairie habitats. Additionally, the Service is responsible for all funding, restoration, management, operations, and maintenance of the property. This agreement is for 10 years, with the option to extend upon agreement by both parties.

In 1992, the Service purchased a voluntary conservation easement on what is now the Wapato Lake Unit to manage the land for the purpose of habitat restoration. In agreement with the landowner, the refuge has the right to establish or reestablish habitat through various management tools. The purposes of this easement are the preservation and maintenance of wetland and floodplain areas as well as protection and enhancement of plant and animal habitat and populations. Easements are a cost-effective method of conservation, allowing us to work with landowners to protect the habitat on their land.

There are also several access easements that allow staff to access refuge property via private property. These are located at the Onion Flats, Riverboat, and Wapato Lake Units.

Photo 5-5. Water control structure. USFWS.

5.2.7 Dikes, Irrigation, Water Control Structures, and Pump Houses

The refuge manages herbaceous wetlands on several units. To manage these wetlands, the refuge manipulates water levels using a system of dikes, levees, water control structures, and pump houses. For the Steinborn tract on the Atfálat'i Unit, the main source of water is Chicken Creek, which was channelized to facilitate farming and is diverted to an irrigation canal to allow further diversion into specific wetland impoundments. At the point where Chicken Creek enters the refuge, there are fish ladders that were installed to facilitate fish movement past the diversion structure from the river to headwaters. There is also a fish screen in place to prevent fish from moving into the irrigation canal. To move the water through the five impoundments totaling 234 acres, a system of 15 water control structures and 2.23 miles of levees and dikes are used. There is a dilapidated pump that was used prior to refuge acquisition for farming and irrigation purposes. The refuge does not use the pump for its habitat management purposes.

The other tract on the Atfálat'i Unit that has managed wetlands is the Morand tract, which is managed by the Service under a cooperative agreement with Metro, as described in Section 5.2.6. This unit has one herbaceous wetland of 6 acres that is managed by one water control structure, and receives water only from rainfall.

On the Tualatin River Unit, there are five wetland impoundments totaling 35 acres on the Dennis tract. Four of these are seasonal and rely on rainfall as their source of water. The main impoundment is also seasonal and is fed primarily by rainfall supplemented by a pump that uses water from the Tualatin River. The system for this unit contains one water control structure, the aforementioned pump, and 0.40 mile of levees and dikes.

On the Riverboat Unit, 48 acres make up four wetland impoundments that are managed by a system of two water control structures, three low-capacity wells, and 0.10 mile of levees and dikes. All four

wetlands received their water primarily from rainfall; however, the main wetland unit can also get limited water pumped from the wells.

There is a concrete pumphouse located on the Onion Flats Unit that was historically used for irrigation purposes prior to refuge acquisition. This pumphouse has fallen into disrepair and is not used by the refuge for habitat management purposes.

5.3 Public Use Overview

5.3.1 Public Use Program History

One of Tualatin River National Wildlife Refuge's current management priorities is to "provide high quality opportunities for wildlands and wildlife-dependent recreation and environmental education to enhance public appreciation, understanding, and enjoyment of the refuge's fish, wildlife, habitats, and cultural resources, with emphasis towards urban residents" (USFWS 2003a). This stems from the refuge's establishment under the guidelines of the Service's Urban Refuge Policy (341 FW 1) (Smith 1991), which strives to connect large populations of people to the concept of national wildlife refuges. In addition, the communities surrounding the refuge have expressed a desire for the refuge to provide a natural legacy where future generations can enjoy and learn about the outdoors. This foundation has led to a robust public use program at the refuge. The overarching goals of the visitor services program closely mirror national efforts to implement one of the six highest priorities of the Service, namely "Connecting People with Nature—Ensuring the Future of Conservation" (USFWS 2008b).

5.3.1.1 Visitor Experience

The protection of fish and wildlife and their habitats on the refuge provides the public with high-quality wildlife-oriented recreation, education, and interpretation opportunities. Visitors of all ages can experience the beauty of the Tualatin River Valley, view abundant wildlife, and discover how this urban national wildlife refuge represents the National Wildlife Refuge System (Refuge System). The Wildlife Center serves as a springboard by introducing the public to the refuge and its purposes, helping visitors hone their wildlife observation skills, and encouraging visitors to get outside and experience first-hand the wildlife wonders of the refuge. Throughout their visit, whether walking on trails, participating in an education program, or enjoying exhibits, visitors are reminded that they play a role in the health and future of the refuge, the watershed, the Refuge System, and ultimately of fish and wildlife conservation.

5.3.2 Open and Closed Areas

The Atfálat'i Unit is open year-round during daylight hours for wildlife-dependent recreation and education. Access within this unit is limited to defined public use areas. Most of the use originates from the headquarters parking area and Wildlife Center, and is concentrated along the year-round trail and its associated features (see Figure 5-1 and Appendix P, Map 11). The spur trail to the wildlife photography blind is open year-round by registration only. From May 1 through September 30, visitors are permitted to walk on 3.1 miles of service roads. From October 1 through April 30, these service roads are closed to all public entry to provide sanctuary for wildlife.

All other areas of the refuge are closed to public use.

5.3.3 Annual Visitation

Demand for interpretive and educational programs has soared, and visitation has been increasing steadily since the refuge opened to the public in 2006. Current visitation is approximately 100,000 people per year, 4,000 of whom participate in formal, curriculum-based education programs (USFWS 2010a). Since the Wildlife Center opened in 2008, it has received as many as 25,000 annual visitors. Projections indicate that refuge public facilities could serve an estimated 200,000 to 300,000 visitors annually (USFWS 2003b).

5.3.4 Entrance and User Fees

In 2009, the refuge received official approval to establish an entrance fee program, but it has not implemented one to date (USFWS 2009a). Implementation of a fee program remains as a possibility in the future and has been described in Chapter 2, Section 2.3.1, "Features Common to All Alternatives."

A fee booth was constructed in 2008, but is currently unused. If a fee program is implemented, each of the three trailhead kiosks currently include a fee canister and a sign explaining a potential future fee program.

5.3.5 Accessibility of Recreation Sites and Programs to Disabled Persons

Except as noted below, all refuge public use facilities are accessible to disabled visitors and conform to standards set forth in the Architectural Barriers Act (42 U.S. Code 4151 et seq.).

The exceptions are:

- The 200-yard spur trail to the Ridgetop Overlook reaches a maximum grade of 20 percent, but is designed to be wheelchair-accessible in all other respects.
- The 3.1 miles of service roads open to seasonal public use consist of uneven gravel surfaces.

5.3.6 Volunteers

The refuge has a robust volunteer program that is essential to maintaining current refuge operations. With the exception of law enforcement, personnel management, contracting, and select other functions prohibited by law, volunteers are involved in almost all aspects of the refuge's visitor services and habitat and wildlife programs. In fiscal year 2010, volunteers donated over 15,000 hours of support to the refuge (USFWS 2010a). This equals more than seven full-time personnel and is valued at more than $327,000 (national volunteer value = $21.79/hour [Independent Sector 2011]). Over 75 percent of the hours contributed were in support of wildlife-dependent public uses.

Photos 5-6 and 5-7. Volunteers assist with many aspects of refuge operations. USFWS.

5.4 Wildlife-dependent Public Uses

5.4.1 Hunting

Currently, hunting is not offered on the refuge.

5.4.2 Fishing

Currently, fishing is not offered on the refuge.

5.4.3 Wildlife Observation and Photography

The refuge provides a variety of facilities and programs that support high-quality wildlife observation and photography. Both the year-round and seasonal trails offer overlooks and observation points. For a complete description of trail lengths and features, refer to Section 5.2.4, “Roads, Trails, and Parking Areas.” Nearly 70,000 pedestrians used the trails in fiscal year 2010. In addition, the refuge is a stop along the Willamette Valley Birding Trail and has been designated by the Audubon Society as an Important Bird Area.

The wildlife photography blind can be reserved at no charge on Wednesdays, Saturdays, and Sundays. The blind can accommodate two photographers at a time. Wildlife observation supporting materials are available to visitors, and include a spotting scope (indoor viewing area), Discovery Packs (loaner field guides and binoculars at no charge), wildlife sightings register, and refuge Watchable Wildlife checklist. In addition, numerous interpretive signs along the trail and within the Wildlife Center are designed to help visitors develop wildlife observation skills and learn about the specific wildlife and habitats of the refuge. The Wildlife Center also includes a gallery hall with a picture hanging system that primarily highlights refuge wildlife and nature photographs from photography contests, calendar entries, and student projects. Nearly 1,800 people participated in wildlife photography activities in fiscal year 2010.

Programs offered for wildlife observation and photography activities include partner-led bird walks, Friends of the Refuge’s Tualatin River Photographic Society (workshops, trainings, monthly meetings, and nature photography contests), plant walks led by a volunteer botanist, and others as staff/volunteers are available. Additionally, Volunteer Trail Rovers welcome, meet, and interact with visitors along the trail, report wildlife sightings and visitor contacts, and help ensure visitor compliance with refuge rules.

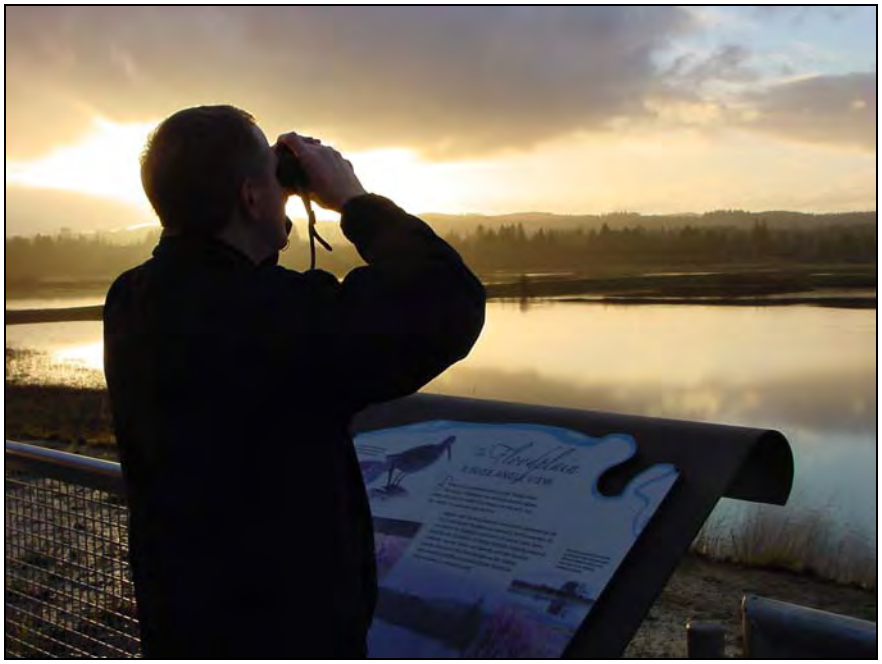

Photo 5-8. Sunset wildlife watcher. Kim Strassburg/USFWS.

5.4.4 Environmental Education

The refuge, in coordination with local educators, has developed a robust curriculum-based environmental education program that is blossoming into a metropolitan resource for teachers, students, youth group leaders, and families. The environmental education program is a key focus of refuge public use activities.

In 2005, the refuge and Friends of the Refuge partnered with a team of elementary and middle school teachers to develop and implement an environmental education program that would be in place by 2006, when the refuge was to open to the public. The result was a written curriculum called *Rhythms of the Refuge: Open Your Eyes to Wildlife*. This curriculum includes a field trip guide and pre-visit, on-site, and post-visit lessons for kindergarten through eighth-grade students. The refuge also supports the use of and offers workshops for national curricula such as *Project Wild*; *Project Flying Wild; Project Learning Tree*; *Growing Up Wild*; *Project Aquatic Wild*; *and 4H Wildlife Stewards*. Modeled after other national wildlife refuge programs, the curriculum is paired with required teacher workshops that prepare educators to bring their students to the refuge, relying on teachers to lead field trips and refuge volunteer naturalists to assist and accompany class visits. The day-to-day coordination of the education field trip program is generally managed by interns, grant-funded short-term staff, and volunteers. Environmental education training for staff/volunteers consists of a four-day class for volunteer naturalists; on-the-job shadowing for interns; coaching by refuge staff and long-term volunteers; online college courses for staff/interns; and regional workshops/trainings with partners. The emphasis on training has resulted in a high-quality program that follows national and statewide standard practices for environmental education.

The refuge offers facilities and equipment specifically in support of the environmental education program. These include a classroom and student patio that accommodates 36 students; the environmental education shelter, which accommodates 65 students; trailhead restrooms; five study sites along the year-round trail, each of which accommodates 15 students at a time and provides exposure to different habitat types on the refuge; learning materials (e.g., study skins, microscopes, craft supplies); and field investigation equipment (e.g., binoculars, field guides, water quality test kits).

The education program has developed strong partnerships within the community that facilitate quality education. Examples of partners include Friends of the Refuge, Oregon Natural Resources Education Program (Oregon State University), Sherwood School District, 4-H (Oregon State University), Tualatin Riverkeepers, Sherwood Foundation for the Arts, and YMCA of Sherwood.

On-site programs: In fiscal year 2010, the refuge provided teacher workshops for 280 educators. Those who attend the workshops can could register their classes to visit the refuge for a field trip. A maximum of 70 students, plus required chaperones, can be accommodated at any given time. In fiscal year 2010, 1,306 students participated in on-site field trip programs. Although no formal program is offered for high school and college students, the refuge will tailor a visit based on the needs of the students/classes. Local schools occasionally transport physically and learning-disabled students to the refuge for short walks and/or visits to the Wildlife Center. No programs currently exist for these students; however, volunteers will welcome and orient groups as needed. The refuge also draws youth groups for whom learning occurs outside the formal school day. Examples include boy/girl scouts, after-school clubs, summer youth programs and day camps, and pre-school. In fiscal year 2010, 917 students attended informal youth programs.

Off-site programs: The refuge participates in off-site programs when funding and staff are available. Examples of such programs include school-based nature festivals/events, outdoor schools, career days, and special requests. In fiscal year 2010, 1,665 students participated in off-site environmental education programs.

Photo 5-9. Students explore and learn at the refuge. USFWS.

5.4.5 Interpretation/Outreach

The refuge has a variety of interpretive and informational media and programs that strive to accomplish a number of objectives, such as welcoming and orienting visitors; conveying the importance of native wildlife, their habitats, and the interconnectedness of lands and waters; encouraging nature exploration and appreciation; exploring the refuge's cultural history; describing the refuge's resources; introducing the Refuge System; and describing ways in which people are part of and can help care for the natural environment. All interpretive approaches follow the basic tenets of the Service's Interpretive Development Model (605 FW 7, Interpretation). Staff and volunteers are offered training in interpretive techniques.

Interpretive facilities include a 1,200-square-foot exhibit hall within the Wildlife Center; numerous outdoor interpretive panels, kiosks, sculptural elements, and trailside signs; temporary exhibits in the atrium of the Wildlife Center; and publications such as general leaflets and trail maps. Outreach tools include the refuge website; online and printed calendar postings by local partners such as Washington County Visitors Association and Metro Greenscene; newspaper articles and radio spots; flyers; complementary online media such as the Friends of the Refuge website and Facebook page; and the Tualatin River Bird Festival website.

A number of "in-person" interpretive programs are typically offered throughout the year, generally led by staff, volunteers, and partners. These are scheduled opportunistically depending on staff and volunteer availability and expertise. Nearly 2,500 people attended interpretive programs in fiscal year 2010. These programs included owl prowls; nature tours; plant identification walks; birding tours;

Puddle Stompers pre-school program; and workshops (e.g., rain gardens, birding). Oftentimes, other organizations bring visitors in large groups to either participate in refuge-led activities or to participate in wildlife-dependent activities on their own (e.g., senior groups, Audubon Society outings, walking clubs). The refuge requires that groups larger than 15 people but not exceeding 50 people register ahead of their visit, and while at the refuge, follow a certain set of requirements. Key requirements include breaking large groups into groups of 15 or fewer people and staggering these smaller groups along the trail; encouraging carpooling; and not charging participants commercial guiding fees. The refuge does acknowledge that group organizers may recover operating costs, such as transportation, for visits to the refuge.

Several on-site special events occur on the refuge. The primary event, held annually in May, is the Tualatin River Bird Festival, which is hosted in partnership with Friends of the Refuge. Starting in May 2011, the event grew from a one-day festival with an average of 700 attendees to a three-day festival that attracted over 3,500 participants. Other smaller events, offered less frequently, include National Wildlife Refuge Week, Spring Break Exploration Days, Family Adventure Days, and a native plant sale, attracting 100 to 200 participants each. Refuge staff and/or volunteers attend local off-site special events as schedules and funding allow. Common off-site venues include nature festivals and health fairs, reaching 300 to 500 people annually.

Photo 5-10. Interpretive programs connect visitors to refuge resources. Bjorn Fredrickson/USFWS.

5.5 Nonwildlife-dependent Recreation

Nonwildlife-dependent recreation activities are not permitted on the refuge. Kiosks, brochures, and informational and regulatory signs articulate prohibited activities.

5.6 Illegal Uses and Law Enforcement

Law enforcement issues that currently occur on the refuge are primarily trespass in closed areas, presence of dogs, jogging and bicycling, and other nonwildlife-dependent uses. Other illegal uses

include low-flying aircraft, trash dumping, theft (vehicle break-in, stolen gas and tools), and using the refuge facilities to access and steal from neighboring business. These illegal uses persist due to lack of public knowledge and support as well as limited law enforcement capability. Currently there is a zone law enforcement officer stationed at the refuge, but their duties require them to be frequently off-site.

5.7 Area Outdoor Recreational Opportunities and Trends

5.7.1 Nearby Recreational Opportunities

The refuge lies just 15 miles southwest of downtown Portland and is located within the Portland metropolitan area, which is known for its natural areas and parks. Metro boasts over 11,000 acres of protected lands, most of which are open to the public. In addition, the greater Portland area is home to thousands of acres of local/city parks, gardens, arboretums, state and local wildlife areas, state parks, nature centers, multi-use trails, and the 5,000+ acre Forest Park. Many of these areas are connected by bike, pedestrian, and boat corridors. These nearby facilities provide a wide range of recreational opportunities such as hiking, bicycling, wildlife observation, fishing, hunting, picnicking, environmental education, interpretation, guided nature tours, outdoor photography, nature festivals, camping, canoeing/kayaking/rafting, sports, and agritourism sites (e.g., vineyards and "u-pick" produce and tree farms). Portland sits at the mouth of the Columbia River Gorge Scenic Area and is the closest major city to Mount Hood and Willamette National Forests. The highways that skirt the refuge are major corridors providing access to the Oregon coast.

5.7.2 Outdoor Recreation Trends and Demographics

Participation in wildlife-associated recreation has been measured by the Service to determine trends and economic impacts, both at national and state levels. The latest survey, completed in 2006, found that 87.5 million (over 38%) of U.S. residents 16 years and older participated in wildlife-related recreation. During that year, 30.0 million people fished, 12.5 million hunted, and 71.1 million participated in at least one type of wildlife-watching activity such as observing, feeding (e.g., backyard bird feeders), or photographing fish and other wildlife in the United States. Participation by Oregonians is higher than the national average. In 2006, 53 percent of Oregonians participated in wildlife-associated recreation, both within and outside of Oregon. More specifically, 44 percent of Oregonians participated in wildlife-watching and 19 percent in hunting and fishing (U.S. Department of the Interior [USDOI] et al. 2007).

Oregon Parks and Recreation Department (OPRD) is responsible for providing guidance, information, and recommendations to Federal, state, and local units of government, as well as the private sector, in making policy and planning decisions regarding outdoor recreation in Oregon. They do this in the Statewide Comprehensive Outdoor Recreation Plan (SCORP). The latest SCORP is a five-year plan covering outdoor recreation in Oregon from 2008 through 2012 (OPRD 2008).

The OPRD began the SCORP planning process in September 2005. The agency took a proactive approach in addressing a limited number of previously identified and defined issues. Key findings from the 2008-2012 SCORP and the 2005-2014 statewide trails planning efforts identified a number of important demographic and social changes specifically facing outdoor recreation providers in the coming years, including: 1) a rapidly aging Oregon population, 2) fewer Oregon youth learning outdoor skills, and 3) an increasingly diverse Oregon population. An additional identified issue

related to human health is the physical inactivity within the population. Key findings especially relevant to the Service regarding these issues are summarized below.

A Rapidly Aging Oregon Population

- On average across all activities, respondents expect to spend 28 percent more days recreating 10 years from now than they currently do.
- The most popular outdoor recreation activities for Oregonians between the ages of 42 and 80 included walking, picnicking, sightseeing, visiting historic sites, and ocean beach activities. A comparison across age categories for the top five activities by the level of participation leads to the following conclusions: Walking is the top activity across all age categories (40-79); jogging is a top activity between the ages of 40-59, but is also popular for those in their 70s; bicycling is a top activity between the ages of 40-64; sightseeing is a top activity between the ages of 45-74; bird watching is a top activity between the ages of 55-79; and RV/trailer camping is a top activity between the ages of 55-74.
- The top five activities in terms of future participation intensity 10 years from now included walking, bicycling, jogging, bird watching, and day hiking.
- Ensuring clean and well-maintained parks and facilities was the most important management action leading to a large increase in recreation, followed by developing walking/hiking trails closer to home and providing more free-of-charge recreation opportunities.
- Over a third of Oregon Boomers, people born between 1946 and 1964, and Pre-Boomers, who were born between 1926 and 1945, volunteered in their community, with an average time commitment of 5.3 hours per week. Of those who volunteered, 43 percent expect future changes in their volunteer activities, with most of the changes involving greater volunteerism: more time, more projects at current volunteer opportunities, and new volunteer opportunities.

Fewer Oregon Youth Learning Outdoor Skills

- The most popular outdoor activities for parents were walking, viewing natural features, and relaxing/hanging out. For children, the most popular were walking, followed by outdoor sports/games, relaxing/hanging out, and general play at neighborhood parks/playgrounds.
- The more a parent engages in an outdoor recreation activity, the more their child does. Participation varies across child age, with both the number of activities and the number of activity-days peaking among 12 to 14 year olds and decreasing for 15 to 17 year olds.
- Rural children spend more days, on average, in outdoor activities relative to urban and suburban children. Suburban children spend the least amount of days engaged in outdoor activities. Outdoor abilities have decreased more, on average, among urban and suburban households.
- Outdoor sports programs and day camps were the most popular types of outdoor recreation programs with respect to past participation. Many parents indicated that it was very likely their children would participate in outdoor sports programs (62%), multiday camps (49%), outdoor adventure trips (45%), and day camps (45%) in the future.

An Increasingly Diverse Oregon Population

- Walking for pleasure was the most common favorite activity for both Hispanics and Asians, with fishing and soccer being the next most common for Hispanics and hiking and fishing the next most common for Asians.
- Both Hispanic and Asian study respondents most commonly did their favorite activity with members of their immediate family. Asians were more likely than Hispanics to do activities alone, as were older respondents relative to younger respondents.
- The most common location for Hispanic and Asian respondents to do their favorite activity was in a park or other area outside their town or city. Males were more likely than females to engage in their favorite activity further from home.
- Survey results suggest that both the Hispanic and Asian populations in Oregon engage in outdoor recreation less than the general population.
- Walking for pleasure was also the activity respondents spent the most days engaged in during the past year. Hispanics engage more intensely than Asians in jogging/running, day hiking, picnicking, fishing, viewing natural features, visiting nature centers, and visiting historic sites.
- The most common activities respondents would like to do more often, or start doing, were walking for Asians and walking and camping for Hispanics. The factor that would most help make this happen is availability of partners, followed by more time.
- For the Hispanic population, being in the outdoors, relaxing, and having fun were the most important motivators or reasons for participating in outdoor activities. For the Asian population, relaxing, fitness, and having fun were the top motivators.
- Ensuring clean and well-maintained parks and facilities were the most important management action, followed by keeping parks safe from crime and providing more free-of-charge recreation opportunities and expanded facilities.

Several management recommendations from the SCORP are relevant to the types of outdoor recreation Tualatin River National Wildlife Refuge provides; relevant recommendations from the SCORP are as follows:

- Develop accessible trails in remote settings in close proximity to urban areas of the state.
- Create a statewide interagency volunteer information website or other communications medium to match Boomer volunteers with recreation or natural resource projects in Oregon.
- Greater priority for trail acquisition and development projects in OPRD-administered grant program (Multnomah, Clackamas, and Washington Counties are considered “high priority” based on increase in aging population).
- Develop a statewide youth outdoor programming framework and funding source to focus youth programming efforts across Oregon to address a specific set of key measurable objectives.
- Create a new Outdoor Recreation Section within Oregon Recreation and Park Association addressing the areas of outdoor recreation and environmental education.
- Provide funding and assistance for innovative park designs to connect youth with nature in high-priority counties and communities … in OPRD-administered grant programs (Multnomah, Clackamas, and Washington Counties are considered “high priority” based on increase in youth population).
- Encourage organizational cultural change within public recreation agencies/organizations to effectively address the diversity issue.

- Develop recommendations for addressing language barriers to encourage underrepresented population use of outdoor recreation facilities and programs
- Create a customer service training module related to serving the outdoor recreation needs of an increasingly diverse population.
- Develop and implement a regional youth framework to encourage underrepresented youth participation in outdoor recreation activities through partnerships and investments in school-based recreation clubs.

5.8 Socioeconomic Environment

5.8.1 Population and Area Economy

Oregon's population (3,782,991) ranks twenty-seventh in the nation. State land area covers 95,997 square miles compared to 3,537,438 square miles (United States), with a population density of 40 persons per square mile compared to 87 nationwide. Located in Washington and Yamhill Counties, Tualatin River National Wildlife Refuge is a 30-minute drive from downtown Portland and only minutes away from the Cities of Sherwood, Tigard, Tualatin, Newberg, Forest Grove, and Hillsboro.

The greater Portland metropolitan area, including Washington, Multnomah, Clackamas, Yamhill, and Marion Counties, is the economic hub for the refuge. Table 5-3 shows the population and area economy. Between 1999 and 2009, the population of Oregon increased 11 percent compared with a 10 percent increase for the United States as a whole. Employment for Clackamas, Marion, and Yamhill Counties increased at a greater rate (see Table 5-3) compared to the rest of Oregon (8 percent) and the United States (8 percent). Only Yamhill and Marion Counties exceeded the increase in per capita income compared with Oregon and the United States as a whole (USFWS 2011d).

Table 5-3. Tualatin River National Wildlife Refuge Summary of Area Economy, 2009

	Population		Employment		Per Capita Income	
	2009	Percent change 1999-2009	2009	Percent change 1999-2009	2009	Percent change 1999-2009
Clackamas County	386.1	15%	219.2	18%	$44,362	−1%
Marion County	318.0	13%	173.2	10%	$33,415	5%
Multnomah County	726.9	11%	560.5	4%	$41,154	3%
Washington County	537.3	23%	284.1	6%	$40,112	−3%
Yamhill County	99.0	17%	44.0	13%	$33,434	9%
Oregon	3,825.7	11%	2,202.7	8%	$36,785	4%

Table 5-3. Tualatin River National Wildlife Refuge Summary of Area Economy, 2009

	Population		Employment		Per Capita Income	
	2009	Percent change 1999-2009	2009	Percent change 1999-2009	2009	Percent change 1999-2009
United States	307,006.6	10%	173,809.2	8%	$40,285	9%

Source: U.S. Department of Commerce 2011.

Note: Population and employment are in thousands; per capita income in 2010 dollars.

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Chapter 6 Environmental Consequences

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Chapter 6 Environmental Consequences

6.1 Summary of Effects

Chapter 6 provides an analysis of the environmental consequences of implementing the alternatives described in Chapter 2. Impacts are described for the main aspects of the environments described in Chapters 3 through 5, including physical, biological, cultural, and socioeconomic resources. The alternatives are compared "side by side" under each topic, and both the adverse and beneficial effects of implementing each alternative are described. The overall cumulative effect on the environment from implementing the various alternatives is summarized in Section 6.8. More detailed assessments of the Tualatin River National Wildlife Refuge's (the refuge's) cumulative effects for relevant impact topics are presented section by section. For additional reference, see Appendix P for maps of land status, hydrology, public use, and management alternatives.

Table 6-1 provides an overview of the effects under each alternative by indicator. Effects are described in terms of the change from current conditions. Although the analysis shows that none of the alternatives would be expected to result in significant effects, some positive (beneficial) or negative effects are expected. The terms intermediate, minor, and slight, are used to describe the magnitude of the effect. To interpret these terms, intermediate is a higher magnitude than minor, which is of a higher magnitude than slight. The word neutral is used to describe a negligible or unnoticeable effect compared to the current management plan as depicted in Alternative 1. For more detail, please refer to the remainder of Chapter 6.

The information used in this comprehensive conservation plan/environmental assessment (CCP/EA) was obtained from relevant scientific literature, existing databases and inventories, consultations with other professionals, and personal knowledge of resources based on field visits and experience.

The terms identified below were used to describe the scope, scale, and intensity of effects on natural, cultural, and recreational resources.

- **Neutral.** Resources would not be affected, or the effects to resources would be at or near the lowest level of detection.
- **Slight.** Resource condition changes would be so slight there would not be any measurable or perceptible consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource.
- **Minor.** Effects would be detectable but localized, small, and of little consequence to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation, if needed to offset adverse effects, would be easily implemented and successful.
- **Intermediate.** Effects would be readily detectable and localized, with consequences to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource. Mitigation measures would be needed to offset adverse effects, and would be extensive, moderately complicated to implement, and probably successful.
- **Significant (major).** Effects would be obvious and would result in substantial positive or negative consequences to a population, wildlife or plant community, recreation opportunity, visitor experience, or cultural resource within the local area and region. Extensive mitigating measures may be needed to offset adverse effects and would be large scale in nature, very

complicated to implement, and may not have a guaranteed probability of success. In some instances, major effects would include the irretrievable loss of the resource.

Time and duration of effects have been defined as follows.

- **Short term or Temporary.** An effect that generally would last less than one year or season.
- **Long term.** A change in a resource or its condition that would last longer than a single year or season. All effects described below are long term unless otherwise indicated.

Table 6-1. Summary of Effects to Habitats, Major Wildlife Groups, and Public Use

	Alternative 1 (No Action)	Alternative 2 (Preferred)	Alternative 3 (Alternative Action)
Effects to the physical environment			
Effects to hydrology	Neutral effects as no changes would be made	Minor positive long-term effects as Rock and Chicken Creeks, and Wapato Lake would be restored	Minor positive long-term effects as Rock and Chicken Creeks, and Wapato Lake would be restored
Effects to water quality	Neutral or slightly positive long-term effects as streams are restored and croplands are converted to native habitat types	Neutral or slightly positive long-term effects as streams are restored and croplands are converted to native habitat types	Neutral or slightly positive long-term effects as streams are restored and croplands are converted to native habitat types
Effects to air quality	Neutral effects as restoration and maintenance of habitats continues	Slight short-term negative effects that would impact vegetation and may displace wildlife, but a slight long-term and beneficial effect as prescribed fire is introduced and restoration of native habitat types allows for increased carbon storage	Slight short-term effects that would impact vegetation and may displace wildlife, but a slight long-term and beneficial effect as prescribed fire is introduced and restoration of native habitat types allows for increased carbon storage
Effects to visual quality	Neutral effects as management activities continue	Neutral to slightly positive long-term effects as new infrastructure designed to enhance visitor viewing opportunities are constructed	Neutral effects as more closed canopy habitats are restored
Effects to habitats			
Effects to bottomland riparian forest and	Slight positive effects from maintaining and	Neutral effects as some bottomland riparian	Intermediate positive effects from expanding

Table 6-1. Summary of Effects to Habitats, Major Wildlife Groups, and Public Use

	Alternative 1 (No Action)	Alternative 2 (Preferred)	Alternative 3 (Alternative Action)
associated species	restoring bottomland riparian forest	forest is converted to other habitat type and new areas are restored to this habitat type	bottomland riparian forest
Effects to mixed coniferous/deciduous forest and associated species	Slight positive effects from maintaining mixed coniferous/deciduous forest	Slight positive effects from expanding mixed coniferous/deciduous forest	Minor positive effects from moderate expansion of mixed coniferous/deciduous forest
Effects to oak savanna and associated species	Slight positive effects from maintaining oak savanna	Slight short-term negative effects that would impact vegetation and may displace wildlife due to prescribed fire, but a slight long-term and beneficial effect as prescribed fire is introduced and restoration of native habitat types allows for increased carbon storage. Overall slight positive effects from restoration of oak savanna	Minor negative effects from conversion of oak savanna to other habitat types
Effects to wet prairie and associated species	Slight positive effects from maintaining wet prairie	Slight short-term negative effects that would impact vegetation and may displace wildlife, but a slight long-term positive and beneficial effect as prescribed fire is introduced and restoration of native habitat types allows for increased carbon storage. Overall, intermediate positive effects from expanding wet prairie from currently farmed areas	Neutral effects from expanding wet prairie in some areas while reducing this habitat type in other areas

Table 6-1. Summary of Effects to Habitats, Major Wildlife Groups, and Public Use

	Alternative 1 (No Action)	Alternative 2 (Preferred)	Alternative 3 (Alternative Action)
Effects to herbaceous and scrub-shrub wetlands and associated species	Neutral effects from maintaining wetlands	Slight positive effects to wetlands by reducing some wetlands in the Sherwood Units while restoring wetlands in the Wapato Lake Unit	Minor negative effects to wetlands by further reducing wetlands in the Sherwood Units while restoring wetlands in the Wapato Lake Unit
Effects to streams, rivers, and backwater sloughs and associated species	Slight positive effects from maintaining streams, rivers, and backwater sloughs	Intermediate positive effects from restoring streams and backwater sloughs	Intermediate positive effects from restoring streams and backwater sloughs
Effects to croplands and associated species	Neutral effects from maintaining croplands	Intermediate negative effects from converting croplands to native habitat types	Intermediate negative effects from converting croplands to native habitat types
Effects to ruderal lands and associated species	Intermediate long-term negative effects as these lands are restored to native habitat types	Intermediate long-term negative effects as these lands are restored to native habitat types	Intermediate long-term negative effects as these lands are restored to native habitat types
Effects to fish and wildlife			
Effects to state- and federally listed and special-status species	Minor long-term positive effects from continuing to introduce and maintain listed and special-status species	Minor long-term positive effects from continuing to introduce and maintain listed and special-status species	Minor long-term positive effects from continuing to introduce and maintain listed and special-status species
Effects to nonnative plant and animal species	Neutral effects from continued management to reduce nonnative plant and animal species	Minor long-term positive effects to native habitat types and native fish and wildlife by implementing measures to further reduce nonnative plant and animal species	Minor long-term positive effects to native habitat types and native fish and wildlife by implementing measures to further reduce nonnative plant and animal species
Effects to waterfowl	Neutral effects from maintaining current habitat types	Minor positive effects for waterfowl by reducing some wetlands in the Sherwood Units while restoring croplands to wetlands in the Wapato Lake Unit	Neutral effects for waterfowl by further reducing wetlands in the Sherwood Units while restoring croplands to wetlands in the Wapato Lake Unit

Table 6-1. Summary of Effects to Habitats, Major Wildlife Groups, and Public Use

	Alternative 1 (No Action)	Alternative 2 (Preferred)	Alternative 3 (Alternative Action)
Effects to songbirds	Slight positive effects as recently restored habitat matures	Intermediate positive effects as more bottomland riparian and mixed coniferous/deciduous forest, oak savanna, and wet prairie habitat types are expanded	Slight positive effects as more bottomland riparian and mixed coniferous/deciduous forest habitat types are expanded, but wetlands, oak savanna, and wet prairie are reduced
Effects to shorebirds	Neutral effects from maintaining current habitat types	Slight positive effects for shorebirds by reducing some wetlands in the Sherwood Units while restoring wetlands in the Wapato Lake Unit	Neutral effects for shorebirds by further reducing wetlands in the Sherwood Units while restoring wetlands in the Wapato Lake Unit
Effects to marshbirds and waders	Neutral effects from maintaining current habitat types	Intermediate positive effects for marshbirds and waders by reducing some wetlands in the Sherwood Units while restoring wetlands in the Onion Flats and Wapato Lake Units	Slight positive effects for marshbirds and waders by further reducing wetlands in the Sherwood Units while restoring wetlands in the Onion Flats and Wapato Lake Units
Effects to raptors	Neutral effects from maintaining current habitat types	Slight positive effects for raptors as a result of habitat conversions	Slight positive effects for raptors as a result of habitat conversions
Effects to mammals	Slight positive effects as current restoration of habitat matures	Minor positive effects for most mammals as native habitat types are restored	Minor positive effects for most mammals as native habitat types are restored
Effects to native fish	Slight positive effects for native fish as current restoration of habitat matures	Intermediate positive effects for native fish as streams and backwater sloughs, and other habitat types, are restored	Intermediate positive effects for native fish as streams and backwater sloughs, and other habitat types, are restored
Effects to reptiles	Slight positive effects as current restoration of habitat matures	Intermediate positive effects as habitats are restored, especially as cropland is taken out of production and streams and backwater sloughs are restored	Intermediate positive effects as habitats are restored, especially as cropland is taken out of production and streams and backwater sloughs are restored

Table 6-1. Summary of Effects to Habitats, Major Wildlife Groups, and Public Use

	Alternative 1 (No Action)	Alternative 2 (Preferred)	Alternative 3 (Alternative Action)
Effects to amphibians	Slight positive effects from maintaining current habitat types	Minor positive effects as cropland, especially in the Wapato Lake Unit, is restored to wetland habitat types	Slight positive effects as cropland, especially in the Wapato Lake Unit, is restored to wetland habitat types, but some negative effects at the Sherwood Units as wetland habitat is reduced
Effects to cultural and historic resources			
Effects to cultural and historic resources	Slight negative effect from lack of adequate protection and interpretation of cultural resources	Minor positive effect from stronger inventory, evaluation, and protection of, and education about, cultural resources	Minor positive effect from stronger inventory, evaluation, and protection of, and education about, cultural resources
Social effects			
Effects to wildlife observation and photography	Neutral effect	Minor positive effect from providing additional facilities and improved program quality	Minor positive effect from improved program quality
Effects to environmental education	Neutral effect	Intermediate positive effect by increasing participation in program, adding new program elements, and improving program quality	Minor positive effect from enhancing current program
Effects to interpretation	Neutral effect	Minor positive effect from improving program quality and building new partnerships	Minor positive effect from improving program quality and building new partnerships
Effects to hunting	Neutral effect	Intermediate positive effect due to establishing waterfowl hunt program(s)	Intermediate positive effect due to establishing waterfowl hunt program(s)
Effects to fishing	Neutral effect	Intermediate positive effect by establishing a fishing program	Neutral effect as no fishing would be established

Table 6-1. Summary of Effects to Habitats, Major Wildlife Groups, and Public Use

	Alternative 1 (No Action)	Alternative 2 (Preferred)	Alternative 3 (Alternative Action)
Effects to nonwildlife-dependent recreation	Neutral effect	Neutral effect as no nonwildlife-dependent uses are proposed	Neutral effect as no nonwildlife-dependent uses are proposed

6.2 Effects to the Physical Environment

Topics addressed under the physical environment section include direct and indirect effects to hydrology, water quality, air quality, visual quality, and geology/soils. Direct effects are generally caused by a particular action and occur at the same time and place as the action. Indirect effects are reasonably foreseeable effects caused by the proposed action, but occur later in time.

6.2.1 Effects to Hydrology

Under Alternative 1 (no action) there would be no change to hydrology as described in Section 3.2 of this CCP/EA.

Under Alternative 2 (preferred) and Alternative 3, intermediate, positive long-term effects would take place in the hydrology of Chicken and Rock Creeks in the Sherwood Units, and Ayers, Wapato, and Hill Creeks in the Wapato Lake Unit as these areas are restored. These positive effects include returning stream channels to a more natural meandering condition, reduced streambank erosion, increased groundwater recharge, and sediment and nutrient trapping by vegetation. Minor short-term negative effects would occur during restoration and include direct impacts such as disturbance to stream channels, erosion, sediment inputs, disturbance of habitat, release of stored nutrients from fertilizers, and displacement of fish and wildlife. Restoring croplands to wetlands and other habitat types in both the Sherwood and Wapato Lake Units would have similar short-term minor negative effects, but these would be offset by long-term intermediate positive effects to habitats, fish, and wildlife. Converting wetlands to wet prairie in the Sherwood Units would likely have a neutral effect on hydrology. Short-term minor negative effects of conducting this conversion would include some local erosion and siltation. Long-term minor positive effects are increased floodplain storage during flood events and trapping sediments and nutrients by vegetation.

6.2.1.1 Overall Effects to Hydrology

Overall, Alternative 1 would be expected to have a neutral effect to hydrology. Alternatives 2 and 3 would be expected to have minor long-term positive effects to hydrology in the vicinity of the refuge.

6.2.2 Effects to Water Quality

Under Alternative 1 (no action), restoration activities might cause a slight short-term negative effect on water quality as a result of heavy equipment operation necessary to conduct habitat restoration. There would be slight long-term positive effects as habitats mature and create shade for water cooling and water filtration as plants mature.

Under Alternative 2 (preferred), there would be short-term minor negative effects due to restoration of croplands to natural habitat types, conversion of wetlands to wet prairie, and restoration and construction of stream channels and backwater sloughs. These effects may include localized siltation and turbidity, and release of trapped nutrients into local waters. Long-term minor positive effects include trapping of sediments and nutrients by vegetation, and increased groundwater recharge. Restoration of vegetation along stream and river channels would have a minor positive effect by cooling water, thus increasing its capacity to hold dissolved oxygen.

Under Alternative 3, there would be short-term minor negative effects due to restoration of croplands to natural habitat types, conversion of wetlands to bottomland riparian forest, and restoration and construction of stream channels. These effects may include localized siltation and turbidity, and release of trapped nutrients into local waters. Long-term minor positive effects include trapping of sediments and nutrients by vegetation, and increased groundwater recharge. Restoration of vegetation along stream and river channels would have a minor positive effect by cooling water, thus increasing its capacity to hold dissolved oxygen.

Under all alternatives the refuge would continue to conduct habitat management that would include periodic discing of wetlands, which may cause short-term slight negative effects to water quality such as sedimentation and turbidity, and reduced trapping of sediments and nutrients. Also the refuge would apply herbicide in situations where other methods of invasive species control are ineffective. Application of U.S. Fish and Wildlife Service (Service; USFWS)-approved herbicide may have a slight short-term negative effect to local water quality as described in Appendix G, Integrated Pest Management (IPM).

6.2.2.1 Overall Effects to Water Quality

Overall, Alternatives 1, 2, and 3 would all be expected to have a neutral or slightly positive long-term effect to local water quality.

6.2.3 Effects to Air Quality

Under all alternatives, restoration activities might cause a slight short-term negative effect on air quality as a result of exhaust and dust from heavy equipment operation necessary to conduct habitat restoration. In addition, during the first few years following a restoration project, it is often necessary to mow or apply Service-approved herbicide to combat weeds until native plants can become established. Mowing and herbicide applications can be expected to produce slight negative short-term air quality impacts from gas- and diesel-powered equipment and possible herbicide drift. Restoration of native habitat types would have a slight long-term positive effect on air quality as plants grow by producing oxygen, and taking in carbon dioxide and storing it in plant fibers as carbon.

Under Alternative 1 (no action), no further effects to air quality would be expected.

Under Alternatives 2 (preferred) and 3, prescribed fire would be implemented as a tool for habitat management and would result in intermediate short-term negative effects on air quality in a localized area. Any prescribed burning would be conducted in accordance with all state, local, and Service policies and regulations. Wilhelm (2004) suggested that burning of wet prairies has a negligible effect on atmospheric carbon dioxide levels because plants store more carbon underground than is released as a result of burning their aboveground parts. With the conversion of croplands to native

habitat types under these two alternatives, there would likely be a slight positive long-term effect on air quality as a result of using less diesel fuel in farm equipment and applying less herbicide necessary for crops.

Under Alternative 3, there may be slight long-term positive effects to air quality as more land is converted into forested habitat types. The increase in forested habitat types would be expected to produce more atmospheric oxygen, take up carbon dioxide, and store carbon in plant materials. In addition, the conversion of wetlands to forest habitat types would negate the need for continued maintenance using heavy equipment, thus reducing the amount of diesel fuel expended.

6.2.3.1 Overall Effects to Air Quality

Overall, effects to air quality would be neutral under all alternatives.

6.2.4 Effects to Visual Quality

All alternatives would have neutral or slight positive effects to visual quality. A few minor developments, such as new photography blinds, kiosks, and hunting blinds, would be incorporated in Alternatives 2 and 3. These would be designed to enhance visitor appreciation of the natural and visual resources in that area, and would be constructed in the same architectural style as existing features. Short-term minor visual effects may occur during construction of new facilities.

Habitat actions proposed in Alternative 2 would enhance a variety of habitats and would therefore slightly improve visual quality, with more diverse wildlife and scenery. Alternative 3 would convert more of the refuge into contiguous forest habitats, resulting in less broad landscape views, less habitat diversity, and more closed canopy views.

6.2.4.1 Overall Effects to Air Quality

Overall, effects to visual quality would be neutral under all alternatives.

6.3 Effects to Habitats and Wildlife

6.3.1 General Effects

Under Alternative 1, most habitat types and fish and wildlife listed below would experience largely neutral or slightly positive long-term effects from continued current management actions. However, Alternative 2 and 3 show some changes to habitats and wildlife. Table 6-2 demonstrates the changes in habitat types across alternatives. As restored and enhanced habitat types continue to mature, slight positive long-term effects might be realized by some species or guilds, while others would remain unchanged. For example, mammals such as black-tailed deer and most songbirds would benefit as bottomland riparian forests mature. Black-tailed deer prefer the sanctuary of a closed forest rather than open habitat types, and many songbird species forage and nest in mid- to large-sized trees. Likewise, marshbirds and waders would see slight benefits as recently restored scrub-shrub wetlands continue to mature. Marshbirds and waders forage on a diversity of invertebrates and amphibians that would flourish in a mature scrub-shrub wetland. Guilds such as waterfowl and shorebirds would likely remain unchanged.

6.3.1.1 General Effects from Public Use Actions

Several general effects from public use apply refuge-wide and are not tied to specific habitats or wildlife guilds. With the proposed increase in public use opportunities, expanded outreach, new facilities, and current rising interest in the refuge, visitation is estimated to grow to 250,000 visitors per year. This could have an intermediate negative effect from wildlife disturbance, introduction of invasive species, and loss/fragmentation of habitat. Some examples of disturbance to wildlife and habitat from public use include flushing of birds, causing additional expenditure of energy to evade humans; disturbance to nest sites; and changes in animal behaviors or patterns of habitat use from off-trail use by refuge visitors. However, disturbance to wildlife and habitat from visitors would be minimized with the use of several techniques, including the use of screening vegetation; seasonal closures; limited use of photography and hunt blinds through reservation systems; establishing maximum group/class sizes; providing accurate regulatory information; and increasing law enforcement.

Construction of new facilities would include proper placement of facilities; constructing during a time of the year when the least amount of disturbance would be caused; using low-impact construction techniques and materials; planning minimal footprints; and timely rehabilitation from ground disturbance.

These techniques would cumulatively result in a minor overall negative effect to wildlife and habitat, and is balanced with an overall positive social effect. See remaining sections of Chapter 6 and Compatibility Determinations in Appendix B for detailed analysis of specific public use actions, where applicable.

Table 6-2. Current and Proposed Habitat Acreages

Habitat type	Current Acreage*	Alternative 1			Alternative 2			Alternative 3		
		Restored	Converted to Other Habitat	Net Gain/ Loss	Restored	Converted to Other Habitat	Net Gain/ Loss	Restored	Converted to Other Habitat	Net Gain/ Loss
Bottomland riparian forest	388	39	7	+32	90	39	+51	318	11	+307
Mixed coniferous/deciduous forest	49	47	0	+47	80	3	+77	129	0	+129
Oak savanna	149	0	0	0	79	33	+46	0	40	−40
Wet prairie	27	0	0	0	114	12	+102	30	12	+18
Herbaceous wetland	294	0	0	0	0	106	−106	0	229	−229
Scrub-shrub wetland	20	0	0	0	180	0	+180	176	0	+176
Cropland	942	0	0	0	0	942	−942	0	942	−942
Ruderal lands	249	0	246	−246	0	249	−249	0	249	−249

* Approximate values based on geographic information system (GIS).

6.3.2 Effects to Bottomland Riparian Forest

Under Alternative 1, bottomland riparian forest would experience slight long-term positive effects as plants mature in newly and previously restored areas, and as plants continue to flourish in maintained areas.

Under Alternative 2 (preferred), bottomland riparian forest would be expanded slightly from the current extent of approximately 388 acres and would experience neutral effects. In the Riverboat Unit, about 11 acres of bottomland riparian forest would be converted to wet prairie and scrub-shrub wetland. In the Tualatin River Unit, 13 acres of bottomland riparian forest would be restored from ruderal land. In the Atfálat'i Unit, about 25 acres of bottomland riparian forest would be restored from ruderal lands. An unknown part of the Wapato Lake Unit might also be restored to bottomland riparian forest.

Under Alternative 3, bottomland riparian forest would experience intermediate positive effects as bottomland riparian forest would be expanded from about 388 to 707 acres. In the Riverboat Unit, about 11 acres of bottomland riparian forest would be converted to wet prairie and scrub-shrub wetland. In the Tualatin River Unit, 13 acres of bottomland riparian forest would be restored from ruderal land, and an additional 28 acres of herbaceous wetland would be converted to riparian forest. In the Atfálat'i Unit, about 248 acres would be converted to bottomland riparian forest from wetlands, ruderal lands, and other habitat types. An unknown part of the Wapato Lake Unit might also be restored to bottomland riparian forest.

Bottomland riparian forest on refuge lands exists as mature forest with large trees creating a relatively closed canopy over a diverse understory of smaller trees, shrubs, and herbaceous layer, and as young restored areas from 2 to10 years old with saplings and shrubby understory. Maintenance of these areas includes protecting young trees in older stands with tree tubes, clearing nonnative invasive plants such as Himalayan blackberry, English ivy, English holly, and English hawthorn using mechanical, cultural, chemical, and/or biological means (as described in Appendix G, IPM).

6.3.2.1 Effects from Public Use Actions

The possibility for one boat access is considered under Alternatives 2 and 3. The location is undetermined, but would be considered if implementation would result in minimal disturbance to vegetation. Implementation would require a shallow slope that could be accessible for wheelchairs, safe parking area, and little to no impact to the floodplain. In these circumstances, a boat access would create the potential for minor amounts of increased erosion and additional visitors within bottomland riparian and riverine habitats.

The 2-acre environmental education off-trail study area proposed in Alternative 2 would likely result in trampling of bottomland riparian forest vegetation and may increase disturbance to forest wildlife species. However, these impacts would not result in displacement of unique habitats, resulting in a minor negative effect to bottomland riparian forest.

6.3.2.2 Overall Effects to Bottomland Riparian Forest

Overall effects to bottomland riparian forest are expected to be slightly positive and long term under Alternative 1, neutral under Alternative 2, and intermediate positive in the long term under Alternative 3.

6.3.3 Effects to Mixed Coniferous/Deciduous Forest

Under Alternative 1, mixed coniferous/deciduous forests would experience slight long-term positive effects as new areas would be restored and other areas maintained to benefit this habitat type.

Under Alternative 2 (preferred), slight long-term positive effects would be expected as mixed coniferous/deciduous forest would be expanded from about 49 to 199 acres. In the Atfálat'i and Rock Creek Units, there would be no change to mixed coniferous/deciduous forest acreage. In the Onion Flats Unit, about 3 acres of mixed forest would be converted to oak savanna. In the Tualatin River Unit, about 33 acres of newly restored oak savanna would be allowed to convert to a mixed coniferous/deciduous forest habitat type, and an additional 10 acres of ruderal habitat would be restored to mixed forest. In the Riverboat Unit, about 36 acres would be restored.

Under Alternative 3, intermediate long-term effects would be expected as mixed coniferous/deciduous forest would be expanded from 49 to 252 acres. In the Rock Creek Units, there would be no change to mixed coniferous/deciduous forest acreage. Similar to Alternative 2, about 33 acres of newly restored oak savanna in the Tualatin River Unit would be converted to mixed coniferous/deciduous forest, and about 36 acres in the Riverboat Unit would be restored. In addition, about 6 acres of oak savanna, and 29 acres of ruderal lands in the Atfálat'i Unit would be converted to mixed forest.

6.3.3.1 Overall Effects to Mixed Coniferous/Deciduous Forest

Overall effects to mixed coniferous/deciduous forest are expected to be slightly positive in the long term under Alternatives 1 and 2, and minor positive effects are expected in the long term under Alternative 3.

6.3.4 Effects to Oak Savanna

Under Alternative 1, oak savanna would be expected to have slight long-term positive effects from new restoration projects and maintaining current oak savanna restoration areas.

Under Alternative 2 (preferred), oak savanna would be expected to have slight long-term positive effects as it is increased from 149 to 226 acres. In the Riverboat and Rock Creek Units, there would be no changes to oak savanna. In the Onion Flats Unit, there would be an increase of 17 acres; in the Tualatin River Unit, about 33 acres would be converted to mixed forest; and on the Atfálat'i Unit, about 62 acres would be restored from ruderal lands and other habitat types.

Under Alternative 3, oak savanna would have minor long-term negative effects as it would be reduced from 149 to 141 acres. In the Riverboat, Rock Creek, and Onion Flats Units, there would be no changes to oak savanna. In the Tualatin River Unit and on the Atfálat'i Unit, about 33 and 6 acres, respectively, would be converted to mixed forest.

6.3.4.1 Effects from Public Use Actions

The proposed nature play area (along the existing year-round trail) in Alternative 2 and the tree screen along highways proposed in Alternatives 2 and 3 would both occur in upland/oak savanna habitats that are currently disturbed/degraded and do not connect to other intact habitats.

6.3.4.2 Overall Effects to Oak Savanna

Overall effects to oak savanna are expected to be slightly positive in the long term under Alternative 1 and Alternative 2, and minor negative effects are expected in the long term under Alternative 3.

6.3.5 Effects to Wet Prairie

Under Alternative 1, there would be slight positive long-term effects from maintaining existing wet prairie habitat.

Under Alternative 2 (preferred), wet prairie would experience intermediate positive effects as prairie would increase substantially, from about 27 to 129 acres. In the Onion Flats, Tualatin River, and Rock Creek Units there would be no change. In the Riverboat Unit, about 30 acres of herbaceous wetland and bottomland riparian forest would be converted to wet prairie, and in the Atfálat'i Unit about 13 acres of wet prairie would be converted to bottomland riparian forest, while 85 acres of herbaceous wetland, riparian forest, and ruderal land would be converted to wet prairie. Wet prairie, similar to scrub-shrub wetlands, relies on precipitation and seasonal high groundwater levels rather than active manipulation of water. To convert herbaceous wetlands to wet prairie, manipulation of water would be discontinued. See Section 6.3.6 for further discussion on wetlands.

Under Alternative 3, wet prairie would experience neutral effects as it would increase from about 27 acres to 45 acres. In the Riverboat Unit, about 30 acres of herbaceous wetland and bottomland riparian forest would be converted to wet prairie. In Atfálat'i Unit, 13 acres of wet prairie would be converted to bottomland riparian forest.

6.3.5.1 Effects from Public Use Actions

The junior waterfowl hunt on the Riverboat Unit, proposed in Alternative 2, would have a neutral to slightly negative effect to wet prairie, due to development of two to five blinds and access trails within prairie areas. Water management would be used to benefit wildlife and habitat and would not be used to enhance hunting without an accompanying wildlife and habitat benefit.

Similar effects to prairies from a waterfowl hunting program proposed in Alternatives 2 and 3 at the Wapato Lake Unit would be expected, but the degree of impacts cannot be determined until restoration decisions are made prior to planning a hunt program.

6.3.5.2 Overall Effects to Wet Prairie

Overall, wet prairie is expected to have slight long-term positive effects under Alternative 1, intermediate long-term positive effects under Alternative 2, and be neutral under Alternative 3.

6.3.6 Effects to Herbaceous and Scrub-shrub Wetlands

Alternative 1 would be expected to have neutral effects to herbaceous and scrub-shrub wetlands as these habitats are maintained in their current condition.

Wetlands on the refuge are roughly classified as either herbaceous or scrub-shrub wetland types. Most of the herbaceous wetlands are intensively managed using water control structures, canals, pumps, and dikes to mimic natural hydrology. Scrub-shrub wetlands are typically not intensively

managed and rely on rain water, overland flows, or flood flows from streams and rivers for hydrologic inputs and natural evapotranspiration for drying cycles. Some refuge wetlands have been difficult to manage and exhibit a natural tendency to convert to other habitat types such as wet prairie or bottomland riparian forest. Therefore, refuge staff in consultation with other professionals have suggested converting some wetlands to these other habitat types.

Under Alternative 2 (preferred), there would be a slight positive effect as wetlands would increase from 314 to 387 acres in the Sherwood Units, and an unknown quantity of wetlands would also be restored in the Wapato Lake Unit. In the Riverboat Unit, about 26 acres of herbaceous wetlands would be converted to wet prairie. In the Atfálat'i Unit, some active manipulation of water levels would cease, allowing about 69 acres of wetlands to convert to wet prairie, oak savanna, and scrub-shrub habitats. In the Onion Flats Unit, about 101 acres of cropland would be restored to scrub-shrub wetland. In the Rock Creek Unit, about 27 acres of ruderal wetland would be restored to scrub-shrub wetland.

Under Alternative 3, there would be a minor negative effect as wetlands would decrease from 314 to 260 acres in the Sherwood Units, and an unknown quantity of wetlands would be restored in the Wapato Lake Unit. In the Riverboat Unit, about 26 acres of herbaceous wetlands would be converted to wet prairie, and in the Tualatin River Unit about 28 acres would be converted to bottomland riparian forest. In the Atfálat'i Unit, about 167 acres of wetland would be converted to bottomland riparian forest, while about 17 acres of ruderal wetland would be restored to scrub-shrub wetland. In the Onion Flats Unit, about 101 acres of cropland would be restored to scrub-shrub wetland.

6.3.6.1 Effects from Public Use Actions

The junior waterfowl hunt on the Riverboat Unit, proposed in Alternative 2, would have a neutral to slightly negative effect to wetlands, due to the development of two to five blinds and access trails within wetland areas. Water management would be used to benefit wildlife and habitat, and would not be used to enhance hunting without an accompanying wildlife and habitat benefit.

Similar effects to wetlands from a waterfowl hunting program proposed in Alternatives 2 and 3 at the Wapato Lake Unit would be expected, but the degree of impacts cannot be determined until restoration decisions are made prior to planning a hunt program.

6.3.6.2 Overall Effects to Wetlands

Overall, wetlands are expected to exhibit neutral effects under Alternative 1, slightly positive long-term effects under Alternative 2, and minor negative long-term effects under Alternative 3.

6.3.7 Effects to Streams, Rivers, and Backwater Sloughs

There are no direct maintenance, restoration, or other impacts planned for the Tualatin River under any of the alternatives. However, maintenance and/or restoration of tributary streams, backwater sloughs, and adjacent habitats would have positive long-term effects, as well as slight short-term negative effects to the river.

Under Alternative 1, the refuge would maintain existing streams and backwater sloughs. Additional lands adjacent to stream channels would be restored or maintained that would benefit these habitat types. Effects would be slightly positive in the long term.

Under Alternative 2 (preferred), there would be intermediate long-term positive effects as the refuge would restore 4.3 miles and maintain 9.5 miles of river frontage, stream channels, and backwater sloughs. In the Atfálat'i Unit, Chicken Creek would be restored to its historical footprint and an additional 0.6 mile of backwater slough would be created. In the Onion Flats and Rock Creek Units, about 1.1 miles of Rock Creek would be restored to a more meandering configuration and an additional 1.0 mile of backwater slough would be created. In the Wapato Lake Unit, about 0.3 mile of Ayers Creek and 0.5 mile of Wapato Creek could be also be restored. Additionally, with restoration of other habitat types such as wet prairie and scrub-shrub wetland, construction of backwater sloughs would be incorporated into restoration plans.

Under Alternative 3, there would be intermediate long-term positive effects as the refuge would restore 4.3 miles and maintain 9.5 miles of river frontage, stream channels, and backwater sloughs. In the Atfálat'i Unit, Chicken Creek would be restored to its historical footprint and an additional 0.6 mile of backwater slough would be created. In the Onion Flats and Rock Creek Units, about 1.1 miles of Rock Creek would be restored to a more meandering configuration and an additional 1.0 mile of backwater slough would be created. In the Wapato Lake Unit, about 0.3 mile of Ayers Creek and 0.5 mile of Wapato Creek could be also be restored. Additionally, with restoration of other habitat types such as wet prairie and scrub-shrub wetland, construction of backwater sloughs would be incorporated into restoration plans. Under this alternative, there would be fewer miles of backwater sloughs in the Atfálat'i Unit as wetlands would be converted to bottomland riparian forest.

Restoration and maintenance of streams and backwater sloughs would require constructing new channels with heavy equipment. Construction would have intermediate negative short-term effects from disturbance of soils, causing dust, erosion, and sedimentation; use of diesel fuel causing reduced air quality; and disturbance to resident fish as channels are rerouted and reconnected. Maintenance of streams, backwater sloughs, and adjacent vegetated areas include removing nonnative invasive plants using mechanical, cultural, chemical, and/or biological means (Appendix G, IPM) and would also have intermediate negative short-term effects.

However, intermediate long-term positive effects from restoration would include increased groundwater recharge, benefits to listed anadromous fish, and benefits to native wildlife.

6.3.7.1 Overall Effects to Streams, Rivers, and Backwater Sloughs

Overall, slight positive long-term effects are expected under Alternative 1, and intermediate positive long-term effects to streams, rivers, and backwater sloughs are expected under both Alternatives 2 and 3.

6.3.8 Effects to Croplands

Under Alternative 1, the effects to croplands would be neutral as croplands would be maintained in their current condition and no changes would be expected.

Under both Alternatives 2 (preferred) and 3, effects would be intermediate, negative, and long term as all refuge croplands would be restored to native habitat types. Currently there are 909 acres of croplands. Croplands are currently only present on the Onion Flats and Wapato Lake Units. Short-term minor negative effects might occur as heavy equipment would be used to restore croplands to native habitat types. Restoration might include earth moving that would result in dust, minor erosion,

and siltation on a localized basis. Restoration might also include application of Service-approved herbicide as described in Appendix G.

6.3.8.1 Overall Effects to Croplands

Overall, croplands are expected to experience neutral long-term effects under Alternative 1, and intermediate long-term negative effects under Alternatives 2 and 3 as these lands are converted to native habitat types.

6.3.9 Effects to Ruderal Lands

Under all alternatives, ruderal lands would be restored to native habitat types and would experience long-term intermediate negative effects. Currently there are 181 and 68 acres of ruderal uplands and wetlands, respectively.

6.3.9.1 Overall Effects to Ruderal Lands

Overall, ruderal lands are expected to experience intermediate long-term negative effects as these lands are converted to native habitat types under all alternatives.

6.3.10 Effects to Waterfowl

Under Alternative 1, waterfowl would be expected to experience neutral effects from maintaining existing habitat types. There would be no increase in wetland areas or other habitat types that would benefit waterfowl.

Under Alternative 2 (preferred), waterfowl would be expected to benefit from increased acreage of wetlands and wet prairie, as well as restoration of croplands to native habitat types. In the Sherwood Units, most of the increase in wetland acres would be composed of scrub-shrub wetland types, while herbaceous wetlands would decrease. While waterfowl use scrub-shrub wetlands, these wetlands would not support the same number or diversity of waterfowl as herbaceous wetlands. Scrub-shrub wetlands are a more closed habitat type that would be used by some waterfowl species such as wood ducks and hooded mergansers for foraging, breeding, and brood rearing. Species such as cackling Canada geese and northern pintails, which constitute the majority of wintering birds on the refuge, prefer the more open habitat of herbaceous wetlands. In the Wapato Lake Unit, it is unknown what wetland types would be restored from croplands, but the effect on local waterfowl populations would likely be neutral or slightly positive. In Alternative 2, wet prairie would be restored primarily from herbaceous wetlands, and this would be expected to have a neutral or slightly negative effect on waterfowl.

Under Alternative 3, the effects to waterfowl would likely be neutral as most existing wetlands and wet prairie would be converted to bottomland riparian forest, but cropland would be converted to wetland. Under this alternative, the emphasis would be on providing the largest contiguous blocks of habitat possible with an emphasis on forested habitat types. In the Sherwood Units most remaining wetlands would be composed of scrub-shrub, and in the Wapato Lake Unit wetlands would be restored from croplands.

The conversion of croplands to wetlands under these two alternatives would likely have a positive effect on waterfowl. Even though waterfowl use croplands extensively for foraging, wetlands would

provide a longer season of use than croplands. Croplands are heavily used during periods of winter flooding, but are typically drained during early spring to facilitate planting, whereas wetlands would typically retain water into late spring or early summer, providing additional foraging, roosting, and breeding opportunities for waterfowl.

6.3.10.1 Effects from Public Use Actions

Under Alternative 2, there would be a youth waterfowl hunt on the Riverboat Unit, and general public waterfowl hunting would be considered under Alternatives 2 and 3 at the Wapato Lake Unit. Blinds would be constructed and placed to minimize disturbance to waterfowl, and vegetative screening on trails approaching blinds may be used to increase cover and reduce silhouetting of hunters. Individual ducks and geese would be taken; however, the impact to the population as a whole would remain neutral. Duck populations have not changed substantially nationwide since comprehensive surveys began in 1955 (USFWS 2011b), and with the exception of dusky Canada geese, all populations of geese that occur on the refuge have been increasing during the past 30 years (USFWS 2011c). Recreational hunting would be implemented in accordance with regulations and laws of the State of Oregon. The junior hunt at the Riverboat Unit would have a minor negative impact to waterfowl. The effects from hunting at the Wapato Lake Unit would likely be similar, but the degree cannot be determined until restoration decisions are made prior to planning a hunt program. Specific effects to waterfowl from hunting are discussed in Section B.2 of Appendix B, Compatibility Determinations.

6.3.10.2 Overall Effects to Waterfowl

Overall, waterfowl are expected to experience neutral effects under Alternative 1, minor long-term positive effects under Alternative 2, and neutral long-term effects under Alternative 3.

6.3.11 Effects to Songbirds

Under Alternative 1, songbirds would be expected to benefit as areas that have been restored begin to mature, and maintenance of intact habitat continues. The presence of croplands would continue to have a slight negative effect on most songbird species. Because cropland areas are often planted or harvested during spring and summer, there would be negative effects because of disturbance and direct impacts to ground-nesting birds attempting to nest in these areas. In addition, application of herbicide may directly or indirectly affect songbirds via direct ingestion, or via foraging on insects or plants that have been sprayed with herbicide. Refer to Appendix G, Integrated Pest Management, for more information.

Under Alternative 2 (preferred), a diversity of habitat types would be maintained, enhanced, and restored that would benefit a multitude of songbird species. Bottomland riparian forest, mixed coniferous/deciduous forest, wet prairie, and scrub-shrub wetland habitat types would all increase, while herbaceous wetland and oak savanna would be reduced in the Sherwood Units. In the Wapato Lake Unit, croplands would be converted mainly to native wetland types, which would benefit some songbird species. Songbirds occupy all the habitat types represented on the refuge. Larger contiguous blocks of forested habitats would benefit forest interior species such as many of the warblers. Habitat edges and transition zones benefit other species such as red-tailed hawks that typically nest and roost in tall forest trees while foraging in open grassy habitat types. Grassland songbirds would benefit from restoration of wet prairie. A variety of resident and migratory songbirds such as swallows, willow flycatchers, and marsh wrens use both herbaceous and scrub-shrub wetland types.

Under Alternative 3, bottomland riparian forest, mixed coniferous/deciduous forest, and scrub-shrub wetland would expand by about 82 percent, 515 percent, and 980 percent, respectively. Many species of songbirds would benefit from these expansions of habitat, especially the expansion of forested habitat types. Herbaceous wetland and oak savanna would be substantially reduced in the Sherwood Units, and wet prairie would remain about the same. The reduction of oak savanna would have indirect negative effects on some songbirds specializing in oak and grassland habitat types. In the Wapato Lake Unit, croplands would be converted mainly to native wetland types, which would benefit some songbird species. Larger contiguous blocks of forested habitat types would benefit a host of interior songbird guilds. One of the goals of the Oregon Conservation Strategy (Oregon Department of Fish and Wildlife [ODFW] 2006) is to maintain and restore important stopover sites for migratory birds, and restoring large blocks of forested habitat helps achieve this goal.

6.3.11.1 Overall Effects to Songbirds

Overall, slight long-term positive effects are expected under Alternative 1, intermediate long-term positive effects to songbirds are expected with an increase in overall diversity of habitat types under Alternative 2, and slight long-term positive effects are expected under Alternative 3.

6.3.12 Effects to Shorebirds

Under Alternative 1, shorebirds would experience neutral effects as current habitat types are maintained.

Under Alternative 2 (preferred), shorebirds would benefit from proposed habitat restoration and maintenance. In the Atfálat'i and Riverboat Units, some herbaceous wetlands would be converted to other habitat types that would not be as attractive to most shorebird species, while restoration of wet prairie in these units would be attractive to such species as Wilson's snipe. However, restoration of wetlands in the Wapato Lake Unit would provide positive benefits for a multitude of shorebird species such as greater yellowlegs, least and western sandpipers, and killdeer. Currently at Wapato Lake, water is drained early in spring to facilitate farming and remains dry into fall, until rain begins to fill the basin. Under its restored condition, water would likely remain throughout much of summer, providing foraging and resting habitat for migrating and locally breeding shorebirds. Restoring cropland in the Onion Flats Unit to native habitat types likewise would have benefits for a number of shorebird species.

Under Alternative 3, with an emphasis on large blocks of forested habitat types, many wetlands in the Atfálat'i, Riverboat, and Tualatin River Units would be converted to habitat types less suitable for shorebirds. Currently, migrating and locally breeding shorebirds use these wetlands for foraging. However, restoration of native wetland habitat types in the Onion Flats and Wapato Lake Units from croplands would provide foraging and nesting opportunities to shorebirds.

6.3.12.1 Overall Effects to Shorebirds

Under Alternative 1 shorebirds would be expected to experience neutral long-term effects from current habitat management. Under Alternative 2 shorebirds are expected to experience slight positive long-term effects from proposed habitat changes. Under Alternative 3 shorebirds are expected to experience neutral long-term effects from proposed habitat changes.

6.3.13 Effects to Marshbirds and Waders

Under Alternative 1, marshbirds and waders would experience neutral effects from maintaining current habitat types.

Under Alternative 2 (preferred), marshbirds and waders would benefit from conversion of cropland in the Onion Flats and Wapato Lake Units to native wetland habitat types. Species such as Virgina rail, American bittern, and great blue heron would thrive in these restored habitat types, which would provide forage and, for some species, nesting cover. In the Atfálat'i Unit habitat changes would likely be neutral overall as some herbaceous wetlands would be converted to other habitat types, while new areas of scrub-shrub and wet prairie would benefit this guild by providing foraging habitat. In the Riverboat Unit changes in habitat types would also likely benefit this guild as herbaceous wetland is converted to scrub-shrub and wet prairie. Any enhancement or restoration projects in the Rock Creek Unit would also benefit this guild by improving habitat conditions there.

Under Alternative 3, several herbaceous wetland areas in the Sherwood Units would be converted to other habitat types. This would likely cause short-term negative effects to marshbirds and waders as some of these herbaceous wetlands are converted to scrub-shrub wetlands and wet prairie, and would cause long-term negative effects as some of these wetlands are converted to forested habitat types that are less suitable for this guild. As in Alternative 2, croplands in the Onion Flats and Wapato Lake Units would be converted to scrub-shrub wetland and other native habitat types that would benefit this guild in the long term.

6.3.13.1 Overall Effects to Marshbirds and Waders

Under Alternative 1 marshbirds and waders would be expected to have neutral long-term effects from current habitat management. Under Alternative 2 marshbirds and waders would be expected to have intermediate positive long-term effects from proposed habitat changes. Under Alternative 3 marshbirds and waders would be expected to experience slight positive long-term effects from habitat changes.

6.3.14 Effects to Raptors

Under Alternative 1, raptors would be expected to experience neutral effects from current habitat management.

Under Alternative 2 (preferred), raptors would benefit from proposed habitat changes such as converting croplands to native habitat types in the Onion Flats and Wapato Lake Units. Species such as bald eagles, peregrine falcons, and northern harriers frequently forage in wetlands such as those that would result from habitat restoration. Increasing bottomland riparian forest habitat in the Tualatin River and Atfálat'i Units would benefit species such as Cooper's hawks, sharp-shinned hawks, and great horned and western screech owls by providing foraging and nesting habitat. Restoring wet prairie would benefit short-eared and barn owls, red-shouldered hawks, and American kestrels by providing foraging habitat.

Under Alternative 3, raptors would benefit from proposed habitat changes such as converting croplands to native habitat types in the Onion Flats and Wapato Lake Units. Under this alternative there would be an emphasis on restoring and expanding forested habitat types that would benefit interior forest species such as Cooper's hawks, sharp-shinned hawks, and great horned and western

screech owls by providing foraging and nesting habitat, but there might be a slight negative effect for edge species such as red-tailed hawks. There would be less wet prairie, oak savanna, and wetlands for open-area foraging species such as American kestrel and northern harrier.

6.3.14.1 Overall Effects to Raptors

Under Alternative 1 raptors would be expected to have neutral long-term effects as a result of current management practices. Under both Alternatives 2 and 3, raptors would be expected to have slight positive long-term effects from proposed changes in habitat.

6.3.15 Effects to Mammals

A wide range of mammal species from shrews to black-tailed deer use refuge lands during all or part of their lives. Most species are adapted to native habitat types, but many thrive in human altered landscapes as well.

Under Alternative 1, mammals would be expected to have slight positive effects as restored areas such as bottomland riparian forest begin to mature and habitat changes occur.

Under both Alternatives 2 (preferred) and 3, most mammal species would be expected to benefit from continued enhancement and restoration of native habitat types. Conversion of croplands to native habitat types would benefit numerous mammal species, especially aquatic-associated species such as beaver, mink, and muskrat, but may negatively affect coyotes by reducing foraging areas. Creating larger blocks of contiguous habitat would also benefit many species such as black-tailed deer, western gray squirrel, and bobcat. In most cases, conversion of one native habitat type to another would require minimal ground-disturbing activities that would have a slight negative effect on small mammals such as rodents. Restoration activities often involve ground-disturbing activities such as mowing and discing, which would have a short-term negative effect on small rodents and possibly other mammals. Long-term effects from most habitat enhancement and restoration would likely be beneficial to mammals.

6.3.15.1 Overall Effects to Mammals

Under Alternative 1, most mammal species would be expected to experience slight long-term positive effects with current management activities. Under both Alternatives 2 and 3, mammals would be expected to have minor positive long-term effects from proposed changes in habitat.

6.3.16 Effects to Native Fish

Under Alternative 1, native fish would likely benefit as native habitat types mature and positively influence river and streamside waterways.

Under both Alternatives 2 (preferred) and 3, most native fish species would benefit from proposed restoration and enhancement measures. Restoration of the historical Chicken and Rock Creek channels would provide benefits such as shaded waterways, off-channel refugia during flood events, coarse woody debris to create channel diversity and refuge from predators, and a diversity of riffle and pool habitats. Riffle and pool habitats are largely missing from Rock Creek at present. Henning et al. (2007) found that enhanced wetlands were beneficial to salmonids and other native fish. Restoration of Wapato Lake would likely result in reconnecting the lake bed with the Tualatin River,

Wapato and Ayers Creeks, and possibly other perennial streams. Reconnecting the lake bed with the river and streams would create off-channel refugia during flood events. Construction of new stream channels and backwater sloughs using heavy equipment might have short-term negative effects such as erosion and siltation, removal of streamside vegetation, and disturbance of stream beds, but resulting habitats would likely provide benefits for salmonids (Jeffres et al. 2008) and have intermediate long-term effects. Any in-stream work would be conducted in accordance with ODFW regulations (ODFW 2008) and best management practices to minimize effects to native fish.

6.3.16.1 Effects from Public Use Actions

Alternative 2 proposes a fishing program in the Tualatin River from the Atfálat'i Unit of the refuge. The most likely catch at this location would be warm-water, nonnative fish such as crappie, bluegill, and largemouth bass. A less-likely catch would be native fish such as cutthroat trout and steelhead, and anglers would be encouraged to release native fish. Recreational fishing would be implemented in accordance with regulations and laws of the State of Oregon. A slight negative effect would result to native fish populations if these species were caught on a regular basis and not released. Specific effects to native fish from fishing are discussed in Section B.5 of Appendix B, Compatibility Determinations.

6.3.16.2 Overall Effects to Native Fish

Under Alternative 1, native fish would be expected to experience slight positive long-term effects as native habitat types mature. Under both Alternatives 2 and 3, native fish species would likely experience intermediate long-term positive effects from proposed activities.

6.3.17 Effects to Reptiles

Under Alternative 1, reptiles would benefit as restoration and maintenance of native habitat types continues.

Under both Alternatives 2 (preferred) and 3, most native reptile species would benefit from proposed restoration and enhancement measures. Native reptiles using refuge lands and waters include various snakes, lizards, and both northwestern pond turtles and painted turtles. Turtles would benefit as croplands are converted to native wetland habitat types and as stream channels and backwater sloughs are restored or created. Restoration activities that include introduction of basking logs or similar structures would enhance habitat for turtles. Restoring wet prairie, oak savanna, and forested habitat types would benefit snakes and lizards, as well as providing nesting sites for turtles. Construction activities, such as disturbance from heavy equipment and removal of nonnative vegetation in preparation for planting native vegetation in restoration sites, might produce short-term negative effects for reptiles. Any in-stream work would be conducted in accordance with ODFW regulations (ODFW 2008) and best management practices to minimize effects to reptiles.

6.3.17.1 Overall Effects to Reptiles

Under Alternative 1, reptiles would be expected to experience slight positive long-term effects as habitats mature. Under Alternatives 2 and 3, reptiles would be expected to experience intermediate long-term positive effects from proposed activities.

6.3.18 Effects to Amphibians

Under Alternative 1, amphibians would benefit as current habitat types mature and prosper with ongoing maintenance activities.

Under Alternative 2 (preferred), most amphibian species would benefit from proposed restoration and enhancement measures. Native salamanders, newts, and frogs use refuge wetlands and adjacent uplands to complete their annual life cycles. Conversion of herbaceous wetlands to wet prairie and scrub-shrub wetlands would likely have a neutral effect on amphibians.

Under Alternative 3, amphibians would likely experience negative effects from loss of breeding habitat as wetlands are converted to forest habitat types on the Atfálat'i and Tualatin River Units.

Under both Alternatives 2 and 3, restoration of streams and backwater sloughs would have positive effects on species such as northern red-legged frogs and long-toed salamanders as these species would use side pools for foraging and breeding. In addition, conversion of croplands to native habitat types such as wetlands would have a positive effect on amphibians by providing additional areas for breeding and over-wintering. Restoration and enhancement activities might have short-term negative effects from heavy equipment and removal of vegetation in preparation for establishing native vegetation. Any in-stream work would be conducted in accordance with ODFW regulations (ODFW 2008) and best management practices to minimize effects to amphibians.

6.3.18.1 Overall Effects to Amphibians

Under Alternative 1, amphibians would be expected to experience slight positive long-term effects from habitat maintenance. Under Alternative 2, amphibians would be expected to experience minor long-term positive effects from proposed activities, and under Alternative 3 amphibians would be expected to experience slight long-term positive effects.

6.3.19 Effects to Federally and State-listed Species

Listed species receive special consideration in terms of refuge management. Federally listed species are trust resources that require additional consultation whenever an activity conducted by or permitted by the refuge may have an effect on these species or their habitats. Impacts to these species from wildlife-dependent recreation and habitat management are assessed in this chapter. Impacts associated with the use of herbicides and pesticides are assessed in the IPM plan in Appendix G.

Federally listed species that are known to occur on or adjacent to the refuge include Nelson's checker-mallow, upper Willamette River Chinook salmon, and upper Willamette River steelhead. In addition to these three species, which are also state-protected under Oregon Administrative Rules (OAR) (OAR 2011), additional Oregon state-listed species known to occur on or adjacent to the refuge include only the bald eagle.

Nelson's checker-mallow exists as experimental populations on the Atfálat'i, Tualatin River, and Riverboat Units of the refuge; there is also one small area on the Atfálat'i Unit that had plants existing before the introduction program began. Nelson's checker-mallow is a hearty perennial plant that prefers wet prairies, wetland margins, sloughs and stream sides, or other moist open habitat (USFWS 2010b). Activities in these habitat types might include mowing, discing, burning, or application of Service-approved herbicide. In areas of known Nelson's checker-mallow populations,

mowing or burning might be conducted, but discing and application of herbicide would be avoided. Mowing and burning would likely have a net positive effect as these management actions help to reduce woody species that would otherwise outcompete or shade out Nelson's checker-mallow. Discing or application of herbicide would likely have a negative effect on Nelson's checker-mallow. Enhancement and restoration of additional native habitat types would provide opportunities for additional planting and expansion of Nelson's checker-mallow into new areas to meet recovery objectives.

Upper Willamette River Chinook and steelhead use the mainstem of the Tualatin River to reach headwater tributary streams, and may use tributary streams along the lower reaches of the river as well. Surveys conducted between 1999 and 2001 (Leader 2001) found that upper Willamette River Chinook represented only 0.08 percent of all fish in 22 reaches of 10 tributary streams of the Tualatin River and were located in only one reach of one stream. Rainbow trout (genetically identical to steelhead) represented 1.01 percent of all fish and were found in seven reaches of five streams. Ward (1995) suggested that enhancing portions of Rock and Chicken Creeks, as proposed in this CCP/EA, would benefit salmonid and other native fish species. Enhancing and restoring streams and backwater sloughs, as well as enhancing and restoring native habitat types adjacent to the Tualatin River, streams, and sloughs would benefit native fish by providing protective cover, food inputs, shade, and reduced erosion. In addition, converting croplands in Wapato Lake to native habitat types and reconnecting the Tualatin River and perennial streams to the lake bed would likely be a benefit to outmigrating juvenile salmonids and other native fish by providing off-channel refugia.

Bald eagles are frequently observed on refuge lands during fall, winter, and spring. During the last decade there have been no bald eagles documented nesting on refuge lands. However, a bald eagle nest was observed during 2008 and 2009 on private land adjacent to the refuge. This nest was blown down during a winter storm and was not rebuilt. During fall and winter, bald eagles primarily forage on waterfowl that are attracted to refuge wetlands. Some waterfowl remain to breed in spring, and bald eagles would continue to prey upon them and their young. In addition, as wetlands are drawn down for management purposes in late spring and early summer, bald eagles would also forage on nonnative fish, particularly carp, that gather in the remaining pools. By mid-summer, food sources are scarce and eagles move off the refuge. Enhancement and restoration of native habitat types that support waterfowl would likely benefit bald eagles. In addition, bald eagles typically nest in tall trees, snags, or power towers. Enhancement of forest habitats would likely benefit bald eagles over the long term. Public use programs on the refuge have been designed to minimize disturbance to waterfowl that in turn benefit bald eagles. Any expansion of public use programs would seek to continue this practice. Restoration projects involving the use of heavy equipment would likely occur during summer and thus minimize disturbance to bald eagles.

6.3.19.1 Overall Effects to Federally and State-listed Species

Under Alternative 1, listed species would be expected to experience minor positive long-term effects from current management, and under Alternative 2, they would experience minor positive long-term effects from the increase in rare habitat types that support those species. Under Alternative 3, listed species would be expected to have slight positive long-term effects as native habitats are restored and enhanced.

6.4 Effects to Cultural and Historical Resources

The Service is committed to the protection of known cultural resources under all alternatives; however, Alternatives 2 and 3 would implement actions to build stronger inventory, evaluation, and protection procedures. In addition, Alternatives 2 and 3 would provide actions to form partnerships and improve interpretation of these resources. In general, this would help to strengthen long-term protection and preservation of all cultural resources.

The National Historic Preservation Act (NHPA) of 1966, as amended, defines historic preservation as the protection, rehabilitation, restoration, and reconstruction of sites, buildings, structures, and objects significant in American history, architecture, engineering, and archaeology.

Title I, Section 106, of the NHPA requires Federal agencies having direct or indirect jurisdiction over a proposed Federal or federally assisted undertaking in any state to take into account the effect of the undertaking on any historic property in the project vicinity. Regulatory procedures for complying with Section 106 are found in 36 Code of Federal Regulations (CFR) 800. All ground-disturbing activities proposed for the refuge and for any parcels that might be acquired in the future, as well as alterations to significant historic structures or infrastructure, would be subject to compliance with Section 106 of the NHPA, which may require a pedestrian survey and other identification efforts as appropriate.

Prior to implementing undertakings, the applicable cultural resource compliance investigation would be undertaken. If significant cultural resources are found, appropriate procedures and protocols would be followed to protect them. Whenever possible, resources would be avoided or mitigated. Mitigation options, in addition to site avoidance by relocating or redesigning facilities, include data recovery, using either collection techniques or in-situ site stabilization procedures, or other measures as appropriate.

Under all alternatives, the Service would seek to develop appropriate strategies to address maintenance needs of existing structures that are eligible or potentially eligible for listing in the National Register of Historic Places (NRHP). The Service would actively recruit funding and seek to develop partnerships to address these needs. However, under Alternatives 2 and 3, unless funding sources are adequate to cover all needs, structures that are either low priority or unsafe without near-term maintenance could potentially be removed. Under Alternative 1, historic structures would continue to deteriorate, though none would be deliberately removed. All structures would need to be evaluated in the context of the NHPA prior to any work or removal. Maintenance and improvement of historic resources would meet the Secretary of the Interior’s standards, resulting in positive impacts to cultural resources, while also causing some temporary noise and disturbance at and near the site. Lead paint may have the potential to be mobilized during any maintenance or removal process; enacting best practices (such as stripping the paint with a product that limits dust and binds with the lead, creating an inert substance for easier disposal, or covering the lead paint with an encapsulating paint product) would minimize this risk. Removal of historic resources would have a negative effect to cultural resources and could cause some temporary disturbance and soil compaction, as heavy equipment would likely be used in the removal process.

Section 110 of the NHPA requires Federal agencies to create a program to identify and protect historic properties. This program includes the nomination of eligible properties to the NRHP; the designation of a qualified agency historic preservation officer; the presence of agency programs and

activities that consider preservation values; and the authority of Federal agencies to include the costs of preservation activities within overall project costs during undertakings. Many opportunities exist to comply with Section 110, including but not limited to the development of interpretive materials and exhibits, refuge-based cultural heritage curricula and resources for use both on and off the refuge, and a systematic program for recording and evaluating the refuge's cultural resources. These opportunities also present excellent prospects for partnerships with Tribal communities and historical societies. The myriad ways in which the refuge's rich cultural history can be shared with refuge audiences should be considered during any planning project or undertaking on the refuge.

A more comprehensive understanding and inventory of cultural resources on-site would occur under Alternatives 2 and 3. The Service would complete a comprehensive review of resources, develop a museum management plan for existing and new properties, and collect oral histories. This gathering of data and knowledge would help the refuge protect and understand the cultural resources of this area, resulting in a slight positive effect for cultural resources as they would be more protected.

Partnerships, interpretation, and education would be expanded under Alternatives 2 and 3, compared to Alternative 1, and this expansion would strengthen current partnerships and provide high-quality interpretation and education opportunities. This effort would assist in laying the groundwork for establishment of more effective partnerships and coordination. Additionally, this would contribute to the public's understanding and appreciation for archaeological and historic resources and would have a slight positive effect to cultural resources.

6.4.1 Overall Effects to Cultural Resources

Under Alternative 1, cultural resources would be expected to experience slight negative long-term effects from lack of adequate protection and interpretation. Under Alternatives 2 and 3, cultural resources would be expected to experience minor long-term positive effects from proposed activities.

6.5 Social Effects

The baseline against which all alternatives are compared is the current public use program as described in Chapter 5. Unless otherwise noted, throughout this section, Alternative 1, the no-action alternative, is assumed to have a neutral effect because minimal or no changes to programs would occur under Alternative 1.

6.5.1 General Effects

6.5.1.1 General Effects from Public Use

Several general social effects from public use apply across the visitor services program and are not tied to specific wildlife-dependent recreation and education opportunities.

With the proposed increase in public use opportunities, expanded outreach and information, new facilities proposed in Alternative 2, new communication tools, and current rising interest in the refuge, visitation is estimated to grow to 250,000 visitors per year. With this increased contact with the public, the most likely results would be better understanding and support of the refuge and the Refuge System; more visitors from diverse backgrounds, in particular urban residents; increased environmental awareness of natural resources; better protection of natural resources; and more

involvement by community members, volunteers, and partners. More formal evaluation of programs would lead to improved and more effective learning outcomes and experiences. Improvement of existing public use facilities would lead to a safer and more comfortable visitor experience. On the other hand, increased visitation may lead to more crowding at times such as weekends and during summer months, when visitation tends to be greatest. This could lead to a slight long-term negative effect to the quality of individual visitor experience.

User fees for photography blinds and hunting and fishing programs, proposed in Alternatives 2 and 3, and entrance fees proposed in all alternatives could provide additional financial support for public use on the refuge. However, if fees were implemented, visitors may be discouraged from visiting the refuge or participating in certain activities. On the other hand, the refuge's need for program support may encourage stakeholders (such as hunting groups or photography clubs) to take an active role in implementing and managing public use programs to offset the need for fees. If implemented, fees would have a minor negative effect to the visiting public.

The cumulative general effects from public use would be a minor positive effect for visitors. See remaining sections of Chapter 6 and Appendix B, Compatibility Determinations, for more detailed analysis of wildlife-dependent recreation and education activities.

6.5.1.2 Effects of Wildlife and Habitat Actions on Public Use from Restoration/Habitat Actions

The refuge is currently composed of a mosaic of fragmented habitats. Alternatives 2 and 3 would strive to combine these fragments into larger contiguous blocks of native habitat types within the landscape and to restore relic or disappearing habitat types. The result for refuge visitors participating in wildlife-dependent recreation and education would generally be positive as these habitat actions would likely result in enhanced opportunities to experience native wildlife and native habitats. As enhancement and restoration projects occur, there would likely be negative short-term minor effects to visitor experience. Examples of these effects in both Alternatives 2 and 3 include disruption from construction activities (heavy equipment, installation of water control structures, earth moving) and habitat actions such as conducting prescribed fire (refer to Chapter 2 for a complete list of habitat management strategies). The effect from day-to-day habitat maintenance as described in Alternative 1 would be neutral, as these activities already occur on the refuge within areas open to the public.

6.5.2 Opportunities for Quality Wildlife Observation and Photography

All existing wildlife observation and photography facilities are to be maintained and/or improved in all alternatives, and several new facilities are being proposed in Alternative 2.

Maintaining seasonal closures, improving habitat conditions near viewing facilities, adding a tree buffer along highways, and altering the trail surface to be quieter would all create a minor positive effect by increasing chances of viewing abundant and diverse wildlife by reducing disturbance and creating a more natural and quieter setting for visitors

The addition of one to three photo blinds in Alternative 2 would provide more people opportunities to participate in wildlife photography; other vantage points with either a landscape view or more intimate habitat setting; a wider variety of habitat types such as oak savanna, scrub-shrub wetland, wet prairie, and forested areas, in addition to the current herbaceous wetland habitat; and increased photo quality by orienting blinds with the sun behind the photographer.

Boat access would be considered in Alternative 2, and connection to regional trail systems would be explored in Alternatives 2 and 3. These new features, if implemented, would increase areas for wildlife observation and photography, provide better connectivity to other natural areas and communities, and encourage alternative transportation to the refuge. Both actions would rely on partners and have the potential to enhance existing and create new partnerships with local organizations.

Collectively, in Alternatives 2 and 3, the result would be a minor positive effect for the public participating in wildlife observation and photography.

6.5.2.1 Effects from Habitat Actions

Restoration and/or enhancement of habitats in all alternatives would continue to provide high-quality viewing and photography opportunities by providing habitats that favor diverse and abundant wildlife, although actual species viewed may shift based on future habitat and restoration actions. Viewing opportunities from the current wetland observation deck (Atfálat'i Unit) would shift from herbaceous wetland to wet prairie in Alternative 2 and to bottomland riparian forest in Alternative 3. Both would still provide a diversity of wildlife, but would be less likely to provide views of abundant waterfowl. Herbaceous wetlands would be maintained below the plaza overlook in all alternatives and would continue to provide abundant waterfowl and waterbird viewing opportunities.

6.5.3 Opportunities for Quality Environmental Education

Alternative 2 proposes to add two new off-trail areas to support the environmental education program—a designated study area within the bottomland riparian forest for students participating in registered field trips and a nature play area in the upland designed for small children to participate in less-structured nature play. Both features would provide a slightly more rustic and/or quieter experience for students and children, provide a better learning environment for certain education lessons, provide an area where students and children can disperse but still be supervised by adults, and provide opportunities for more individual learning in addition to the group learning that occurs in the trail study sites. The nature play area would specifically provide a new activity area dedicated to young children (6 years and under) that would teach children and their parents how to interact with nature. These two new opportunities would result in an intermediate positive effect by offering opportunities that do not currently exist on the refuge.

Alternatives 2 and 3 propose to improve the quality of the existing environmental education program through formal evaluation, educational materials enhancement, and adaptive management. Both Alternatives 2 and 3 propose to add environmental education opportunities for communities surrounding the Wapato Lake Unit. Alternative 2 proposes to increase the capacity of the environmental education program by reaching more students, youth, and educators through on-site field trips, teacher workshops, after-school programs, and off-site education programs. In addition, capacity would be increased by enhancing the quality of the education programs through evaluation and better alignment with state learning standards. This would result in the development of environmental literacy for more students; more involvement with diverse communities; more environmental education teaching skills and resources for educators and schools; and overall better learning outcomes.

Collectively, these actions would create an intermediate positive effect in Alternatives 2 and a minor positive effect in Alternative 3 by enhancing the current program.

6.5.4 Opportunities for Quality Interpretation

All existing interpretive facilities, signs, kiosks, and overlooks would be maintained in all alternatives. In Alternatives 2 and 3, the refuge would improve the quality of interpretive programs through more in-depth staff/volunteer training and program evaluation. These improvements would be guided by the nationally recognized and Service-adopted Interpretive Process Model, which has interpretative guidelines (Larsen 2003). Alternatives 2 and 3 would also build new partnerships with organizations such as the National Association of Interpretation and the Confederated Tribes of Grand Ronde to develop new programs. Collectively, these enhancements would result in a minor positive effect to the quality of the interpretive program.

6.5.5 Opportunities for Quality Hunting

Alternative 2 proposes to establish a youth waterfowl hunting program on the Riverboat Unit. This would provide an opportunity for youth to hunt where very few nearby opportunities currently exist in the community; it would also meet the community's desire to share and teach hunting traditions to youth, provide an opportunity for the refuge to offer hunter education and mentorship programs, and provide an opportunity for stakeholders and partners to get involved in implementing and sustaining the program. Alternatives 2 and 3 propose to establish waterfowl hunting at the Wapato Lake Unit once land acquisition and habitat restoration have progressed enough to sustain a safe and quality hunt program. Adding youth and/or general public waterfowl hunts would result in an intermediate positive effect because the refuge would provide a new wildlife-dependent public use (as defined in the National Wildlife Refuge System Improvement Act [Improvement Act]) that is not currently offered on the refuge.

6.5.6 Opportunities for Quality Fishing

Alternative 2 proposes to establish a fishing program from the existing River Overlook on the Atfálat'i Unit of the refuge. Due to the presence of the existing trail and overlook, this action would provide a location for disabled visitors and families to fish where they may otherwise not have safe and/or wheelchair access to the Tualatin River. In addition, this action would provide an opportunity to teach angler education and for stakeholders and partners to get involved in implementing and sustaining a fishing program. Adding fishing would result in an intermediate positive effect because the refuge would provide a new wildlife-dependent public use (as defined in the Improvement Act) that is not currently offered on the refuge.

6.5.7 Opportunities for Nonwildlife-dependent Recreation

Currently, nonwildlife-dependent recreation activities are not permitted or offered on the refuge and no new nonwildlife-dependent activities are being proposed. Thus, the resulting effect for all alternatives is neutral.

6.5.8 Projected User Numbers in 15 Years

Refuge management can influence the number of visitors. Refuge decisions about features of public use management—such as how many facilities to build, where to build those facilities, how much staff time to devote to programs, and how much parking to provide—influence visitation for years to

come. Similarly, and often playing a greater role, demographic shifts, cultural preferences, and economics influence refuge visitation. Even small annual shifts can have a profound effect over time.

As a piece of the analysis, the CCP planning team projected the number of visits that would be expected at the end of 15 years, by alternative. Table 6-3 displays the number of visits to the refuge expected under a variety of different uses. Assumptions used in generating the projections are provided as footnotes to the table. A key assumption was that overall visitation would increase by 2.5 times over the course of 15 years, to 250,000 visitors annually.

Table 6-3. Annual Refuge Visits, Projected in 15 Years, by Activity

Estimated Number of Annual Recreation Visits			
Recreation Activity	**Alternative 1 (baseline: 2011 recorded annual visitation)**	**Alternative 2**	**Alternative 3**
Wildlife observation	69,900	250,000	250,000
Wildlife photography	1,764	10,000	9,000
Environmental education	4,228	12,000	6,000
Interpretation	4,288	9,000	5,000
Waterfowl hunting	0	1,200	1,140
Fishing	0	1,000	0
Auto tour visits	0	100,000	100,000

Notes

Activity Descriptions:
Wildlife observation includes pedestrian visits to trails and overlooks.
Wildlife photography includes photo blind reservations, photographers using trails and overlooks, and photography club events
Environmental education includes formal student programs (field trips), teacher workshops, youth group programs (scouts, after-school clubs), off-site education fairs, off-site student programs led by the Service
Interpretation includes guided walks and talks, naturalist-led programs, workshops, and special events (e.g., bird festival, refuge week, spring break exploration days, and others).
Waterfowl hunting includes youth hunt on the Riverboat Unit and public hunt on the Wapato Lake Unit.
Fishing includes fishing in the Tualatin River from the existing river overlook on the Atfálat'i Unit.
Auto tour visits reflect potential future use at the Wapato Lake Unit that would occur on existing state and county roads, if overlooks, kiosks, and pullouts were to be developed over the life of the CCP.

Assumptions for Projections in Alternatives 2 and 3:
Wildlife observation: Alternatives 2 and 3 assume 2.5-fold increase in visitors at the Sherwood Units (175,000), plus an additional 75,000 people at the Wapato Lake Unit. Potential future visits to the Wapato Lake Unit were calculated based on the current visits of nearby Jackson Bottom Wetlands Preserve (30,000) multiplied by 2.5.

Wildlife photography: Alternative 2 assumes a 2.5-fold increase in visitors at the Sherwood Units (4,500), plus an additional 4,500 visits at the Wapato Lake Unit. It is expected that although the Wapato Lake Unit

is more rural, it would command a large draw of photographers due to its large expanse and potential for photographing abundant waterfowl such as tundra swan. Alternative 3 would not include new photography blinds at the Sherwood Units and is therefore projected to experience a 10% decrease as compared to Alternative 2.

Environmental education: Alternative 2 assumes a 2.5-fold increase in visitors at the Sherwood Units (10,000), plus an additional 2,000 students at the Wapato Lake Unit. Student use at the Wapato Lake Unit was calculated as 25% of the total 2010-2011 student body of the Gaston, Forest Grove, and Yamhill-Carlton School Districts. Alternative 3 would not include expansion of the environmental education program and would rely on current management capacity and staffing; therefore, it is expected to only have a modest increase to 6,000 students a year.

Interpretation: Alternative 2 assumes a twofold increase in visitors for the Sherwood Units (9,000 people), plus an additional 1,000 participants at the Wapato Lake Unit. This projection includes special events, where participation tends to be steadier than other activities; therefore, interpretation was calculated at a lower growth rate as compared to wildlife observation, photography, and education. Participation at the Wapato Lake Unit is based on an estimated 600 people a year attending special events and 25 to 30 attendees at monthly, guided interpretive programs. Alternative 3 would not include expansion of the interpretive program and would rely on current management capacity and staffing; therefore, we would only expect a modest increase to 5,000 participants a year.

Fishing: Alternative 2 assumes that fishing would attract 30% of the participation that currently occurs at nearby refuges (William L. Finley National Wildlife Refuge in Oregon and Nisqually National Wildlife Refuge in Washington). Access to fishing at Tualatin River National Wildlife Refuge would be considerably more limited than at these nearby refuges. Alternative 3 does not include a fishing program.

Waterfowl hunting: Alternative 2 assumes that a youth hunt on the Riverboat Unit would include two people per four blinds, two days a month, for three months a year. At the Wapato Lake Unit, it is assumed that the refuge would draw approximately 60% of the participation that currently occurs (1,900) at nearby Ridgefield National Wildlife Refuge in Washington. It is assumed that the Wapato Lake Unit could support slightly more than half the number of blinds that Ridgefield Refuge has. Alternative 3 would not include a youth waterfowl hunt.

Auto tour visits: Alternatives 2 and 3 assume that a future auto tour route would attract a similar number of visitors to what Baskett Slough National Wildlife Refuge in Oregon currently experiences. As compared to Baskett Slough Refuge, the Wapato Lake Unit sits in a similar setting and with similar proximity to urban areas and travel corridors.

6.5.9 Amount of Illegal Use

Trespass into closed areas, nonwildlife-dependent activities (e.g., jogging, dog walking, bicycling), and theft are the primary illegal activities that occur on the refuge. Under all alternatives, the refuge intends to curb illegal activities, protect natural resources, and provide a safe environment for visitors. In all alternatives, visitation to the refuge is projected to increase substantially. With more visitors comes increased likelihood of illegal activities, creating a minor to intermediate negative effect. In Alternatives 2 and 3, a new law enforcement officer position is proposed to provide full-time resource and visitor protection, and if this strategy is implemented, a minor positive effect would be expected.

6.5.10 Environmental Justice

Since CCP implementation is expected to result in generally positive effects on the human environment, all alternatives and their proposed actions have little risk of having disproportionate adverse effects on human health, economics, or the social environment. All public use alternatives propose to reach out to increasingly diverse audiences and therefore would likely increase the amount of benefit provided to the whole community and have a minor long-term positive effect.

6.5.11 Overall Social Effects

As indicated in the beginning of Section 6.5, Alternative 1, the no-action alternative, is assumed to have a neutral effect because minimal or no changes to programs would occur. Alternative 2 would result in an overall intermediate positive effect due to addition of new wildlife-dependent public uses, addition of new facilities, enhancement of current programs, and expansion of the number of people reached through programs resulting from increased environmental awareness of natural resources, better protection of natural resources, and more effective learning outcomes and experiences. Alternative 3 would result in similar effects for the reasons described for Alternative 2, except that Alternative 3 does not add new wildlife-dependent public uses or new facilities, resulting in an overall minor positive effect for Alternative 3.

6.6 Economic Effects

6.6.1 Approach to Estimating Economic Effects

From an economic perspective, Tualatin River National Wildlife Refuge provides a variety of environmental and natural resource goods and services used by people either directly or indirectly. The use of these goods and services may result in economic impacts to both local and state economies. The various services the refuge provides can be grouped into five broad categories: (1) maintenance and conservation of environmental resources, services, and ecological processes; (2) production and protection of natural resources such as fish and wildlife; (3) production and protection of cultural and historic sites and objects; (4) provision of educational and research opportunities; and (5) outdoor and wildlife-related recreation. People who use these services benefit in the sense that their individual welfare or satisfaction level increases with the use of a particular good or service.

One measure of the magnitude of the change in welfare or satisfaction associated with using a particular good or service is economic value. *Economic value* is the economic trade-off people would

be willing to make to obtain some good or service. It is the maximum amount people would be willing to pay to obtain a particular good or service minus the actual cost of acquisition. In economic theory this is known as *net economic value* or *consumer surplus*. In the context of this report, estimates of the economic value of particular recreational activities are used to determine the aggregate value of recreational use of Tualatin River National Wildlife Refuge.

Aside from the effect on the individual, use of the good or service usually entails spending money in some fashion. These expenditures, in turn, create a variety of economic effects collectively known as economic impacts. *Economic impacts* refer to employment, employment or labor earnings, economic output and Federal, local, county, and state tax revenue that occur as the result of refuge activities. To estimate the total economic activity, employment, employment income, and Federal and state taxes generated by refuge activities, this report uses IMPLAN[1] (Impact Analysis for Planning), a regional input-output model and software system. The following is a list of terms and definitions that are commonly used in economic impact analysis (Miller and Blair 1985; Minnesota IMPLAN Group, Inc. 2004).

Economic output includes three types of effects: direct, indirect, and induced effects. Direct effects are the expenditures associated with a particular activity (such as refuge recreation visits and management activities). "Indirect effects result from changes in sales for suppliers to the directly-affected businesses (including trade and services at the retail, wholesale and producer levels). Induced effects are associated with further shifts in spending on food, clothing, shelter and other consumer goods and services, as a consequence of the change in workers and payroll of directly and indirectly affected businesses" (Weisbrod and Weisbrod 1997:11). The indirect and induced effects represent any multiplier effect. Both job income and tax revenue are derived from total economic output (aggregate sales). For example, labor costs are paid out of total sales revenue for a company as are taxes. To add taxes and job income to output would double-count economic impacts.

Jobs and *job income* include direct, indirect, and induced effects in a manner similar to economic output. Employment includes both full- and part-time jobs, with a job defined as one person working for at least part of the calendar year, whether one day or the entire year.

Tax revenues[2] are shown for business taxes, income taxes, and a variety of taxes at the local, state, and national level. Like output, employment, and income, tax impacts include direct, indirect, and induced tax effects.

A comprehensive economic profile (baseline) of the refuge and estimates of the economic effects of alternative management strategies would address all applicable economic effects associated with the use of refuge-produced goods and services. However, for those goods and services having nebulous or nonexistent links to the marketplace, economic effects are more difficult or perhaps even impossible to estimate. Some of the major contributions of the refuge to the natural environment, such as watershed protection, maintenance and stabilization of ecological processes, and the enhancement of biodiversity would require extensive on-site knowledge of biological, ecological,

[1]"IMPLAN … was originally developed by the USDA [U.S. Department of Agriculture] Forest Service in cooperation with the Federal Emergency Management Agency and the USDOI [U.S. Department of the Interior] Bureau of Land Management to assist the Forest Service in land and resource management planning" (Minnesota IMPLAN Group, Inc. 2004). First developed in 1979, IMPLAN data and software was privatized in 1993 by the Minnesota IMPLAN Group, Inc. For additional information, see www.implan.com. For additional information on input-output modeling, see *Input-Output Analysis* (Miller and Blair 1985).
[2] The overall tax rate is about 13.7 percent of economic output and includes direct, indirect, and induced tax effects nationwide. The tax rate is calculated within the economic modeling software used to estimate economic impacts.

and physical processes and interrelationships even to begin to formulate economic benefit estimates. This is beyond the scope of this report.

This report focuses on a limited subset of refuge goods and services, primarily those directly linked in some fashion to the marketplace, such as recreation use and refuge budget expenditures. It should be kept in mind that the emphasis on these particular market-oriented goods and services should not be interpreted to imply that these types of goods and services are somehow more important or of greater value (economic or otherwise) than the nonmarket goods and services previously discussed.

For this report, two types of economic impacts are addressed: (1) impacts associated with annual consumer expenditures on refuge-related recreation and (2) impacts associated with refuge budget expenditures. The economic impacts are presented as annual impacts over a 15-year time period. For Alternative 1, the analysis is based on 2011 refuge recreation visits and budget expenditures. For Alternatives 2 and 3, the analysis presents the impacts that would result assuming that all management objectives are implemented and achieved. Note that funds are not currently present to implement all objectives and strategies identified; however, the analysis for Alternatives 2 and 3 assumes that funding would manifest.

6.6.2 Economic Impacts from Recreational Activities

Tualatin River National Wildlife Refuge receives visitors from across North America and the world. The majority of refuge visitors live in the local area. Spending by recreational visitors when visiting the refuge impacts the local economy by creating jobs and generating tax revenue.

Economic impacts for the recreation baseline (Alternative 1) and action alternatives (Alternatives 2 and 3) are addressed in this section. Two types of information are needed to estimate the economic impacts of recreational visits to the refuge: (1) the amount of recreational use on the refuge by activity and (2) expenditures associated with recreational visits to the refuge. Recreational use is estimated by refuge staff (Table 6-4). Expenditure patterns used in this report were obtained from the *2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation* (U.S. Department of the Interior [USDOI] et al. 2007). These expenditures include only travel-related expenses, including food, lodging, transportation, and other miscellaneous travel-related expenses. With this information, total expenditures for each activity can be estimated. These expenditures, in turn, can be used in conjunction with regional economic models to estimate industrial output, employment, employment income and tax impacts associated with these expenditures. The economic impact area for recreational activities is defined as the greater Portland metropolitan area including Clackamas, Marion, Multnomah, Washington, and Yamhill Counties. It is assumed that visitor expenditures occur primarily within this five-county area.

The economic impacts from recreation expenditures estimated in this report are gross area-wide impacts. Information on where expenditures may occur locally and the magnitude and location of resident and nonresident expenditures (resident and nonresident relative to the geographical area of interest) is not currently available. Generally speaking, nonresident expenditures bring outside money into the area and thus generate increases in real income or wealth. Spending by residents is simply a transfer of expenditures on one set of goods and services to a different set within the same area. To calculate net economic impacts within a given area derived from resident expenditures, much more detailed information would be necessary on expenditure patterns and visitor characteristics. Since this information is not currently available, the gross area-wide estimates are the maximum impact for the net economic impacts of total resident and nonresident spending in the five-county area. The

economic impacts of nonresident spending represent a real increase in wealth and income for the area (for additional information, see Loomis 1993:191).

6.6.3 Alternative 1 (Baseline): Recreational Activities

Under Alternative 1, there would be no changes to the recreational activities offered at the refuge. All programs would continue to follow current management goals. The refuge would continue to offer a variety of nonconsumptive public uses, including wildlife observation, photography, interpretation, and environmental education. Visitation is increasing as people continue to discover the refuge, which opened to the public in 2006. Refer to Section 6.5.8 for a summary of projected user numbers in 15 years.

Table 6-4 shows the 2010 visitation for the refuge. The refuge had 80,180 visits in 2010. Pedestrian visits represented 87 percent of all visits. Interpretation visits include naturalist-led programs and special events. In addition to recreation visits, the refuge also had about 4,200 environmental education visits. The environmental education program includes student field trips, teacher workshops, youth group programs, and various off-site educational programs.

Table 6-4. Alternative 1: Fiscal Year 2010 Visitation at the Refuge

Activity	Residents*	Nonresidents*	Total
Nonconsumptive			
Pedestrian	55,920	13,980	69,900
Auto tour	0	0	0
Boat trail/launch	0	0	0
Bicycling	0	0	0
Photography	1,676	88	1,764
Interpretation	4,074	214	4,288
Environmental education	4,228	0	4,228
Hunting			
Waterfowl	0	0	0
Other migratory birds	0	0	0
Upland game	0	0	0
Big game	0	0	0
Fishing			
Fresh water	0	0	0
Salt water	0	0	0
Total visitation	**65,897**	**14,283**	**80,180**

*Resident versus nonresident estimates are based on informal data gathered from visitor logbook, special event records, and direct visitor contacts.

6.6.3.1 Regional Economic Analysis

Visitor recreation expenditures for Alternative 1 are shown in Table 6-5. Environmental education opportunities for residents do not contribute to the local economic impacts because the events typically do not bring visitors who spend money on travel-related goods and services. Total annual expenditures were about $927,400, with nonresidents accounting for about $422,100 or 46 percent of total expenditures. Under Alternative 1, these annual expenditures are expected to continue.

Table 6-5. Alternative 1: Visitor Recreation Expenditure (2010 dollars in thousands)

Activity	Residents	Nonresidents	Total
Nonconsumptive			
Pedestrian	$452.0	$411.9	$863.9
Photography	$20.3	$3.9	$24.2
Interpretation	$32.9	$6.3	$39.2
Total nonconsumptive	$505.2	$422.1	$927.4
Hunting			
Total hunting	–	–	–
Fishing			
Total fishing	–	–	–
Total Expenditures	**$505.2**	**$422.1**	**$927.4**

Input-output models were used to determine the economic impact of expenditures on the refuge's local economy. The estimated economic impacts are expected to occur in the greater Portland metropolitan area. It is assumed that visitor expenditures occur primarily within this area. Table 6-6 summarizes the local economic effects associated with recreation visits. Final demand totaled $1.8 million, with associated employment of 14 jobs, $543,000 in employment income, and $258,700 in total tax revenue.

Table 6-6. Alternative 1: Local Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Residents	Nonresidents	Total
Final demand	$1,011.5	$798.0	$1,809.5
Jobs	8	6	14
Job income	$305.9	$237.1	$543.0
Total tax revenue	$144.8	$113.9	$258.7

6.6.4 Alternative 2: Recreational Activities

6.6.4.1 Description of Recreational Activities

Under Alternative 2, additional activities would be assessed as future land acquisition and habitat restoration progresses on the Wapato Lake Unit. New opportunities that would be considered include expanded environmental education and interpretation programs, and new waterfowl hunting and fishing opportunities. Management under this alternative would be focused on expanding developed facilities and programs for casual visitors, and beginning, moderate, and advanced birders.

Table 6-7 shows the visitation that would occur if Alternative 2 is fully implemented. Approximately 383,200 visits would be related to a variety of recreational opportunities, interpretation programs, and environmental education. Pedestrian visits would continue to represent the majority of all visits. In addition to recreation visits (nonconsumptive activities, hunting, and fishing), the refuge also would support 9,800 environmental education visits.

Under Alternative 2, recreation visits are projected to more than quadruple at the end of 15 years, compared to Alternative 1. Refuge staff estimate that the majority of recreational visitors would live within the greater Portland metropolitan area. Similar to Alternative 1, nearly all recreational visitors would participate in nonconsumptive activities. Less than 1 percent of visitors would participate in hunting and fishing combined.

Table 6-7. Alternative 2: Annual Refuge Visitation

Activity	Residents	Nonresidents	Total
Nonconsumptive			
Pedestrian	200,000	50,000	250,000
Auto tour	80,000	20,000	100,000
Boat trail/launch	0	0	0
Bicycling	0	0	0
Photography	9,000	1,000	10,000
Interpretation	8,100	900	9,000
Environmental education	12,000	0	12,000
Hunting			
Waterfowl	1,080	120	1,200
Other migratory birds	0	0	0
Upland game	0	0	0
Big game	0	0	0
Fishing			
Fresh water	1,000	0	1,000

Table 6-7. Alternative 2: Annual Refuge Visitation

Activity	Residents	Nonresidents	Total
Salt water	0	0	0
Total Visitation	**311,180**	**72,020**	**383,200**

6.6.4.2 Regional Economic Analysis

Visitor recreation expenditures associated with a fully implemented Alternative 2 are shown in Table 6-8. Total annual expenditures would be about $6.2 million, with nonresidents accounting for about $2.9 million or 46 percent of total expenditures. Expenditures associated with nonconsumptive activities would account for 99 percent of all expenditures, followed by hunting and fishing at less than 1 percent.

Table 6-8. Alternative 2: Visitor Recreation Expenditures (2010 dollars in thousands)

Activity	Residents	Nonresidents	Total
Nonconsumptive			
Pedestrian	$2,424.8	$2,209.9	$4,634.7
Auto tour	$646.6	$589.3	$1,235.9
Boat trail/launch	–	–	–
Bicycling	–	–	–
Photography	$109.1	$44.2	$153.3
Interpretation	$98.2	$39.8	$138.0
Total nonconsumptive	$3,278.8	$2,883.2	$6,161.9
Hunting			
Waterfowl	$43.6	$16.8	$60.5
Other migratory birds	–	–	–
Upland game	–	–	–
Big game	–	–	–
Total hunting	$43.6	$16.8	$60.5
Fishing			
Fresh water	$14.8	–	$14.8
Salt water	–	–	–
Total fishing	$14.8	–	$14.8
Total Annual Expenditures	**$3,337.2**	**$2,900.0**	**$6,237.2**

Input-output models were used to determine the economic impact of expenditures on the refuge's local economy under Alternative 2. The estimated economic impacts are expected to occur in the greater Portland metropolitan area. It is assumed that visitor expenditures occur primarily within the five-county area. Table 6-9 summarizes the local economic effects associated with recreation visits. Under Alternative 2, final demand would total $12.2 million, with associated employment of 96 jobs, $3.6 million in employment income, and $1.7 million in total tax revenue.

Table 6-9. Alternative 2: Local Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Residents	Nonresidents	Total
Final demand	$6,681.2	$5,482.3	$12,163.5
Jobs	54	42	96
Job income	$2,020.5	$1,628.6	$3,649.1
Total tax revenue	$956.5	$782.7	$1,739.2

6.6.5 Alternative 3: Recreational Activities

6.6.5.1 Description of Recreational Activities

Under Alternative 3, additional activities would be assessed as future land acquisition and habitat restoration progresses on the Wapato Lake Unit. Visitation related to nonconsumptive activities and hunting would increase compared to Alternative 1. Management for recreational activities, environmental education, and interpretation would be similar to Alternative 2, but photography, interpretation, and environmental education programs would be developed to a lesser extent. Also, fishing would not be permitted under Alternative 3.

Table 6-10 shows the visitation that would occur if Alternative 3 is fully implemented. Approximately 371,140 visits would be related to a variety of recreational opportunities, interpretation programs, and environmental education. Pedestrian visits would continue to represent the majority of all visits. In addition to recreation visits (nonconsumptive activities and waterfowl hunting), the refuge would also support 6,000 environmental education visits.

Under Alternative 3, recreation visits are projected to more than quadruple at the end of 15 years, compared to Alternative 1. Refuge staff estimate that the majority of recreational visitors would live within the greater Portland metropolitan area. Similar to Alternative 1, nearly all recreational visitors would participate in nonconsumptive activities. Less than 1 percent of visitors would participate in waterfowl hunting.

Table 6-10. Alternative 3: Refuge Visitation

Activity	Residents	Nonresidents	Total
Nonconsumptive			
Pedestrian	200,000	50,000	250,000
Auto tour	80,000	20,000	100,000
Boat trail/launch	0	0	0
Bicycling	0	0	0
Photography	8,100	900	9,000
Interpretation	4,500	500	5,000
Environmental education	6,000	0	6,000
Hunting			
Waterfowl	1,026	114	1,140
Other migratory birds	0	0	0
Upland game	0	0	0
Big game	0	0	0
Fishing			
Fresh water	0	0	0
Salt water	0	0	0
Total Visitation	**299,626**	**71,514**	**371,140**

6.6.5.2 Regional Economic Analysis

Visitor recreation expenditures estimated for Alternative 3 are shown in Table 6-11. Total annual expenditures would be about $6.1 million, with nonresidents accounting for $2.9 million or 47 percent of total expenditures.

Table 6-11. Alternative 3: Visitor Recreation Expenditures (2010 dollars in thousands)

Activity	Residents	Nonresidents	Total
Nonconsumptive			
Pedestrian	$2,424.8	$2,209.9	$4,634.7
Auto tour	$646.6	$589.3	$1,235.9
Boat trail/launch	–	–	–
Bicycling	–	–	–
Photography	$98.2	$39.8	$138.0

Table 6-11. Alternative 3: Visitor Recreation Expenditures (2010 dollars in thousands)

Activity	Residents	Nonresidents	Total
Interpretation	$54.6	$22.1	$76.7
Total nonconsumptive	$3,224.2	$2,861.1	$6,085.3
Hunting			
Waterfowl	$41.5	$16.0	$57.4
Other migratory birds	–	–	–
Upland game	–	–	–
Big game	–	–	–
Total hunting	$41.5	$16.0	$57.4
Fishing			
Fresh water	–	–	–
Salt water	–	–	–
Total fishing	–	–	–
Total Annual Expenditures	**$3,265.6**	**$2,877.1**	**$6,142.7**

Input-output models were used to determine the economic impact of expenditures on the refuge's local economy. The estimated economic impacts, including visitor expenditures, are expected to occur in the local five-county area. Table 6-12 summarizes the local economic effects associated with recreation visits. Under Alternative 3, final demand would total nearly $12.0 million, with associated employment of 95 jobs, $3.6 million in employment income, and $1.7 million in total tax revenue.

Table 6-12. Alternative 3: Local Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Residents	Nonresidents	Total
Final demand	$6,537.9	$5,438.9	$11,976.8
Jobs	53	41	95
Job income	$1,977.2	$1,615.7	$3,592.9
Total tax revenue	$936.0	$776.5	$1,712.5

6.6.6 Summary of Recreational Visitation Impacts

Tables 6-13 and 6-14 provide a summary of the potential economic impacts related to recreational visitation for each alternative. Under Alternatives 2 and 3, recreation visitation would quadruple after the management alternative is fully implemented. As a result, economic output, jobs, job income, and tax revenue would increase.

Table 6-13. Annual Economic Effects Associated with Recreation Visits (2010 dollars in thousands)

	Alternative 1	Alternative 2	Alternative 3
Recreation visits	80,180	383,200	371,140
Expenditures	$927.4	$6,237.2	$6,142.7
Economic output	$1,809.5	$12,163.5	$11,976.8
Jobs	14	96	95
Job income	$543.0	$3,649.1	$3,592.9
Total tax revenue	$258.7	$1,739.2	$1,712.5

Table 6-14. Change in Average Annual Recreation Visitors and Expenditures Compared to the Baseline (Alternative 1) (2010 dollars in thousands)

	Alternative 2	Alternative 3
Visitors	+303,020	+290,960
Economic output	+$10,354.0	+$10,167.3
Jobs	+82	+80
Job income	+$3,106.2	+$3,049.9
Total tax revenue	+$1,480.5	+$1,453.8

6.6.7 Economic Effects from Refuge Budget

Annual costs reflect refuge spending of base funds allocated each year. These are also known as recurring costs and are usually associated with day-to-day operations. Nonsalary expenditures are primarily fixed costs such as utilities, fuel, office supplies, water district assessments, and other expenses. Large restoration and facility costs are currently undetermined for each alternative and are not included in the average annual expenditures presented below.

Table 6-15 shows that average annual expenditure would be about $732,000 for Alternative 1, and about $1.5 million for Alternatives 2 and 3. The estimated expenditures for Alternatives 2 and 3 assume that the alternatives are fully funded as described in the CCP. Thus, the expenditures for Alternatives 2 and 3 include an additional six full-time staff members compared to Alternative 1.

Table 6-15. Refuge Average Annual Expenditures (2010 dollars in thousands)

Expenditure	Alternative 1	Alternative 2	Alternative 3
Salary	$498.0	$996.1	$996.1
Nonsalary	$233.8	$467.5	$467.5
Total	$731.8	$1,463.6	$1,463.6

Table 6-16 shows the economic impact of average annual (salary and nonsalary) expenditures. Impacts associated with annual expenditures would continue to occur throughout the 15-year timeline of the CCP if the alternative chosen is fully funded. Under Alternative 1, the refuge's annual expenditures would generate approximately $1.3 million in economic output, 10 jobs, $500,000 in job income, and $193,000 in tax revenue. Economic impacts for Alternatives 2 and 3 would be the same. Annual expenditure under Alternatives 2 and 3 would generate an economic output of $2.7 million, 19 jobs, $1.0 million in job income, and $385,300 in tax revenue.

Table 6-16. Local Annual Economic Effects Associated with Average Annual Refuge Budget (2010 dollars in thousands)

	Alternative 1	Alternative 2	Alternative 3
Economic output	$1,340.4	$2,680.8	$2,680.8
Jobs	10	19	19
Job income	$499.6	$999.3	$999.3
Total tax revenue	$192.5	$385.0	$385.0

Table 6-17 shows the change in economic impacts associated with the refuge budget compared to the baseline (Alternative 1). Once fully funded, annual expenditures for Alternatives 2 and 3 would each increase by about $732,000, compared to Alternative 1 (Table 6.15). Under Alternatives 2 and 3, economic impacts associated with annual expenditures would increase by $1.3 million in economic output, 9 jobs, and $500,000 in job income.

Table 6-17. Change in Annual Expenditures Compared to the Baseline (Alternative 1) (2010 dollars in thousands)

	Alternatives 2 and 3
Annual expenditures	+$731.8
Economic output	+$1,340.4
Jobs	+9
Job income	+$499.6
Total tax revenue	+$192.5

6.6.8 Summary of Economic Impacts by Alternative

This section summarizes the economic impacts generated by refuge management activities for each alternative. Table 6-18 summarizes the economic impacts in the greater Portland metropolitan area for Alternative 1. Under Alternative 1, refuge activities would generate an estimated $3.1 million in economic output, 24 jobs, $1.0 million in job income, and $451,300 in tax revenue in the local economy. These economic impacts under Alternative 1 represent less than 1 percent of total income and total employment in the local area economy.

Table 6-18. Summary of Annual Economic Impacts for Alternative 1 (2010 dollars in thousands)

	Economic Output	Jobs	Job Income	Tax Revenue
Recreation	$1,809.5	14	$543.0	$258.7
Budget	$1,340.4	10	$499.6	$192.5
Total	$3,149.9	24	$1,042.6	$451.3

Table 6-19 summarizes the economic impacts for Alternative 2. Under Alternative 2, refuge activities would generate an estimated $14.8 million in economic output, 115 jobs, $4.6 million in job income, and $2.1 million in tax revenue in the local economy. These economic impacts under Alternative 2 represent less than 1 percent of total income and total employment in the local area economy.

Table 6-19. Summary of Annual Economic Impacts for Alternative 2 (2010 dollars in thousands)

	Economic Output	Jobs	Job Income	Tax Revenue
Recreation	$12,163.5	96	$3,649.1	$1,739.2
Budget	$2,680.8	19	$999.3	$385.0
Total	$14,844.2	115	$4,648.4	$2,124.3

Table 6-20 summarizes the economic impacts for Alternative 3. Under Alternative 3, refuge activities would generate an estimated $14.7 million in economic output, 114 jobs, $4.6 million in job income, and $2.1 million in tax revenue in the local economy. These economic impacts under Alternative 3 represent less than 1 percent of total income and total employment in the local area economy.

Table 6-20. Summary of Annual Economic Impacts for Alternative 3 (2010 dollars in thousands)

	Economic Output	Jobs	Job Income	Tax Revenue
Recreation	$11,976.8	95	$3,592.9	$1,712.5
Budget	$2,680.8	19	$999.3	$385.0
Total	$14,657.6	114	$4,592.2	$2,097.6

6.7 Other Effects

6.7.1 Potential Impacts on Adjacent Lands and Associated Natural Resources

Under Alternative 1, as maintenance and management continue across all refuge lands, there is potential for both positive and negative effects to surrounding natural resources. Various land uses surround the Sherwood Units, including residential, retail/commercial, industrial, agricultural, recreational, and native habitat types. The land around the Wapato Lake Unit is mainly agricultural with some residential and commercial uses. As management and maintenance continue, waterfowl hunting clubs may benefit from waterfowl using habitats in the refuge that also venture to the nearby hunting clubs. As native habitat types on the refuge mature, adjacent native habitats may benefit from exchange of genetic material among plants, and animals may benefit from larger blocks of habitat. As refuge habitats are maintained, nonnative plants may be reduced and produce less seed that has the potential to spread to neighboring lands. On the other hand, many neighboring landowners may consider native or other plants beneficial to the refuge as nuisance species especially to agricultural operations. For example, many native grass species are unwelcome for agricultural growers, who may have to control these species. For natural areas owned by Metro and others, the refuge and its habitats provide a stepping stone in a chain of native habitats within the Tualatin River Basin. Overall, slight positive long-term benefits should result from continuing Alternative 1.

Under Alternative 2 (preferred), proposed restoration and maintenance activities would create larger contiguous blocks of habitat both within the refuge and connecting with habitats outside the boundary, which should benefit a number of wildlife communities. Mammals such as black-tailed deer and mink would have larger blocks of habitat in which to live and move about the Tualatin River Basin. Many songbird species would benefit from larger blocks of habitat as well. Lands adjacent to the refuge may see an increase in local populations of wildlife as a result of improved habitat conditions. For some landowners, this increase in population may be welcome, but for others such as agricultural operators an increase in some wildlife populations may have a negative effect. One of the largest impacts would be terminating farming of croplands and restoring those parcels to native habitat types. These conversions would be expected to have positive effects to wildlife and neighboring native habitats. On the Sherwood Units, conversion of herbaceous wetlands to other native habitat types and restoration of croplands to native habitat types could cause a decrease in waterfowl numbers using this area of the refuge. This may be considered a negative impact among waterfowl hunters in the area who hunt on neighboring land. Overall, intermediate positive long-term effects would be expected under this alternative.

Under Alternative 3, larger blocks of forested habitat types would be restored, providing even more contiguous forested habitat connecting with neighboring lands. Croplands would also be restored to native habitat types. This would likely have similar results to wildlife populations as described under Alternative 2 above. Overall, intermediate positive long-term effects would be expected under this alternative.

6.7.2 Potential Impacts to Nearby Residents

Under all alternatives, effects that may occur from management and maintenance activities include dust created while mowing or discing, and possibly the smell and effects of unwanted drift of herbicide being used on refuge lands; however, these effects would be greatly reduced by following the refuge IPM plan (Appendix G). There would be some level of noise associated with operating heavy equipment such as farm tractors and backhoes.

Under Alternative 1, refuge habitats would continue to be maintained as they currently are. Most effects to local residents would be expected to be positive as habitats mature and provide viewing opportunities for wildlife. Most residents enjoy observing wildlife, and this opportunity should increase slightly over the 15-year life of this plan. Although black-tailed deer and other wildlife species currently inhabit the refuge and surrounding areas, slight negative effects might occur as wildlife interact with nearby residents and cause damage to gardens or crops.

Under both Alternatives 2 (preferred) and 3, as larger blocks of contiguous habitats are restored, local wildlife populations may increase, providing both benefits in terms of wildlife observation and negative effects in wildlife conflicts with local residents. At the Wapato Lake Unit, conversion of croplands to native habitat types would likely change the look of the area and composition of wildlife communities using the area. This also may result in both positive and negative effect to neighboring residents, such as an increase in watchable wildlife and an increase in wildlife/human interactions. Additionally, fully restoring Wapato Lake may result in a change in interactions of the Tualatin River and creeks in the area with the restored lake. This may result in reduced flooding of neighboring lands during winter or other unknown effects. Maintaining water in the lake during summer may increase the incidence of mosquitoes in the area. Prescribed fire would be used to maintain certain habitat types and may cause irritation due to smoke and falling ash to nearby residents.

6.8 Cumulative Effects

Cumulative effects can result from the incremental effects of a project when added to other past, present, and reasonably foreseeable future projects in the area. Cumulative impacts can result from individually minor but cumulatively significant actions over a period of time. This analysis is intended to consider the interaction of activities at the refuge with other actions occurring over a larger spatial and temporal frame of reference.

The Council on Environmental Quality (CEQ) regulations for implementing the provisions of the National Environmental Policy Act (NEPA) define several different types of effects that should be evaluated in an EA, including direct, indirect, and cumulative effects. Direct and indirect effects are addressed in the resource-specific sections of this draft CCP/EA. This section addresses cumulative effects.

The CEQ (40 CFR 1508.7) (CEQ 1997) provides the following definition of cumulative effects as:

> *The impact on the environment which 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 such other actions.*

It should be noted that the cumulative effects analysis has essentially been completed by virtue of the comprehensive nature by which direct and indirect effects associated with implementing the various alternatives were presented. The analysis in this section primarily focuses on effects associated with reasonably foreseeable future events and/or actions regardless of what entity undertakes that action.

6.8.1 Effects from Reasonably Foreseeable Future Refuge Activities

As described in Chapter 4, cumulatively, there has been a substantial modification to native habitats of the Tualatin River Basin over the past 150 years. Although a number of natural areas have been designated and are maintained in the area, modification and loss of native habitats continue at a regional scale. There is a clear trend of regionally increasing population growth, which is bringing increased development and associated habitat loss, particularly in the Portland area. Invasive species and altered ecosystem processes are widespread within the area. Within this context, region-wide biological integrity may be at risk. Over time, the refuge, although relatively small and isolated from other natural lands, may become increasingly valuable for the persistence of native wildlife of the Willamette Valley. Active improvement of refuge habitats would increase or maintain the value of refuge lands and waters for a wide variety of native fish and wildlife, and biological diversity (the number of species present on the refuge) would probably remain about the same. All of the alternatives would maintain refuge habitats valuable to wildlife. The Service would improve the availability and quality of wildlife-dependent recreation, but within a regional context, there would be little cumulative difference in recreational opportunity. Although mortality would occur to some wildlife under the refuge's hunt program, the analysis presented in this chapter supports the conclusion that there would be no adverse population-level impacts to hunted or nonhunted wildlife species, even when added to other hunt programs regionally or nationally.

Compared to Alternative 1, Alternatives 2 and 3 present the potential for more benefit to conservation of native species in the Tualatin River Basin and to recreational users, because under these alternatives the Service would restore and maintain larger blocks of wildlife habitat, restore waterways, and develop additional public use features. Further land acquisition would provide protection and restoration of additional habitats that may presently, or in the future, support rare species. Such additional lands may eventually be opened to public use, providing direct opportunity for enjoyment of nature and wildlife. However, even if they are never opened to the public, managing additional lands for conservation values would bolster and support native species populations in the Tualatin River Basin, benefiting recreationists using the refuge and surrounding lands.

6.8.2 Potential Effects from Climate Change

According to the Climate Impacts Group at the University of Washington, "even subtle changes in Pacific Northwest precipitation and temperature have noticeable impacts on the region's mountain snowpack, river flows and flooding, the likelihood of summer droughts, forest productivity and forest fire risk, salmon abundance, and quality of coastal and near-shore habitat" (Climate Impacts Group 2011). Warming is expected to affect a variety of natural processes and associated resources. However, the complexity of ecological systems and interactions means that there is tremendous uncertainty about the exact eeffect climate change would have. In addition, localized effects still require more research (Parmesan et al. 2011). The following paragraphs attempt to identify the key

potential effects of climate change on refuge-specific habitats and plants and wildlife, using the available science and projections, combined with awareness of refuge-specific conditions. By necessity this brief assessment is incomplete, and all projected effects should be treated as hypotheses and tested over time using scientific methods.

Vegetation models indicate that in western Oregon, areas of mixed evergreen and subtropical mixed forest are projected to expand, marking a major transition from temperate to subtropical species (Oregon Climate Change Research Institute [OCCRI] 2010). Pests and diseases would continue to expand northward into Oregon, affecting forest species (Waring et al. 2011). Mountain pine beetle occurrence has been increasing over the last eight years and would likely continue to increase in a warmer climate, along with forest pathogens. Drought also increases vulnerability to mountain pine beetle. Other pests and diseases, including sudden oak death, have been spreading northward from California into southwestern Oregon since the beginning of the twenty-first century. In the case of sudden oak death, extreme precipitation events tend to infect more trees, which then become more vulnerable to mortality during droughts. Generally, insects and diseases would expand northward in latitude, toward the coast, and upward in elevation in a warming climate.

Wildfires would likely increase in all Oregon forest types in the coming decades. Warmer and drier summers leave forests more vulnerable to fire, while wetter winters provide abundant fuel in the form of grasses and shrubs. Wildfire frequency in western forests increased fourfold during 1987-2003 as compared to 1970-1986, while the total area burned increased sixfold (Westerling et al. 2006). Westerling et al. (2006) demonstrated that earlier snowmelt dates correspond to increased wildfire frequency. Trouet et al. (2006) confirmed that these increases in area burned are tied to climate conditions, despite forest suppression management practices such as thinning. As shown above, virtually all climate model projections indicate that warmer springs and summers would occur over the region in coming decades. Prolonged dry and hot periods are generally required for large fires (Gedalof et al. 2005), and future conditions would likely make these periods, and resultant wildfires, more likely.

Climate change effects on species' ranges, phenology, and physiology have been well documented (Lovejoy and Hannah 2005; Parmesan 2006; Rosenzweig et al. 2008; Schneider and Root 2002). Fish and wildlife in the Willamette Valley include both migratory and resident species. There is evidence that the abundance and distribution of species are shifting in response to climate change, and would shift more rapidly as habitats on land and in water are altered due to increasing temperatures and related environmental changes (OCCRI 2010). Among the observed species changes:

- Insects are moving in from the south of Oregon;
- Frogs are reproducing earlier in the year;
- Landbirds are shifting their distributions northward and migrating earlier; and
- Fish are losing their cool-water habitats.

Rising temperatures, shifts in precipitation patterns, and other climatic change may also affect other ecological interactions, such as densities of species; timing of events such as spring flowering times, emergence timing, patterns for insect and pollinator species, egg laying, and migration; changes in morphology, such as body size, and behavior; and changes in genetic frequencies such as those caused by a disruption in the connectedness among species (Root et al. 2003). These changes can unfold in complex cascading direct and indirect effects such as those described by Martin and Marin

(2012). The refuge's wetland, riparian, and aquatic species are perhaps the most vulnerable to these effects (Lawler et al. 2008).

However, predicting biological response at the population level is difficult (Akcakaya et al. 2006; Pereira et al. 2010). In a warmer climate, plant and animal species may respond by occupying different parts of the landscape. Rare or endangered species may become less abundant or extinct; insect pests, invasive species, and harmful algal blooms may become more abundant. Declines in abundance of species may be caused directly by physiological stress related to changes in temperature, water availability, and other environmental shifts, and/or indirectly by habitat degradation and negative interactions with factors that are benefited by climate change (diseases, parasites, predators, and competitors), but it remains difficult to model how species' range and population abundance (increasing or declining) can be projected from a suite of interrelated climate-related variables (Fordham et al. 2012). Researchers are improving models, and the refuge would evaluate the results of a new Willamette Valley vegetative and species response model currently being undertaken by the University of Washington (led by Dr. Josh Lawler and funded by the North Pacific Landscape Conservation Cooperative).

The increase of invasive species risk is due to a variety of reasons. For example, invasive species have a broader climate tolerance and larger geographic ranges, along with characteristics that favor rapid range shifts. Also, climate change may alter transport and introduction mechanisms, establish new invasive species, alter the impact of existing invasive species, and affect other risk factors (Hellmann et al. 2008; Rahel and Olden 2008; Willis et al. 2010). One example that affects Tualatin River National Wildlife Refuge is the potential population growth of nutria. Nutria are currently at a nuisance level at the refuge in terms of physical damage to embankments and vegetation, but with milder winters projected, they may become more abundant and more disruptive to water management, recreation access, and native species conservation.

The good news is that hotter and drier summers generally favor fire-adapted communities such as Willamette Valley prairie and savanna communities (Bachelet et al. 2011). Bachelet et al. (2011) also found that:

> *Many of the aggressive exotic species that occur in both wet and dry prairies in the western Pacific Northwest currently have wide range distributions in the U.S. (Dennehy et al. 2011), so it is reasonable to assume that they will be relatively adaptable to changing climate. Consequently, they may provide even more of a competitive challenge to native Pacific Northwest prairie species in the future than they do currently. However, as we mentioned above, many native prairie species are well adapted to summer drought, which could give them an advantage over many exotic species as summer drought extends and intensifies…*
>
> *Directly relevant to the future of prairies and oak savannas, Shafer et al. (2001) showed significant contraction of the range of Garry oak [Oregon White Oak] on the west side of the Cascades and a shift and expansion to the east side of the mountains by the end of the 21st century. However, a recent study conducted by Bodtker et al. (2009) found that climate suitability for Garry oak is likely to improve overall in Washington, Oregon, and British Columbia, where it is the dominant oak species, with some declines in specific areas…*
>
> *The effects of warming on grasslands have also been experimentally studied by a variety of scientists who focused on plant community structure, productivity, or phenology… Findings include: warming often causes a decrease in plant biodiversity (Zavaleta et al. 2003, Klein et*

> *al. 2004, Walker et al. 2006), while species-specific effects are mediated through changes in litter quantity (Weltzin et al. 2001, Klein et al. 2004, Weltzin et al. 2005, Suttle et al. 2007) and nutrient availability (Shaver et al. 2000, De Valpine and Harte 2001, Rustad et al. 2001, An et al. 2005, Suttle et al. 2007). Pfeifer-Meister and Bridgham (2007) showed strong seasonal controls of temperature and moisture on carbon and nutrient cycling in a Willamette Valley/Puget Trough/Georgia Basin prairie, with competition between native and exotic species mediated by moisture and nutrient availability (Pfeifer-Meister et al. 2008).*

A recently completed vulnerability assessment for Willamette Valley provides an analysis of effects to many species and habitats managed by the refuge (Steel et al. 2011). A summary of the findings is excerpted here:

> *Of the 46 species and subspecies assessed, the four most vulnerable to climate change were Coastal Cutthroat Trout (Southwest Columbia River ESU; Oncorhynchus clarkii pop. 2), Chinook Salmon (Lower Columbia River ESU, Fall Run; Oncorhynchus tshawytscha pop. 22), Way-side Aster (Aster vialis), and Fender's Blue Butterfly (Icaricia icarioides fendereri). Among the species assessed, invertebrates, fishes, and plants tended to be the most vulnerable groups on average. The ecological parameters that most contributed to climate change sensitivity were inferred limitations in temperature tolerance, negative response to disturbance regimes, dependence on current precipitation/hydrologic regimes, dependence on specific habitat attributes, and dependence on cooler microsites within habitats.*

When analyzing Conservation Opportunity Areas (COAs), the authors focused on climate sensitivity and overall vulnerability. The Tualatin River is ranked as a highly vulnerable area. However, the authors also note that in many cases nonclimate factors may remain more threatening to COAs than climate change.

6.8.3 Other Reasonably Foreseeable Events and Activities

Development and population growth: By 2030, the population of the greater Portland area is expected to be as high as 3.5 million people. Population growth would continue to place stress upon the ecosystems of the Willamette Valley, both through direct loss of remaining habitats, and indirectly through fragmentation and degradation of the valley's remaining parcels of wildlife habitat.

Appendix A
Appropriate Use Findings and Justifications

USFWS

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Appropriate Use Findings

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Appendix A. Appropriate Use Findings

Introduction

The Appropriate Refuge Uses Policy (603 FW 1), finalized in 2006, outlines the process that the U.S. Fish and Wildlife Service (USFWS; Service) uses to determine when general public uses on refuges may be considered. Public uses, previously defined as wildlife-dependent uses under the National Wildlife Refuge System Improvement Act of 1997 (hunting, fishing, wildlife observation and photography, environmental education and interpretation), are generally exempt from appropriate use review. Other exempt uses include situations where the Service does not have adequate jurisdiction to control the activity and refuge management activities. Other existing, proposed, or requested public uses are required to undergo the appropriateness screening.

The policy provides refuge managers with a consistent procedure to screen and document decisions concerning public uses, with the use of the following questions:

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, compatible, wildlife-dependent recreation into the future?

Uses marked "no" for questions (a) or (b) are not evaluated further. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. When a use is determined to be appropriate, a refuge manager must then decide if the use is compatible before allowing it on a refuge.

The following forms show which uses have been determined appropriate and which determined not appropriate. Narrative answers for negative findings follow the forms.

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Appropriate Uses Findings

Appropriate Use Justification, Attachment 1

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Bicycling/Jogging

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✓
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✓ **Appropriate** ____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge (the refuge)

Use: Bicycling/jogging on the refuge

Summary: Jogging and bicycling are currently not allowed on the refuge. However, the refuge gets occasional requests to allow these uses, including opportunities to connect the refuge with regional trail systems. These uses have been determined to be not appropriate at the current time.

Further explanation of the answers from US. Fish and Wildlife Service (USFWS) Form 3-2319 is provided below:

(e) These uses are not consistent with the goals and objectives of the comprehensive conservation plan (CCP) due to the potential for joggers and bicyclists to disturb wildlife or interfer with other priority wildlife-dependent public uses.

(f) While the 2003 refuge environmental assessment (EA) (USFWS 2003a) for the Wildlife Center and visitor services facilities addressed several activities and limited trail use to foot traffic only, it did not specifically address jogging or bicycling.

(g) and (h) Due to the urban nature of the refuge, the potential demand for these uses would be very high. The amount of oversight needed to adequately carry out this activity would require additional resources that are not available with current resources.

(i) The uses present no benefits to the refuge's natural or cultural resources and are not thought to contribute to the public's understanding or appreciation of those resources.

(j) Currently, these uses cannot be accommodated without impairing existing wildlife-dependent recreational uses. Animals show greater flight response to humans moving unpredictably than to humans following a distinct path. Also, rapid movements by joggers and cyclists are more disturbing to wildlife than slower moving hikers. Burger (1981) examined the effects of human activity on roosting and migrating birds at a coastal bay refuge along the Atlantic coast. Human activities that involved rapid movements or close proximity to roosting birds, such as jogging, even on pathways, caused the birds to flush; in comparison, slow-walking bird watchers and people walking on paths around ponds did not usually cause birds to flush.

However, as stated under Objective 10.4 of this CCP/EA (Chapter 2), we would explore opportunities with partners to connect with regional trails while ensuring the uses minimize disturbance. At that time, we would re-evaluate the appropriateness of the uses.

References

Burger, J. 1981. The effects of human activity on birds at a coastal bay. Biological Conservation 21:231-241.

USFWS (U.S. Fish and Wildlife Service). 2003a. Tualatin River National Wildlife Refuge environmental assessment, Wildlife Center and visitor services facilities, Washington County, Oregon. U.S. Fish and Wildlife Service, Portland, OR. 318 pp.

Appropriate Uses Justification, Attachment 2

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Boat Access

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✓	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✓ **Appropriate**____

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Boat access

Summary: Access to or from the refuge by boat is currently not allowed. However, the refuge receives occasional requests to allow this use, including opportunities to connect the refuge with future planned water trail systems. This use has been determined to be not appropriate at the current time.

Further explanation of the answers from USFWS Form 3-2319 is provided below:

(d) No safe facilities currently exist for providing boat access to and/or from the refuge. River banks are steep and slippery and create a significant safety risk, especially when rainy or when river levels are running high.

(f) An assessment for provision of a boat launch facility off of Roy Rogers Road was conducted in the refuge environmental assessment for the Wildlife Center and visitor services facilities (USFWS 2003a). This use was examined but eliminated from further study for a number of reasons, including considerable resource damage that would occur to construct a boat launch that was safe and accessible; impacts to fish and riparian species; and the potential of other jurisdictions to provide nearby river access points.

(g) and (h) Due to the urban nature of the refuge, the potential demand for this use would be very high. The amount of oversight needed to adequately carry out this activity would require additional resources that are not available now or in future budget and staff projections. Also, construction would need to occur to develop a boat launch and this most likely would cause direct resource damage.

(j) Currently the use cannot be accommodated without impairing existing wildlife-dependent recreational uses. However, as stated under Objective 10.4 in this CCP/EA, the refuge would "partner with interested parties/organizations to identify potential locations for one public river access for nonmotorized boats in or near the refuge." At that time, if a location is identified on the refuge, refuge staff would re-evaluate the appropriateness of the use.

References

USFWS. 2003a. Tualatin River National Wildlife Refuge environmental assessment, Wildlife Center and visitor services facilities, Washington County, Oregon. U.S. Fish and Wildlife Service, Portland, OR. 318 pp.

Appropriate Uses Justification, Attachment 3

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Commercial or Recreational Trapping

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✓
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✓ **Appropriate**____

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Commercial or recreational trapping

Summary: Commercial and/or recreational trapping does not contribute to the goals of the refuge and would require more oversight from staff than is currently available. This use was determined to be not appropriate.

Further explanation of the answers from USFWS Form 3-2319 is provided below:

(e) There are no refuge management plans that address commercial or recreational trapping. This use is not consistent with the goals and objectives as written in the CCP/EA. The use would significantly conflict with wildlife.

(g) and (h) Current limited budget and staff time would be diverted from priority wildlife-dependent public use and management activities to administer commercial or recreational trapping activities. Future management of commercial or recreational trapping would not be achievable with existing resources. Providing appropriate oversight of the use would exceed existing and future projections of budget and staff.

(i) Commercial or recreational trapping would not contribute to the public's understanding and appreciation of cultural or natural resources.

Appropriate Uses Justification, Attachment 4

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Commercial or Recreational Trapping

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?		✓
(h) Will this be manageable in the future within existing resources?		✓
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✓
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✓ **Appropriate**____

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Commercial visitor services

Summary: Commercial visitor services on the refuge cover a broad range of wildlife-dependent recreation and education activities that are led by any organization or individual that charges a fee to participate in the activity. Activities could include, but are not limited to: birding tours, plant identification, wildlife photography, art, interpretive programs, guided trail walks, training workshops, summer youth camp, nature classes, and other similar non-consumptive uses. These uses would occur in areas and facilities that are open to the public and would support the identified wildlife-dependent public uses of the refuge. Organizations conducting commercial visitor services would require a Special Use Permit (SUP), except for the Friends of Tualatin River Refuge (Friends) for which commercial activities that are governed by statute under an existing Memorandum of Understanding.

Further explanation of the answers from USFWS Form 3-2319 is provided below:

(c) As defined in federal regulations (50 Code of Federal Regulations [CFR] 29.1), a commercial recreational use is a use that generates revenue or that results in a commodity that is or can be sold for income or revenue.

The Appropriate Use policy (603 FW 1) specifically references commercial uses of this kind. The policy states that "Commercial uses of a refuge may be considered appropriate if they are a refuge management economic activity (see 50 CFR 25.12), if they directly support a priority general public use, or if they are specifically authorized by statute."

(d) Through SUP review and/or coordination with the Friends of the Refuge group, the refuge would ensure that each approved activity is consistent with public safety. If necessary, stipulations to ensure public safety would be included in the project's SUP.

(e) The use is consistent with Goals 12, 13, and 14 of the CCP/EA. Requests would be approved in instances where they can provide meaningful public appreciation of natural resources in support of the refuge's wildlife-dependent recreation and education programs.

(j) The refuge would ensure that the activities do not impair existing or future wildlife-dependent recreational use of the refuge during individual project review, prior to issuing SUPs and/or approvals.

Appropriate Uses Justification, Attachment 5

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Cooperative Farming

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		✓
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✓	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate_____ **Appropriate** ✓

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Cooperative farming on the refuge

Summary: Cooperative farming is currently allowed on the refuge. Seventy percent of small grain croplands (corn, wheat, barley, and oats) are harvested, while 30 percent are left standing, and green pastures (clover and hay grass) are harvested and mowed at less than 4 inches in the fall for grazing. Cooperative farming is an interim management tool used to control invasive plant species. This use has been determined to be appropriate.

Further explanation of the answers from USFWS Form 3-2319 is provided below:

(e) Cooperative farming is consistent with Goal 7 in Chapter 2 of the CCP/EA. Cultivating and maintaining small croplands helps control nonnative invasive species such as reed canarygrass and Himalayan blackberry prior to restoration of native habitats.

(f) The use is ongoing on the Onion Flats and Wapato Lake Units of the refuge as an interim management tool prior to restoring acquired lands.

(g) Cooperative farming is conducted by local growers who incur all costs associated with growing and harvesting crops. The cooperator is responsible for all aspects of farming including site preparation, seeding, application of any fertilizers or herbicides, harvesting, and any follow-up work necessary to remove the crop or prepare the field for the following year. Cooperators are required to leave a share of crops as determined by a cooperative agreement.

(i) As mentioned in the features common to all alternatives in Chapter 2 of this CCP/EA, cooperative farming contributes to the public's understanding and appreciation of the refuge's natural resources by providing public use and focus on habitat restoration.

Appropriate Uses Justification, Attachment 6

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Dog walking and training

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		✓
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		✓
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?		✓

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✓ **Appropriate**____

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Dog walking and training

Summary: Dog walking and training have been determined to be not appropriate due to wildlife disturbance and lack of a contribution to the refuge's cultural or natural resources. This use is not considered a wildlife-dependent use.

Further explanation of the answers from USFWS Form 3-2319 is provided below:

(e) The amount of disturbance that would be created by these uses is considered inconsistent with other goals and objectives in the CCP/EA.

(i) These uses are not likely to contribute to public understanding of the refuge's natural or cultural resources. The uses are not likely to be beneficial to the refuge's natural or cultural resources, and could be detrimental to those resources.

(j) It is likely that these uses would degrade the quality of the visitor experience and would impair existing wildlife-dependent uses. Dogs elicit a greater response from wildlife than people on foot alone (Hoopes 1993; MacArthur et al. 1982). The presence of dogs may flush incubating birds from nests (Yalden and Yalden 1990), disrupt breeding displays (Baydack 1986), disrupt foraging activity in shorebirds (Hoopes 1993), and disturb roosting activity in ducks (Keller 1991). For mule deer in Colorado, the presence of a dog resulted in a greater area of influence, alert and flush distance, and distance moved than when a pedestrian was alone (Miller et al. 2001). Many of these authors indicated that dogs with people, dogs on leash, or loose dogs provoked the most pronounced disturbance reactions from their study animals. Indirectly, domestic dogs can also potentially introduce diseases and transport parasites into wildlife habitats (Sime 1999).

References

Baydack, R.K. 1986. Sharp-tailed grouse response to lek disturbance in the Carberry Sand Hills of Manitoba. Colorado State University. Fort Collins, Colorado.

Hoopes, E.M. 1993. Relationship between human recreation and piping plover foraging ecology and chick survival. M.S. thesis. University of Massachusetts, Amherst, MA.

Keller, V. 1991. Effects of human disturbance on eider ducklings *Somateria mollissima* in an estuarine habitat in Scotland. Biological Conservation 58:213-228.

MacArthur, R.A., V. Geist, and R.H. Johnston. 1982. Cardiac and behavioral responses of mountain sheep to human disturbance. Journal of Wildlife Management 46:351-358.

Miller, S.G., R.L. Knight, and C.K. Clinton. 2001. Wildlife responses to pedestrians and dogs. Wildlife Society Bulletin 29:124-132.

Sime, C.A. 1999. Domestic dogs in wildlife habitats. Pages 8.1-8.17 in: G. Joslin and H. Youmans, coordinators. Effects of recreation on Rocky Mountain wildlife: a review for Montana. Committee on Effects of Recreation on Wildlife, Montana chapter, Wildlife Society. 307 pp.

Yalden, P.E. and D. Yalden. 1990. Recreational disturbance of breeding golden plovers (*Pluvialis apricarious*). Biological Conservation 51:243-262.

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Appropriate Uses Justification, Attachment 7

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Geocaching

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?		✓
(c) Is the use consistent with applicable Executive orders and Department and Service policies?		
(d) Is the use consistent with public safety?		
(e) Is the use consistent with goals and objectives in an approved management plan or other document?		
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?		
(g) Is the use manageable within available budget and staff?		
(h) Will this be manageable in the future within existing resources?		
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?		
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?		

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate ✓ **Appropriate** ____

Refuge Manager: _____ Date: _____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor: _____ Date: _____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Geocaching

Summary: Geocaching, also known as letterboxing, is an outdoor activity in which participants use a global positioning system (GPS) device or other navigational technique to hide and seek containers called "geocaches" or "caches." When physical placement is not involved and instead participants take a photograph of themselves in front of the defined feature or record some information about such a feature, the use is known as "virtual geocaching." This appropriate use determination covers only physical geocaching.

Further explanation of the answers from USFWS Form 3-2319 is provided below:

(b) According to 50 CFR 27.93, abandoning, discarding, or otherwise leaving any personal property in any national wildlife refuge is prohibited.

Due to the negative finding on (b), the use was not evaluated further and is considered inappropriate.

Appropriate Uses Justification, Attachment 8

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Mosquito and disease vector management

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✓	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate_____ **Appropriate** ✓

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Mosquito and disease vector management

Summary: In the interest of human health and public safety, mosquito and disease vector management has been determined to be an appropriate use to help control the spread of mosquito-borne diseases.

Further explanation of the answers from USFWS Form 3-2319 is provided below:

(e) Mosquito and disease vector management is consistent with features common to all alternatives in Chapter 2 of this CCP/EA. With the spread of mosquito-borne diseases across the country, refuges have come under increasing pressure to manage mosquito populations that are bred or harbored within refuge boundaries. The refuge will refer to the interim guidance for refuges that the Director of the Service has produced until the Service policy document is finalized.

(f) This is the first time the use has been formally proposed.

(g) The use would be manageable within available budget and staff. Monitoring and control of target mosquito larvae would be conducted by the Washington County Mosquito Control District (District). The District would be responsible for staffing and expenditures for sampling and pesticide applications. Refuge staff resources would be needed to review annual proposals, prepare SUPs, and monitor District personnel to ensure compliance.

(h) Future mosquito and disease vector management would be conducted by non-refuge staff with minimal refuge staff oversight.

(i) Providing information on mosquito-borne diseases is beneficial to the public. Arboviral (arthropod-borne viral) diseases are a potential concern. These include West Nile virus, western equine encephalitis, and St. Louis encephalitis.

(j) The impacts of mosquito monitoring and treatment would be localized and temporary. The treatments and monitoring would be conducted in areas closed to public use, meaning they would likely not conflict with any wildlife-dependent public uses in the future. Any mosquito control undertaken would have minimal impact on any priority wildlife-dependent public use program. The disturbance of wildlife by District staff is minimized to the extent practicable by restricting access to sensitive areas and by controlling the type of access. The impacts anticipated from the logistical activities resulting from the proposed monitoring and treatment actions on wildlife are minimal.

Appropriate Uses Justification, Attachment 9

FINDING OF APPROPRIATENESS OF A REFUGE USE

Refuge Name: Tualatin River National Wildlife Refuge

Use: Research and monitoring

This form is not required for wildlife-dependent recreational uses, take regulated by the State, or uses already described in a refuge CCP or step-down management plan approved after October 9, 1997.

Decision Criteria:	YES	NO
(a) Do we have jurisdiction over the use?	✓	
(b) Does the use comply with applicable laws and regulations (Federal, State, tribal, and local)?	✓	
(c) Is the use consistent with applicable Executive orders and Department and Service policies?	✓	
(d) Is the use consistent with public safety?	✓	
(e) Is the use consistent with goals and objectives in an approved management plan or other document?	✓	
(f) Has an earlier documented analysis not denied the use or is this the first time the use has been proposed?	✓	
(g) Is the use manageable within available budget and staff?	✓	
(h) Will this be manageable in the future within existing resources?	✓	
(i) Does the use contribute to the public's understanding and appreciation of the refuge's natural or cultural resources, or is the use beneficial to the refuge's natural or cultural resources?	✓	
(j) Can the use be accommodated without impairing existing wildlife-dependent recreational uses or reducing the potential to provide quality (see section 1.6D, 603 FW 1, for description), compatible, wildlife-dependent recreation into the future?	✓	

Where we do not have jurisdiction over the use ("no" to (a)), there is no need to evaluate it further as we cannot control the use. Uses that are illegal, inconsistent with existing policy, or unsafe ("no" to (b), (c), or (d)) may not be found appropriate. If the answer is "no" to any of the other questions above, we will **generally** not allow the use.

If indicated, the refuge manager has consulted with State fish and wildlife agencies. Yes ___ No ✓

When the refuge manager finds the use appropriate based on sound professional judgment, the refuge manager must justify the use in writing on an attached sheet and obtain the refuge supervisor's concurrence.

Based on an overall assessment of these factors, my summary conclusion is that the proposed use is:

Not Appropriate_____ **Appropriate** ✓

Refuge Manager:_____ Date:_____

If found to be **Not Appropriate**, the refuge supervisor does not need to sign concurrence if the use is a new use.

If an existing use is found **Not Appropriate** outside the CCP process, the refuge supervisor must sign concurrence.

If found to be **Appropriate**, the refuge supervisor must sign concurrence.

Refuge Supervisor:_____ Date:_____

A compatibility determination is required before the use may be allowed.

FWS Form 3-2319
02/06

Refuge: Tualatin River National Wildlife Refuge

Use: Research and monitoring

Summary: Research and monitoring on refuge lands are fundamentally valuable as they make available scientific information for resource management decisions. The refuge receives requests from universities and other organizations to conduct scientific research and monitoring efforts within the refuge. These uses have been ongoing on the refuge for many years, and are consistent with the CCP goals. Research and monitoring are determined to be appropriate uses.

Further explanation of the answers from FWS Form 3-2319 is provided below:

(e) Research and monitoring are consistent with Goal 8 of this CCP/EA. Conducting research and monitoring studies would provide the refuge with the best science with which to conduct refuge operations. Determining resource status and evaluating progress toward achieving objectives is essential to implementing adaptive management on the refuge. Research projects on refuge lands would address a wide range of natural and public use management issues. Examples of research projects include habitat use and life history requirements for specific species/species groups, practical methods for habitat management and restoration, extent and severity of environmental contaminants, techniques to control or eradicate pest species, effects of climate change on environmental conditions and associated habitat/wildlife response, modeling of wildlife populations, and assessing response of habitat/wildlife to disturbance from public uses.

(f) This is the first time these uses have been formally proposed.

(g) The use would be manageable within available budget and staff. Proposed research and monitoring would be conducted by outside entities, not refuge staff. Minimal refuge staff time is anticipated for project oversight.

(h) Future use would not be conducted by refuge staff, but by outside personnel, with minimal refuge staff oversight.

(i) Providing information on current status and trends of fish and wildlife populations is beneficial for public education and interpretation.

(j) Any research or monitoring project would be undertaken such that it would have minimal interference with any priority wildlife-dependent public use program.

Appendix B Compatibility Determinations

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Appendix A
Appropriate Use Findings

Appendix B
Compatibility Determinations

Appendix C
Implementation

Appendix D
Wilderness Review

Appendix E
Biological Resources of Concern

Appendix F
Statement of Compliance

Appendix G
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Appendix H
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Appendix I
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Appendix B. Compatibility Determinations

B.1 Introduction

The compatibility determinations (CDs) developed during the comprehensive conservation plan (CCP) planning process evaluate uses that are projected to occur under Alternative 2, the preferred alternative. The evaluation of funds needed for management and implementation of each use also assume implementation as described under Alternative 2. Chapter 6 of the draft CCP/EA contains analysis of the impacts of public uses to wildlife and habitats. That portion of the document is incorporated through reference into this set of CDs.

B.1.1 Uses Evaluated at This Time

The following section includes full CDs for all refuge uses that are required to be evaluated at this time. According to Service policy, compatibility determinations will be completed for all uses proposed under a CCP that have been determined to be appropriate. Existing wildlife-dependent recreational uses must also be reevaluated and new CDs prepared during development of a CCP.

According to the Service's compatibility policy, uses other than wildlife-dependent recreational uses are not explicitly required to be reevaluated in concert with preparation of a CCP, unless conditions of the use have changed or unless significant new information relative to the use and its effects have become available, or the existing CDs are more than 10 years old. However, the Service planning policy recommends preparing CDs for all individual uses, specific use programs, or groups of related uses associated with the proposed action.

B.1.2 Compatibility—Legal and Historical Context

Compatibility is a tool refuge managers use to ensure that recreational and other uses do not interfere with wildlife conservation, the primary focus of the refuge. Compatibility is not new to the Refuge System and dates back to 1918 as a concept. As policy, it has been used since 1962. The Refuge Recreation Act of 1962 directed the Secretary of the Interior to allow only those public uses of refuge lands that were "compatible with the primary purposes for which the area was established."

Legally, refuges are closed to all public uses until officially opened through a compatibility determination. Regulations require that adequate funds be available for administration and protection of refuges before opening them to any public uses. However, wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation) are to receive enhanced consideration and cannot be rejected simply for lack of funding resources unless the refuge has made a concerted effort to seek out funds from all potential partners. Once found compatible, wildlife-dependent recreational uses are deemed the priority public uses at the refuge. If a proposed use is found not compatible, the refuge manager is legally precluded from approving it. However, a use found not compatible may be modified such that it can be found compatible. Economic uses that are conducted by or authorized by the refuge also require compatibility determinations.

Under compatibility policy, uses are defined as recreational, economic/commercial, or management uses of a refuge by the public or a non-Refuge System entity. Uses generally providing an economic return (even if conducted for the purposes of habitat management) are also subject to compatibility

determinations. The Service does not prepare compatibility determinations for uses when the Service does not have jurisdiction. For example, the Service may have limited jurisdiction over refuge areas where property rights are vested by others, where legally binding agreements exist, or where there are treaty rights held by tribes. In addition, aircraft overflights, emergency actions, some activities on navigable waters, and activities by other federal agencies on "overlay refuges" are exempt from the compatibility review process.

New compatibility regulations, required by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), were adopted by the Service in October 2000 (http://refuges.fws.gov/policymakers/nwrpolicies.html). The regulations require that a use must be compatible with both the mission of the Refuge System and the purposes of the individual refuge. This standard helps to ensure consistency in application across the Refuge System. The Act also requires that compatibility determinations be in writing and that the public have an opportunity to comment on most use evaluations.

The Refuge System mission emphasizes that the needs of fish, wildlife, and plants must be of primary consideration. The Improvement Act defined a compatible use as one 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." Sound professional judgment is defined under the Improvement Act as "… a finding, determination, or decision, that is consistent with principles of sound fish and wildlife management and administration, available science and resources …." Compatibility for priority wildlife-dependent uses may depend on the level or extent of a use.

Court interpretations of the compatibility standard have found that compatibility is a biological standard and cannot be used to balance or weigh economic, political, or recreational interests against the primary purpose of the Refuge (Defenders of Wildlife v. Andrus [Ruby Lake Refuge]). The Service recognizes that compatibility determinations are complex. For this reason, refuge managers are required to consider "principles of sound fish and wildlife management" and "best available science" in making these determinations (House of Representatives 1997).

Evaluations of the existing uses on the Tualatin River National Wildlife Refuge are based on the professional judgment of refuge and planning personnel, including observations of refuge uses and reviews of appropriate scientific literature.

In July 2006, the Service published its Appropriate Refuge Uses Policy (603 FW 1). Under this policy, most proposed uses must also undergo a review prior to compatibility. Uses excepted from the policy include the "Big Six" uses and uses under reserved rights—see the policy for more detail.

References

Defenders of Wildlife v. Andrus (Ruby Lake Refuge I). Case 2098 (D.D.C. 1978). Environmental Reporter 11:873.

House of Representatives. 1997. Report 105-106 on National Wildlife Refuge System Improvement Act. Available at: http://www.fws.gov/Refuges/policiesandbudget/HR1420_part1.html.

B.2 Compatibility Determination for Wildlife Observation, Wildlife Photography, and Interpretation at Tualatin River National Wildlife Refuge

Use: Wildlife observation, wildlife photography, and interpretation

Station Name: Tualatin River National Wildlife Refuge (the refuge)

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S. Code [U.S.C.] § 742a. et seq.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purpose(s):

" … for the development, advancement, management, conservation, and protection of fish and wildlife resources … " 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd et seq.]).

Description of Use:

This compatibility determination (CD) examines wildlife observation, wildlife photography, and interpretation as proposed under Preferred Alternative 2 of the Tualatin River National Wildlife Refuge (refuge) draft comprehensive conservation plan (CCP)/environmental assessment (EA). There is substantial overlap between activities associated with wildlife observation, wildlife photography, and interpretation where participants are engaged in self-directed learning about the natural and cultural resources on the refuge, and as such these uses are evaluated together in this CD. This use would foster an aware and involved citizenry that would take an active role in conservation.

Visitors typically engage in wildlife observation, wildlife photography, and interpretation uses at the refuge Wildlife Center, along the year-round and seasonal trails, at a number of overlooks, and at the wildlife photography blind—all located on the Atfálat'i Unit of the refuge. Projections indicate that refuge public facilities could serve an estimated 200,000 to 300,000 visitors annually (U.S. Fish and

Wildlife Service [Service; USFWS] 2003a). Currently, nearly 100,000 people visit the refuge annually. See Sections 5.3 and 5.4 of the refuge CCP/EA for a complete description of visitor use statistics.

The highest visitor use generally occurs spring through fall, though there is some use throughout the year. The seasonal trail is open from May 1 through September 30 to minimize disturbance to migrating and wintering waterfowl. Visitor use is limited to developed facilities, and other areas of the refuge remain closed to general public use. Visitors are limited to pedestrian use only—bicycling, dog walking, and jogging are prohibited. Maps, brochures, kiosks, and directional and regulatory signs would be provided to visitors to communicate activities that are encouraged and those that are prohibited.

Group size is usually small (families, individuals, and couples constitute the majority of groups) but occasionally larger groups use the refuge. Local nonprofit groups (e.g., Audubon Society, walking clubs, parent groups) as well as for-profit organizations (tour buses) frequently visit the refuge and lead field trips on the trails and/or visit the Wildlife Center. As is currently the case, groups of 15 people or more must: make advance reservations; be limited to no more than 50 people; break up into subgroups of 15 people or less when on trails; strive to carpool or provide group transportation; follow all refuge regulations; and not charge any fee to their participants. Any organization that charges a fee to their participants would be subject to the stipulations in the commercial visitor services CD. Fundraising activities (including providing guided tours and hosting special events and meetings) conducted by Friends of the Tualatin River National Wildlife Refuge (Friends of the Refuge) are not subject to the commercial visitor services CD, but are subject to refuge approval, per the memorandum of understanding (MOU) between the Service and the Friends of the Refuge.

Preferred Alternative 2 provides more opportunities for developing wildlife observation, photography, and interpretation programs and structured visitor experiences with enhanced facilities and improved access. Proposed actions are as follows.

Up to three additional wildlife photography blinds would be constructed on the Atfálat'i Unit of the refuge. Access trails to the blind(s) would be developed with minimal footprint and be constructed out of gravel or other low-impact and low-maintenance material. Use of the blind(s) would be managed on a reservation basis for up to two people at a time. Blinds would be available up to three days a week, from dawn to dusk. For both wildlife photography and observation areas, the refuge would maintain "viewing lanes" by selectively trimming branches, mowing tall grass, and/or occasionally removing vegetation. In addition, areas around these facilities may be enhanced to maximize wildlife use of the area. Examples of enhancements include planting vegetation for additional habitat; providing habitat structure such as basking logs; increasing vegetation cover to serve as a natural blind; and adding trees and/or shrubs to minimize "urban noise" from off-refuge sources (i.e., roads, industrial activities). Though no public use facilities currently exist at the Wapato Lake Unit, one or two additional kiosks are proposed and have potential to be developed off-refuge in partnership with local city and county jurisdictions.

Several regional land and water trail systems outside of the refuge being studied by local jurisdictions and organizations have the potential of connecting to the refuge. However, at this time, no specific location for connection has been proposed; therefore, additional appropriateness and CDs for new trails would be completed at a later date. The refuge supports providing additional wildlife observation, photography, and interpretation opportunities by linking to regional trail systems and plans to continue working with local organizations to explore this further.

Wildlife observation, photography, and interpretation would continue to occur primarily informally as self-guided activities on the refuge. Refer to Section 5.4 in Chapter 5 for a complete description of existing programs. In addition, regular staff-, volunteer-, or partner-led tours, workshops, and demonstrations would be expanded to diversify the visitor experience and opportunities for these uses. Increased outreach and program offerings would likely result in increased visitation to the refuge. Refuge-approved and guided activities may include the use of the Wildlife Center or other refuge public use facilities, and may occasionally occur after dark when the refuge is normally closed to the public. The Friends of the Refuge may also conduct similar activities in support of wildlife observation, photography, and interpretation. These programs would require preapproval by the refuge manager and would be subject to all of the same regulations as the general public (i.e., no special access to closed areas would be granted) and stipulations of this CD.

Virtual geocaching (drawing people to specific sites via electronic means) is considered a legitimate form of interpretation under this CD. Physical geocaching (the actual placement of objects in the landscape by the public) is not appropriate (see Appendix A) and is not included as a form of interpretation.

A number of existing and new special events, hosted by the refuge or in partnership with the Friends of the Refuge, could occur on the refuge in support of wildlife-dependent recreation and education activities. Examples include, but are not limited to, Tualatin River Bird Festival, National Wildlife Refuge Week, Spring Break Exploration Days, native plant sales, and one-time celebratory events such as dedications, groundbreakings, and grand openings. Special events typically last anywhere from 4 hours to all day, and may include multiple back-to-back days. Past events have attracted over 1,200 a day and may attract more, up to 2,000 people a day, in the future. Special event activities typically include, but are not limited to, guided nature walks; evening programs; indoor and outdoor temporary exhibits; self-guided tours/walks; hands-on educational activities; live animal shows; workshops; nature-related music (generally in the plaza area of the Wildlife Center); awards ceremonies for nature photography contests; and keynote speakers. Activities are limited to the areas of the refuge open to the public. Any special event activity occurring outside the public use areas would be subject to case-by-case refuge manager approval and, if necessary, a special use permit (SUP).

In support of enhanced wildlife observation, photography, and interpretation programs proposed in Preferred Alternative 2, the refuge would continue to pursue additional volunteers and interns. This would include providing bunkhouses or recreational vehicle (RV) pads to support long-term housing on the refuge. These facilities would be located in areas such as the maintenance and shop facility on the Tualatin River Unit and/or within proximity of existing or newly acquired quarters buildings.

Availability of Resources:

Estimated costs for operating the environmental education program as envisioned under Alternative 2 are displayed in the following table. Estimated costs for operating the wildlife observation, photography, and interpretation programs as envisioned under Alternative 2 are also displayed in the following table. With assistance from Friends of the Refuge, grants, volunteers, and other partners, the refuge currently has sufficient staff and funding to support these programs at their current levels. Additional resources would be needed to fully implement the uses and strategies described in the CCP/EA.

Costs to Administer and Manage Wildlife Observation, Wildlife Photography, and Interpretation under the Preferred Alternative (Alternative 2)

Activity or Project	One-time Expenses ($)	Recurring Expenses ($/year)
Volunteer Coordinator		55,000
Law Enforcement Officer		78,500
Develop new kiosks at Wapato Lake Unit	20,000	
Maintain Wildlife Center and exhibits		5,000
Host special events		5,000
Transportation study		30,000
Maintain parking lots, trails, overlooks, blinds, signs, outdoor exhibits		15,000
Construct up to 3 additional photo blinds and associated trails		40,000
Construct RV pads and bunkhouse	300,000	5,000
Maintain existing and develop new signage and publications	5,000	5,000
Program oversight: Visitor Services Manager		20,000
Total	327,000	258,500

Anticipated Impacts of Use:

General Impacts Expected:

A general assessment of impacts resulting from wildlife observation, photography, and interpretation uses has been compiled from the literature and is briefly summarized below.

Disturbance intensity (frequency, distance, etc.): Human activities on recreational lands, trails, and other access points can result in direct effects on wildlife. Disturbance responses can depend upon the activity type, recreationists' behavior, and the distance, duration, frequency, predictability, timing, and visibility of the use (Knight and Cole 1995). Disturbance to migrant shorebirds on eastern coastal bays was found to increase as the total number of disturbances and recreationists increased and the duration of the disturbance and distance from the disturbance decreased (Burger 1986). Flushing, especially repetitive flushing, can strongly impact patterns of many bird species. Migratory birds have been observed to be more sensitive than resident species to disturbance (Klein 1989), and in the case of the eastern coastal migrant shorebirds, the percentage of observed shorebirds that were flushed and did not return increased by 53 percent from 1982 to 2002, suggesting that the birds were not adapting to the presence of people by habituation and were being affected in the long term (Burger et al. 2004).

Nest predation for songbirds (Miller et al. 1998), raptors (Glinski 1976), colonial nesting species (Buckley and Buckley 1976), and waterfowl (Boyle and Samson 1985) tends to increase in areas

more frequently visited by people where disturbance flushes birds away from their nests and creates vulnerabilities during nesting seasons. Frequency is a major factor, and songbirds have been found to alter behavior after repeated human disturbance, particularly red-winged blackbirds, goldfinches, and American robins, which became much more aggressive toward humans who repeatedly visited their nests (Knight and Temple 1986a, 1986b, 1986c).

Set-back distances for public use facilities have been found to be important in limiting human disturbance to wildlife. In Florida, 15 species of colonial waterbirds nesting at 17 colonies were exposed to three different human disturbance mechanisms to determine recommended set-back distances for protecting mixed-species nesting assemblages (Rodgers and Smith 1995). In general, a recommended set-back distance of about 100 meters (m) for wading bird colonies and 180 m for mixed tern/skimmer colonies was found to be adequate to effectively buffer sites from human disturbance caused by approach of pedestrians and motor boats (Rodgers and Smith 1995). In Nebraska, roosting sandhill cranes avoided sites near human disturbance features at 500 m from nearest paved road, 400 m from nearest gravel road, and 400 m from a single dwelling structure (Norling et al. 1992). Klein (1989) studied the effect of visitation on migrant and resident waterbirds at Ding Darling National Wildlife Refuge, finding that resident birds were less sensitive to human disturbance than migrants. Migrant ducks were particularly sensitive when they first arrived on-site in the fall. They usually remained at a distance of more than 80 m [from a visitor footpath on a dike], even at very low visitor levels. Herons, egrets, brown pelicans, and anhingas were most likely to habituate to humans, thus exposing them to direct disturbance as they fed on or near the dike. Shorebirds showed intermediate sensitivity. Strauss (1990) observed piping plover chicks spent less time feeding (50% versus 91%) and more time running (33% versus 2%), fighting with other chicks (4% versus 0.1%), and standing alert (9% versus 0.1%) when pedestrians or moving vehicles were closer than 100 m than when they were undisturbed. In addition, plover chicks spent less time out on the feeding flats (8% versus 97%) and more time up in the grass (66% versus 0.1%) during periods of human disturbance.

Conversely, wildlife tends to habituate best to disturbance that is predictable, as indicated by sandhill cranes in Florida and in Nebraska that nested within 400 m of highways, railroads, mines, and power lines, which provided a predictable background disturbance (Dwyer and Tanner 1992; Norling et al. 1992). Taylor and Knight (2003) found that for mule deer, the area of influence around off-trail areas was much greater than for on-trail areas, suggesting habituation to trails. However, the time it takes for wildlife to habituate, and what wildlife use is like compared to pre-disturbance uses, remains a question.

Group size: Disturbance impact to wildlife in relation to visitor group size is not a well-documented research area; however, a few studies have analyzed these impacts. Most animals flee from humans, and large groups of people may represent greater perceived risk of predation (Geist et al. 2005). Remacha et al. (2011) analyzed visitor group size influences on the number and variety of birds observed during guided educational tours in a forested area in central Spain, with group sizes ranging from 7 to 20 people. The study showed that increasing visitor group sizes had an impact on wildlife, as large groups were associated with decreased bird numbers; additionally, the study found that birds may demonstrate reduced tolerance when faced with large groups of visitors, not only reducing their frequency of occurrence but also reducing the number of individuals. The study concluded that reducing the group size of visitors helps minimize the negative impacts on wildlife and also allows visitors to watch more wildlife (Remacha et al. 2011).

Another study by Beale and Monaghan (2004) on human disturbance effects to seabird colonies at St. Abbs Head National Nature Reserve in Scotland examined the variation in nesting success for two birds, kittiwakes and guillemots, as a function of different disturbance regimes, including varying the average number of people per hour and people load, which takes into consideration the number of visitors and their distance from the nest. Human disturbance was found to have a significant negative effect on nesting success in both species of birds. Increasing visitor numbers by 8.5 percent resulted in a 22 percent increase in the failure rate of kittiwakes and a 13 percent increase in the failure rate for guillemots. Beale and Monaghan concluded that perhaps the most likely explanation is that nesting birds perceive people to be a potential predator and show appropriate anti-predator physiological responses, which interferes with energy resources available for nesting. The results showed that safe distances, or buffer zones, depend on the numbers of people visiting an area and that both numbers and distance matter in determining disturbance effects.

In addition to group size, loudness has also been found as an important variable in whether birds altered their behavior. A study was conducted at the Arthur B. Marshall Loxahatchee National Wildlife Refuge in Florida between 1992 and 1994 to observe foraging behavior of birds at the refuge and understand how people affect foraging birds (Burger and Gochfeld 1991). Variation in feeding behavior was largely explained by whether people were present, the number of people present, and the amount of noise made by the people (Burger and Gochfeld 1991). For all species, time devoted to feeding and number of strikes or pecks decreased while people were present and as the noise made by people increased; interestingly, loudness was found to be more important than the number of people present (Burger and Gochfeld 1991). Noise level is not necessarily correlated with number of people present, but larger groups might be more prone to producing noise than small groups or individuals.

Literature suggests that organizing visitors in small numbers is recommended for groups, but also spreading out visits and locations of visits is recommended to mitigate disturbance across the landscape.

Pedestrian (hiking) versus vehicular access: It is widely accepted that wildlife are frequently more sensitive to disturbance from people on foot than in vehicles (Grubb and King 1991; MacArthur et al. 1982; Pease et al. 2005; Skagen 1980). Numerous studies have confirmed that people on foot can cause a variety of disturbance reactions in wildlife, including flushing or displacement (Erwin 1989; Fraser et al. 1985; Freddy 1986; Pease et al. 2005), heart rate increases (MacArthur et al. 1982), altered foraging patterns (Burger and Gochfeld 1991), and even, in some cases, diminished reproductive success (Boyle and Samson 1985).

A study on seven species of dabbling ducks at the Back Bay National Wildlife Refuge in Virginia found a significant difference between vehicular (diesel truck and electric passenger tram) and nonvehicular (pedestrian and bicyclist) treatments in the number of ducks that were flushed. In this study, 90 percent of the birds showed an observable response to nonvehicular treatments, of which 43 percent flew; the proportion of ducks that flew was greatest when they were located less than 100 m from the disturbance (Pease et al. 2005). In a review of several studies of the reaction of waterfowl and other wetland birds to people on foot, it was found that distances greater than 100 m in general did not result in a behavioral response (DeLong 2002). Mule deer in sagebrush-grassland habitat in Utah showed a 96 percent probability of flushing at 100 m from the line of movement of off-trail recreationists, with the probability not dropping to 70 percent until the perpendicular distance increased to 390 m (Taylor and Knight 2003).

These studies and others have shown that the severity of the effects depends upon the wildlife's distance from the disturbance and its duration, frequency, predictability, and visibility to wildlife (Knight and Cole 1995). In a logistic regression analyzing mule deer, pronghorn antelope, and bison response to mountain biking and hiking on- and off-trail, Taylor and Knight (2003) found that the variables best explaining wildlife response included wildlife species, perpendicular distance of animals to trail (closest distance of animal to trail, regardless of recreationist position), trail position (on-trail or off-trail), and degree of vegetation cover.

Wildlife photography: Wildlife photography in particular can be a more disturbing activity because photographers are more likely to leave vehicles and wander off-trail, approach wildlife, and remain close for an extended period of time to capture a detailed photograph, as observed at Ding Darling National Wildlife Refuge and other places (Dobb 1998; Klein 1993; Morton 1995). This may also apply to the experience of the user, as avid wildlife viewers tend to intentionally seek out rare or spectacular species and/or are more eager to see the most viewing opportunities in the limited amount of time (e.g., bird listing), and thus potentially pose a larger negative impact to wildlife (Knight and Cole 1995). People engaged in wildlife observation and photography react to the presence of birds and thus are generally more unpredictable on foot depending on excitement level, curiosity, and desire to observe closely.

Refuge-specific Impacts:

People engaging in wildlife observation, photography, or interpretation generally access the refuge by motorized vehicles traveling on public roads and parking lots. Additional wildlife photography blinds and associated access trails of less than a 0.25 mile each would be added under the preferred alternative. Minimal effect as a whole would occur as a result of new wildlife observation and photography facilities constructed under Preferred Alternative 2. Interpretive signs were not included as an impact as the assumption is that signs do not displace habitat.

Pedestrian access: Pedestrian use of the refuge creates the highest potential for disturbance or damage to natural resources. Foot travel associated with wildlife observation or photography could potentially result in temporary and minor vegetation trampling. Foot travel may also potentially create disturbance in or near any habitat. During the wintering season, pedestrian access is limited to the year-round trail. This limits pedestrian human disturbance during the season of highest waterbird activity at the vast majority of key wintertime wildlife congregation areas (primarily wetlands and upland fields) and allows wildlife to habituate to the few areas where humans and wildlife may both be regularly present. Outside the winter season, people may access the seasonal trail as well.

Some interpretive programs are large, organized special events that differ in character from the more informal day-to-day observation and interpretive activities. These types of programs create more disturbance and can overfill parking facilities to the point where parking lots fill and off-site parking and shuttle service is necessary to avoid safety issues and parking off roadways.

Both refuge visitation and the number of facilities and emphasis devoted to wildlife observation, photography, and interpretation are projected to increase under the Preferred Alternative 2. Given this, future disturbance effects are likely to be somewhat higher than present. Most studies cited above have demonstrated immediate, rather than long-term responses to disturbance. Long-term responses are inherently more difficult and expensive to determine. Given that wildlife observation, photography, and interpretation are not typically loud or intense kinds of activities, the area of habitat within a known distance of human activity centers (trails, kiosks, blinds, etc.) is considered a

reasonable indicator to evaluate the disturbance effects of public uses on refuge wildlife. As mentioned previously, in a review of several studies of the reaction of waterfowl and other wetland birds to people on foot, distances greater than 328 feet (100 m) generally did not result in a behavioral response (DeLong 2002).

Public education that informs photographers of ethical and least intrusive methods could reduce some impacts. Careful placement and camouflaging of additional photography blinds would likely reduce disturbance from wildlife photographers.

Although disturbance to wildlife from these activities would be higher than at present, the overall effect to refuge wildlife is expected to be minor. In addition, if disturbance to wildlife or damage to habitat reaches unacceptable levels, the refuge would limit access to areas where unacceptable impacts occur (see stipulations).

Impacts to Listed Species:

No direct impact to listed species is anticipated to occur as a result of the wildlife observation, photography, or interpretation programs. Any unanticipated future impacts would be reduced by ensuring that the public avoids or severely limits activity in areas hosting rare species.

Impacts to Other Priority Public Uses:

Wildlife observation, photography, and interpretation generally result in little disturbance to other visitors. However, some wildlife observers may inadvertently flush animals being observed or photographed by others. This conflict would be expected to be minimal

No significant effects to roads, trails, or other infrastructure from wildlife observation, photography, and interpretation programs are foreseen. Normal road, trail, and facility maintenance would continue to be necessary. Additional facility construction or upgrade, if needed, is addressed in the Availability of Resources section.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____ Use is Not Compatible

_X_Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- Motorized vehicles and bicycles would be limited to designated public roads and parking lots. Bicycles would not be allowed.
- Registration would be required for organized groups of 15 people or more.
- Electric wheelchairs shall be allowed on trails for persons with disabilities.

- During special events, tours must avoid sensitive sites occupied by rare species.
- Wintertime sanctuary closures would be maintained. The refuge would be open dawn to dusk daily. Evening guided activities are approved by the refuge manager on a case-by-case basis.
- Dogs are not allowed outside of vehicles. Registered service animals are an exception.
- Signs, pamphlets, and verbal instructions from refuge staff and volunteers would promote appropriate use of facilities to minimize wildlife and habitat disturbance.
- Periodic monitoring and evaluation of sites and programs would be conducted to assess if objectives are being met and ensure that the resource is not being unacceptably degraded. If disturbance to wildlife or damage to habitat reaches unacceptable levels, the refuge would avoid or limit activities in areas where unacceptable impacts occur.

Justification:

As wildlife-dependent recreational uses, wildlife observation, photography, and interpretation receive enhanced consideration in the CCP planning process. Given the location of wintertime sanctuary closed areas and the locations of wildlife viewing, photography, and interpretation facilities, these uses would be expected to have a minor direct impact on refuge resources. The associated disturbance to wildlife from these activities under Alternative 2, though larger than at present, is also expected to be minor. It is anticipated that wildlife populations would find sufficient food resources and resting places such that their abundance and use of the refuge would not be measurably lessened from allowing these activities to occur. The relatively limited number of individual animals and plants expected to be adversely affected would not cause populations to materially decline, the physiological condition and production of refuge species would not be impaired, their behavior and normal activity patterns would not be altered dramatically, and their overall welfare would not be negatively impacted. Thus, allowing wildlife photography, observation, interpretation to occur under the stipulations described above would not materially detract from or interfere with the purposes for which the refuge was established or the refuge mission. Wildlife observation, photography, and interpretation provide visitors with the joy of experiencing wildlife on their public lands, and as such, help fulfill the mission of the National Wildlife Refuge System (Refuge System).

Mandatory 10- or 15-year Re-evaluation Date (provide month and year for "allowed" uses):

__2027_Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

_____Mandatory 10-year re-evaluation date (for all uses other than wildlife-dependent public uses)

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Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

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B.3 Compatibility Determination for Waterfowl Hunting at Tualatin River National Wildlife Refuge

Use: Waterfowl hunting

Station Name: Tualatin River National Wildlife Refuge

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S.C. § 742a. *et seq*.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purpose(s):

" … for the development, advancement, management, conservation, and protection of fish and wildlife resources …" 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd et seq.]).

Description of Use:

The Service proposes to allow hunting of ducks, geese, coots, and snipe in accordance with state and Federal regulations and refuge-specific special conditions. A youth waterfowl hunt would be conducted on the Oleson parcel of the Riverboat Unit, and general waterfowl hunting would be conducted at Wapato Lake on the Wapato Lake Unit once restoration activities are completed and infrastructure for hunting is in place. It is estimated that up to 48 youth hunters per year would participate in youth hunts, and up to 1,920 hunters per year would participate in waterfowl hunting at the Wapato Lake Unit. Youth waterfowl hunting would occur on approximately 50 acres in the Riverboat Unit, or on about 2 percent of refuge lands. Waterfowl hunting at the Wapato Lake Unit would likely occur on no more than 800 acres, or about 37 percent of current refuge lands.

Hunting would take place during regular state seasons, which generally run from October to January, but dates are subject to change annually. Youth hunts would be conducted on selected Saturdays

only, on no more than two days per month. General waterfowl hunting at Wapato Lake would be conducted no more than three days per week. Youth hunting would be allowed using two to five blinds on the Riverboat Unit. A maximum of two youth and two supervising (but nonhunting) adults would be accommodated in each blind. Blind assignments would be conducted via lottery prior to each hunt date. At the Wapato Lake Unit, it is anticipated that there would be up to 20 hunting blinds. Blinds would be assigned via lottery or on a first-come first-served basis. Although dogs are generally prohibited for all other uses on the refuge, they are a vital part of the waterfowl hunting tradition and can reduce the loss of waterfowl, thus reducing the overall impact to the resource. Because of their role in retrieving waterfowl, dogs used for waterfowl retrieval purposes are allowed on the refuge during hunting.

In accordance with the National Wildlife Refuge System Administration Act of 1966, as amended, hunting is a priority wildlife-dependent public use. Public land for waterfowl hunting is in limited supply, especially near large metropolitan areas (U.S. Department of the Interior [USDOI] et al. 2007) such as Portland. In general, there has been a static or declining trend in hunting participation relative to population growth in the United States (USFWS 2004) since 1985. The trend also indicates a declining number of young hunters. From 1991 to 2001, the number of Americans 16 years of age and older who hunted declined by 7 percent. However, in Oregon from 1991 to 2001, hunter participation increased by 2 percent (USFWS 2004). According to Raftovich et al. (2011) there were approximately 21,400 active waterfowl hunters in Oregon during 2010. Opportunities to hunt in the greater Portland area are increasingly scarce due to an ever-growing population, urbanization, and a relative lack of public lands open to these uses. Hunting (both for and against) was the subject of more letters and e-mails received during scoping for the CCP than any other topic. In particular, the community has expressed a very strong interest in sharing hunting traditions with youth. Opening the refuge to waterfowl hunting would provide the public an opportunity to hunt in proximity to the urban area, in uncrowded and relatively natural environments, and at a reasonable cost. The habitat and wildlife objectives for Wapato Lake Unit are very likely to support quality waterfowl hunts as the refuge would be restoring riparian habitat used by waterfowl. Refuge hunting opportunities would be offered consistent with relevant state hunting regulations, and with management plans for applicable species and the Pacific Flyway Council's (PFC's) plans for cackling Canada geese (PFC 1999) and dusky Canada geese (PFC 2008).

Hunters have helped buy land for the Refuge System for nearly 70 years through the purchase of Migratory Bird Hunting and Conservation Stamps—also known as Duck Stamps—and continue to support and advocate for refuges and conservation. Hunters also participate and share in wildlife photography, education, and interpretation while hunting. These activities would tend to promote and support the mission of the Refuge System.

Tualatin River National Wildlife Refuge was established under, or to fulfill the purpose of, the Migratory Bird Conservation Act (16 U.S.C. § 715a-715r), or through approval of the Migratory Bird Conservation Committee, as an "inviolate sanctuary for migratory birds, or for any other management purpose, for migratory birds." On units of the Refuge System or portions thereof established as an "inviolate sanctuary," the Service may only allow hunting of migratory gamebirds on no more than 40 percent of that refuge, or portion, at any one time unless the Service finds that taking of any such species in more than 40 percent of such an area would be beneficial to the species (National Wildlife Refuge System Administration Act and Migratory Bird Conservation Act).

Availability of Resources:

Administering the refuge hunt program requires substantial staff time, equipment, and funding. To provide a quality hunting experience, access trails, parking lots, signs, and other facilities must be maintained annually. The refuge does not have a law enforcement officer on staff and must rely on zone officers or partnering law enforcement agencies to ensure compliance with state and Federal regulations and refuge-specific special conditions. A portion of the funding to support this program could be provided by monies collected as part of a hunt lottery or by blind fees charged to participants. Funding associated with facilities maintenance (roads, parking areas, signs, etc.) is included in other refuge programs requiring the same support.

Increased volunteer assistance, stronger existing partnerships, and new partnerships would be sought to support these programs in an effective, safe, and compatible manner. Refuge staff would increase volunteer recruitment efforts. Volunteers, interns, and various user groups when provided appropriate training can assist the refuge with monitoring, education and interpretation programs, and maintenance projects. With additional assistance as described above, staffing and funding is expected to be sufficient to manage these uses.

Costs to Administer and Manage Hunting under the Preferred Alternative

Category and Itemization for Waterfowl Hunting Program	One-time Expenses	Annual Expenses
Develop youth hunting program opening package	$10,000	
Develop general hunting program opening package	$10,000	
Construct youth hunting blinds (Riverboat Unit)	$15,000	
Construct general hunting blinds (Wapato Lake Unit)	$50,000	
Develop signage and brochures	$5,000	$1,000
Administration and management		$20,000
Maintenance		$4,000
Law enforcement staff		$25,000
Total one-time expenses for youth hunt	**$25,000**	
Total one-time expenses for general hunt	**$65,000**	
Total annual expenses for waterfowl hunting program		**$50,000**

Anticipated Impacts of the Use:

Short-term Impacts:

Short-term impacts include disturbance to wetland habitat to install hunting blinds. Blinds would be installed during late summer when wetland water levels are low or dry, migratory waterfowl are not present, and locally nesting birds have hatched their young. Short-term impacts would also include disturbance of migratory waterfowl and other wildlife during hunting activities. Direct take of waterfowl would occur, and take of some non-target species might also occur. The presence of

hunters and dogs, sounds of gunfire, and the sight of hunters traveling to and from hunt areas can disturb wildlife species such as pied-billed grebe, great blue heron, bald eagle, and tundra swan, which forage in refuge wetlands. This disturbance, especially when repeated over a period of time, may result in some wildlife species altering their behavior or moving to other areas. Hunting would occur outside of the breeding season. No significant effects are expected for refuge fish populations.

Long-term Impacts:

Long-term impacts include loss of some vegetation surrounding hunting blinds and impacts to migratory waterfowl and other wildlife species from repeated disturbance. The hunting blind itself would have a "footprint" of vegetation disturbance and trampling of vegetation by hunters using the blind. Migratory waterfowl and other wildlife species would be disturbed during times when hunting is occurring, and to some extent some would avoid the hunt area during nonhunting days as well. Annual maintenance of hunting blinds would also cause disturbance to both habitat and wildlife in the vicinity of the blinds.

Although hunting directly impacts individuals, the amount of waterfowl harvest is not expected to change or to have a measurable effect on refuge, Willamette Valley, or Pacific Flyway populations, as waterfowl hunting activity is not extremely high in the highly urbanized Willamette Valley. Hunting may be either compensatory or additive to natural mortality (Anderson 1995). Compensatory mortality occurs when hunting substitutes for other forms of mortality (disease, competition, predation, severe weather, etc.). Additive mortality occurs when hunting compounds the total mortality. In some cases, hunting can be used as a management tool to control populations. In concert with Canada, Mexico, and multi-state flyway councils, the Service and state wildlife agencies regulate hunting so that harvest does not reduce populations to unsustainable levels.

Direct effects of hunting on waterfowl are mortality, wounding, and disturbance (DeLong 2002). Hunting can alter behavior (e.g., foraging time), population structure, and distribution patterns of wildlife (Bartelt 1987; Cole and Knight 1990; Madsen 1985; Owens 1977; Raveling 1979; Thomas 1983; White-Robinson 1982). In Denmark, hunting was documented to affect the diversity and number of birds using a site (Madsen 1995). Avian diversity changed from predominantly mute swan and mallard to a more even distribution of a greater number of species when a sanctuary was established. Hence, species diversity increased with the elimination of hunting. There also appears to be an inverse relationship between the numbers of birds using an area and hunting intensity (DeLong 2002). In Connecticut, lesser scaup were observed to forage less in areas that were heavily hunted (Cronan 1957). In California, the numbers of northern pintails on Sacramento Refuge's non-hunt areas increased after the first week of hunting and remained high until the season was over in early January (Heitmeyer and Raveling 1988). Following the close of hunting season, ducks generally increased their use of the hunt area; however, use was lower than before the hunting season began.

Human disturbance to wintering birds and other wildlife using the open waters of the refuge would occur as a result of hunting activity. Migratory and wintering waterfowl generally attempt to minimize time spent in flight and maximize foraging time because flight requires considerably more energy than any other activity other than egg laying. Human disturbance associated with hunting includes loud noises and rapid movements, such as those produced by shotguns and boats powered by outboard motors. This disturbance, especially when repeated over a period of time, compels waterfowl to change food habits, feed only at night, lose weight, or desert feeding areas (Madsen 1995; Wolder 1993). Disturbance levels from hunting activity outside Chincoteague Refuge were found to be high enough to force wintering black ducks into a pattern of nocturnal feeding within

surrounding salt marsh and diurnal resting within refuge impoundments (Morton et al. 1989a, 1989b). Unhunted populations have been documented to behave differently from hunted ones (Wood 1993).

The impacts noted above can be reduced by the presence of adjacent sanctuary areas where hunting does not occur, and birds can feed and rest relatively undisturbed. Sanctuaries or non-hunt areas have been identified as the most common solution to disturbance problems caused from hunting (Havera et al. 1992). Prolonged and extensive disturbances may cause large numbers of waterfowl to leave disturbed areas and migrate elsewhere (Madsen 1995; Paulus 1984). In Denmark, hunting disturbance effects were experimentally tested by establishing two sanctuaries (Madsen 1995). Over a five-year period, these sanctuaries became two of the most important staging areas for coastal waterfowl. Numbers of dabbling ducks and geese increased fourfold to 20-fold within the sanctuary (Madsen 1995). On the refuge, all units except the Atfálat'i and Riverboat Units would be closed to public entry, and with numerous wetlands and sloughs available, these units act as a sanctuary during the waterfowl season.

Cumulative Impacts:

The hunting of waterfowl in the United States is based upon a thorough regulatory setting process that involves numerous sources of waterfowl population and harvest monitoring data. Waterfowl populations throughout North America are managed through an administrative process known as flyways, of which there are four (Pacific, Central, Mississippi, and Atlantic). Oregon is included in the Pacific Flyway.

National Environmental Policy Act (NEPA) considerations incorporated by the Service for hunted migratory gamebird species are addressed by the programmatic document *Final Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Sport Hunting of Migratory Birds*, which was filed with the U.S. Environmental Protection Agency (EPA) on June 9, 1988. The Service published the record of decision for this document on August 18, 1988 (53 Federal Register [FR] 31341). This document is in the process of being updated; in August 2009, the *Draft Supplemental Environmental Impact Statement: Issuance of Annual Regulations Permitting the Hunting of Migratory Birds* was released (USDOI 2009). Annual NEPA considerations for waterfowl hunting frameworks are covered under a separate environmental assessment and finding of no significant impact.

The Migratory Bird Treaty Act stipulates that all hunting seasons for migratory gamebirds be closed unless specifically opened by the Secretary of the Interior. The Service annually promulgates regulations establishing the Migratory Bird Hunting Frameworks. The frameworks are essentially permissive in that hunting of migratory birds would not be permitted without them. Thus, in effect, Federal annual regulations both allow and limit the hunting of migratory birds.

The Migratory Bird Hunting Frameworks provide season dates, bag limits, and other options for the states to select that should result in the level of harvest determined to be appropriate based upon Service-prepared annual biological assessments detailing the status of migratory game bird populations. In North America, the process for establishing waterfowl hunting regulations is conducted annually. In the United States, the process involves a number of scheduled meetings (Flyway Study Committees, Flyway Councils, Service Regulations Committee, etc.) in which information regarding the status of waterfowl populations and their habitats is presented to individuals within the agencies responsible for setting hunting regulations. In addition, public

hearings are held, and the proposed regulations are published in the Federal Register to allow public comment.

For waterfowl, annual assessments used in establishing the frameworks include the Breeding Population and Habitat Survey, which is conducted throughout portions of the United States and Canada. This survey is used to establish a Waterfowl Population Status Report annually. In addition, the number of waterfowl hunters and resulting harvest are closely monitored through both the Harvest Information Program and the Parts Collection Survey. Since 1995, such information has been used to support the adaptive harvest management (AHM) process for setting duck-hunting regulations. Under AHM, a number of decision-making protocols determine the choice (package) of predetermined regulations (appropriate levels of harvest) that constitute the framework offered to the states that year. Each state's wildlife commission then selects season dates, bag limits, shooting hours, and other options from the Pacific Flyway package. Their selections can be more restrictive but not more liberal than AHM allows. Thus, the level of hunting opportunity afforded each state depends on the annual status of waterfowl populations.

Season dates and bag limits for national wildlife refuges open to hunting are never longer or larger than state regulations. In fact, season dates and bag limits may be more restrictive than the state allows. Each national wildlife refuge considers the cumulative impacts to hunted migratory species through the Migratory Bird Hunting Frameworks published annually in the Service's regulations on migratory bird hunting.

According to Raftovich et al. (2011) total waterfowl harvest in Oregon during 2009-2010 was estimated at 464,500 out of a total Pacific Flyway harvest of 3,458,700, or approximately 13 percent of the flyway total. It is estimated that refuge youth hunters would harvest approximately 144 waterfowl and general hunters would harvest 5,760. The total estimated annual harvest of both programs would be about 1 percent and 0.002 percent of the Oregon and Pacific Flyway harvests, respectively.

The cumulative effects of disturbance to nonhunted birds and other species under the proposed action are expected to be minor. Hunting seasons would not coincide with the nesting season; thus, reproduction would not be reduced by hunting. Disturbance to foraging or resting migrating or resident birds might occur, but would be minor because of the small amount of area allowed for these hunts relative to the size of the refuge and the limited time parameters for hunting. Disturbance to other taxa would be unlikely or negligible. Encounters with reptiles and amphibians in the early fall would be few and should not have cumulative negative effects on reptile and amphibian populations. Refuge regulations further mitigate possible disturbance by hunters to nonhunted wildlife. Vehicles would be restricted to roads, and the harassment or taking of any wildlife other than the game species legal for the season would not be permitted.

Hunting has the potential to disturb refuge visitors engaged in other priority public uses, and mitigation measures to avoid user conflict would be undertaken. For example, the youth waterfowl hunt would be conducted on the Riverboat Unit, a location that is not open to other public uses. The Wapato Lake Unit general waterfowl hunt would be conducted in the Wapato Lake lake bed, and future other priority public uses would be managed with waterfowl hunting to minimize user conflicts.

Waterfowl hunting opportunity helps to better provide a priority public "big six" use, and this use is currently not provided at the refuge. Providing opportunities for youth is an important initiative in the Service and helps address a public desire to see more hunting opportunities for youth.

There could be some indirect beneficial impacts from implementing a hunting program on the refuge. Refuge hunting can contribute to wildlife and habitat conservation and provide educational and sociological benefits. The hunting community in general remains the largest support base for funding land acquisitions in the Refuge System through the purchase of Duck Stamps. Refuges provide an opportunity for a high-quality waterfowl hunting experience to all citizens regardless of economic standing. Many individual refuges have developed extensive public information and education programs bringing hunters into contact with refuge activities and facilitating awareness of wildlife issues beyond hunting.

Summary of Effects:

The Service believes that hunting on the Tualatin River National Wildlife Refuge, as proposed under Alternative 2, would not have a significant impact on local, regional, or Pacific Flyway waterfowl populations because the percentage likely to be taken on the refuge, though possibly additive to existing hunting take, would be a tiny fraction of the estimated populations. In addition, overall populations would continue to be monitored and future harvests would be adjusted as needed under the existing flyway and state regulatory processes.

This hunt would not add to cumulative impacts to waterfowl stemming from hunting on national wildlife refuges. Several points support this conclusion: 1) the proportion of the national waterfowl harvest that occurs on national wildlife refuges is only 6 percent (USDOI 2009); 2) there are no waterfowl populations that exist wholly and exclusively on national wildlife refuges; 3) annual hunting regulations within the United States are established at levels consistent with the current population status; 4) refuges cannot permit more liberal seasons than provided for in Federal frameworks; and 5) refuges purchased with funds derived from Federal Duck Stamps must limit hunting to 40 percent of the available area.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____ Use is Not Compatible

_X_Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- Hunting would be conducted in accordance with all Federal, state, and refuge-specific regulations.
- Only ducks, geese, and coots may be taken in accordance with state regulations.
- Hunting would only be allowed from established blinds or blind sites.

- The hunting program would be conducted as outlined in Chapter 2 of the CCP/EA and follow a step-down hunting management plan.
- Hunting program leaflets and 50 Code of Federal Regulations [CFR] 32 would be updated as necessary.
- Law enforcement patrols would be conducted on a regular basis to ensure compliance with state, Federal, and refuge regulations.
- The refuge would ensure safety and minimize conflict with other priority public uses by providing information about hunting boundaries and seasons to the general public and those engaging in other refuge programs. Information would be provided at interpretive kiosks, on the refuge website, and in refuge offices.
- Camping, overnight use, and fires would be prohibited.

Justification:

Under the National Wildlife Refuge System Administration Act of 1966, as amended, hunting is a wildlife-dependent recreational activity, which receives enhanced consideration in the CCP planning process and is to be encouraged on national wildlife refuges if compatible with refuge purposes. This refuge hunting program is designed to provide a high-quality, safe experience, with a reasonable opportunity to harvest waterfowl. Despite the direct and indirect impacts associated with waterfowl hunting, waterfowl populations are unlikely to be affected significantly by the hunting program. Waterfowl population objectives and allowable harvests are determined on a flyway basis using an established annual regulatory process as described above. Limited hunt seasons and days, no-hunt zones, and established winter sanctuary on the majority of the acreage of the Tualatin River National Wildlife Refuge ensure that wintering and migrating waterfowl, as well as non-target species, find adequate food and rest areas on the refuge even during the hunting season.

In addition, by respecting seasons and limits, purchasing all required licenses, and paying Federal excise taxes on hunting equipment and ammunition, individual hunters make a big contribution toward ensuring the future of many species of wildlife and habitat for the future. By paying the Federal excise tax on hunting equipment, hunters are contributing hundreds of millions of dollars for conservation programs that benefit many wildlife species, both hunted and nonhunted. Each year, nearly $200 million in hunters' Federal excise taxes are distributed to state agencies to support wildlife management programs, the purchase of lands open to hunters, and hunter education and safety classes. Since 1934, the Service has spent more than $1 billion Migratory Bird Conservation Fund dollars from sales of Federal Duck Stamps (USFWS 2011f). Proceeds from the Federal Duck Stamp, a required purchase for migratory waterfowl hunters, have purchased more than five million acres of important waterfowl habitat, including land in the Wapato Lake Unit—these lands support waterfowl and many other wildlife species, and are usually open to hunting (USFWS 2011g). Thus, allowing waterfowl hunting under the stipulations described above would not materially detract from or interfere with the purposes for which the refuge was established or the refuge mission.

Mandatory 10- or 15-Year Re-evaluation Date (provide month and year for "allowed" uses only):

__2027_Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

_____Mandatory 10-year re-evaluation date (for all uses other than wildlife-dependent public uses)

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Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

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B.4 Compatibility Determination for Research, Scientific Collecting, and Surveys at Tualatin River National Wildlife Refuge

Uses: Research, scientific collecting, and surveys

Research: Planned, organized, and systematic investigation of a scientific nature

Scientific collecting: Gathering of refuge natural resources or cultural artifacts for scientific purposes

Surveys: Scientific inventory or monitoring

Station Name: Tualatin River National Wildlife Refuge

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S.C. § 742a. et seq.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purposes:

" … for the development, advancement, management, conservation, and protection of fish and wildlife resources …" 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd et seq.]).

Description of Uses:

Refuge staff receives periodic requests from non-Service entities (e.g., universities, state agencies, other Federal agencies, non-governmental organizations) to conduct research, scientific collecting, and surveys on refuge lands. These project requests can involve a wide range of natural and cultural resources as well as public use management issues including basic absence/presence surveys, collection of new species for identification, habitat use and life history requirements for specific species/species groups, practical methods for habitat restoration, extent and severity of environmental

contaminants, techniques to control or eradicate pest species, effects of climate change on environmental conditions and associated habitat/wildlife response, identification and analyses of paleontological specimens, wilderness character, modeling of wildlife populations, bioprospecting, and assessing response of habitat/wildlife to disturbance from public uses. Projects may be species-specific or refuge-specific, or evaluate the relative contribution of the refuge lands to larger landscapes (e.g., ecoregion, region, flyway, national, international) and issues and trends.

The Service's Research and Management Studies and Appropriate Refuge Uses policies indicate priority for scientific investigatory studies that contribute to the enhancement, protection, use, preservation, and management of native wildlife populations and their habitats as well as their natural diversity. Projects that contribute to refuge-specific needs for resource and/or wilderness management goals and objectives, where applicable, would be given a higher priority over other requests.

Research, scientific collecting, and surveys may be conducted on any and all refuge-managed lands during any part of the year as appropriate. Research, scientific collecting, and surveys may be conducted in cooperation with other Federal, state, or local agencies; colleges and universities; nonprofit organizations; consultants; or individuals. These studies are conducted to better inform refuge management decisions and increase general knowledge about the flora, fauna, and abiotic factors affecting refuge habitats.

Availability of Resources:

Refuge staff responsibilities for projects by non-Service entities would primarily be limited to the following: review of proposals, preparation of SUPs and other compliance documents (e.g., Section 7 of the Endangered Species Act of 1973, Section 106 of the National Historic Preservation Act), and monitoring of project implementation to ensure that impacts and conflicts remain within acceptable levels (compatible) over time. Additional administrative, logistical, and operational support may also be provided depending on each specific request. Estimated costs for one-time (e.g., SUP preparation) and annually recurring tasks by refuge staff and other Service employees would be determined for each project. Sufficient funding in the general operating budget of the refuge must be available to cover expenses for these projects. The terms and conditions for funding and staff support necessary to administer each project on the refuge would be clearly stated in the SUP(s).

The refuge has the following staffing and funding to administratively support and monitor research that is currently taking place on refuge lands (see table below). Any substantial increase in the number of projects would create a need for additional resources to oversee the administration and monitoring of the investigators and their projects. Any substantial additional costs above those listed below may result in finding a project not compatible unless expenses are offset by the investigator(s), sponsoring agency, or organization.

Current Refuge Staffing and Funding to Support and Monitor Research

Category and Itemization	One-time Expenses	Annual Expenses
Administration and management		$10,000

Anticipated Impacts of the Uses:

Use of the refuge to conduct research, scientific collecting, and surveys would generally provide information that would benefit fish, wildlife, plants, and their habitats. Scientific findings gained through these projects provide important information regarding life history needs of species and species groups, and identify or refine management actions to achieve resource management objectives in refuge management plans (especially CCPs). Reducing uncertainty regarding wildlife and habitat responses to refuge management actions to achieve desired outcomes reflected in resource management objectives is essential for adaptive management in accordance with 522 DM 1.

If project methods impact or conflict with refuge-specific resources, priority wildlife-dependent public uses, other high-priority research, and refuge habitat and wildlife management programs, then for the project to be compatible it must be clearly demonstrated that the project's scientific findings would contribute to resource management and that the project cannot be conducted off refuge lands. The investigator(s) must identify methods/strategies necessary to minimize or eliminate potential impact(s) and conflict(s) in advance. If unacceptable impacts cannot be avoided, then the project would not be determined compatible. Projects that represent public or private economic use of natural resources of any national wildlife refuge (e.g., bioprospecting) must contribute to the achievement of the national wildlife refuge purposes or the Refuge System mission to be compatible.

Impacts would be project- and site-specific, where they would vary depending upon the nature and scope of fieldwork. Data collection techniques would generally have minimal animal mortality or disturbance, minimal habitat destruction, no introduction of contaminants, and no introduction of nonindigenous species. Projects involving the collection of biotic samples (plants or animals) or requiring intensive ground-based data or sample collection would have short-term impacts. To reduce impacts, the minimum number of samples (e.g., water, soils, vegetative litter, plants, macroinvertebrates, vertebrates) would be collected for identification and/or experimentation and statistical analysis. Where possible, researchers would coordinate and share collections to reduce sampling needed for multiple projects. For example, if one investigator collects fish for a diet study and another researcher examines otoliths, then it may be possible to accomplish sampling for both projects with one collection effort.

Investigator(s) obtaining required state and Federal collecting permits would also ensure minimal impacts to fish, wildlife, plants, and their habitats. If projects result in long-term or cumulative effects to federally listed species and/or critical habitat, the Section 7 consultation under the Endangered Species Act would be required . Only projects that have no effect or that have "not likely to adversely affect" determinations would be considered compatible.

There is the potential for the spread of invasive plants and/or pathogens from ground disturbance and/or transportation of project equipment and personnel, but it would be minimized or eliminated by requiring proper cleaning of investigator equipment and clothing as well as quarantine methods, where necessary. If after all practical measures are taken, unacceptable spread of invasive species is still expected to occur, the project would be found not compatible without a restoration or mitigation plan.

There also could be localized and temporary effects from vegetation trampling, collecting of soil and plant samples, or trapping and handling of wildlife. Impacts may also occur from infrastructure necessary to support a project (e.g., permanent transects or plot markers, exclosure devices, monitoring equipment, solar panels to power unattended monitoring equipment). Some level of

disturbance is expected with these projects, especially if investigators enter areas closed to the public and collect samples or handle wildlife. However, wildlife disturbance (including altered behavior) would usually be localized and temporary in nature. Where long-term or unacceptable cumulative effects cannot be avoided, the project would not be found compatible.

At least 3 months before initiation of fieldwork (unless an exception is made by prior approval of the refuge manager), project investigator(s) must submit a detailed proposal. Project proposals would be reviewed by refuge staff and others, as needed, to assess the potential impacts (short, long-term, and cumulative) relative to the benefits of the investigation to refuge management issues and understanding of natural systems. This assessment would form the primary basis for allowing or denying a specific project. Projects that result in unacceptable refuge impacts would not be found compatible. If allowed and found compatible after approval, all projects would also be assessed during implementation to ensure impacts and conflicts remain within acceptable levels.

If a proposal is approved, the refuge manager would issue an SUP(s) with required stipulations (terms and conditions) of the project to avoid and/or minimize potential impacts to refuge resources as well as conflicts with other public use activities and refuge field management operations. After approval, projects would also be monitored during implementation to ensure impacts and conflicts remain within acceptable levels based upon documented stipulations.

The combination of stipulations identified above and conditions included in any SUP(s) would ensure that proposed projects contribute to the enhancement, protection, conservation, and management of native fish and wildlife populations and their habitats on the refuge. As a result, these projects would help fulfill refuge purpose(s); contribute to the mission of the Refuge System; and maintain the biological integrity, diversity, and environmental health of the refuge.

Projects that are not covered by the CCP (objectives under Goal 8 [Collect scientific information—surveys, scientific assessments, and research]) would require additional NEPA documentation.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____Use is Not Compatible

__X__Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

Each project would require an SUP. Annual or other short-term SUPs are preferred; however, some permits would be for a longer period, if needed, to allow completion of the project. Renewals would be subject to refuge manager review and approval based on timely submission of and content in progress reports, compliance with SUP stipulations, and required permits.

- Projects would adhere to scientifically defensible protocols for data collection, where available and applicable.
- Investigators must possess appropriate permits and comply with conditions of state or Federal permits for their projects.
- If unacceptable impacts to natural resources or conflicts arise or are documented by refuge staff, then the refuge manager can suspend, modify conditions of, or terminate an ongoing project already permitted by SUP(s) on the refuge.
- Progress reports are required at least annually for multiple-year projects. The minimum required elements for a progress report would be provided to investigator(s).
- Final reports are due after completion of the project unless negotiated otherwise with the refuge manager.
- Continuation of existing projects would require approval by the refuge manager.
- Refuge staff would be given the opportunity to review draft manuscript(s) from the project before manuscripts are submitted to a scientific journal(s) for consideration of publication.
- Refuge staff would be provided with copies (reprints) of all publications resulting from a refuge project.
- Refuge staff would be provided with copies of raw data (preferably electronic database format) at the conclusion of the project.
- Upon completion of the project or annually, all equipment and markers (unless required for long-term projects) must be removed and sites must restored to the refuge manager's satisfaction. Conditions for clean-up and removal of equipment and physical markers would be stipulated in the SUP(s).
- All samples collected on refuge lands are the property of the Service even while in the possession of the investigator(s). Any future work with previously collected samples not clearly identified in the project proposal would require submission of a subsequent proposal for review and approval. In addition, a new SUP would be required for additional project work. For samples or specimens to be stored at other facilities (e.g., museums), a memorandum of understand would be necessary.
- Sampling equipment as well as investigator(s) clothing and vehicles (e.g., all-terrain vehicles [ATVs], boats) would be thoroughly cleaned (free of dirt and plant material) before being allowed on refuge lands to prevent the introduction and/or spread of pests.
- The Refuge System, specific refuge, names of refuge staff, and other Service personnel that supported or contributed to the project would be appropriately cited and acknowledged in all written and oral presentations resulting from projects on refuge lands.
- Refuge staff may accompany investigator(s) in the field at any time.
- Investigator(s) and support staff would follow all refuge-specific regulations that specify access and travel on the refuge.
- There may be other permits or paperwork required in addition to the SUP.

Justification:

Research, scientific collecting, and surveys on refuge lands are inherently valuable to the Service because they expand scientific information available for resource management decisions. In addition, only projects that directly or indirectly contribute to the enhancement, protection, use, preservation, and management of refuge fish and wildlife populations and their habitats would generally be authorized on refuge lands. By allowing the use to occur under the stipulations described above, it is anticipated that fish and wildlife species would experience minimal disturbance. Additionally, it is anticipated that monitoring, as needed, would prevent unacceptable or irreversible impacts to fish,

wildlife, plants, and their habitats. Allowing the use as described above would not materially detract from or interfere with the purposes for which the refuge was established or the mission of the Refuge System.

Mandatory 10- or 15-Year Re-evaluation Date (provide month and year for "allowed" uses only):

_____ Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

__2022__ Mandatory 10-year re-evaluation date (for all uses other than wildlife-dependent public uses)

Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

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B.5 Compatibility Determination for Mosquito and Disease Vector Management on Tualatin River National Wildlife Refuge

Use: Mosquito and disease vector management

Station Name: Tualatin River National Wildlife Refuge

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S.C. § 742a. et seq.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purpose(s):

" … for the development, advancement, management, conservation, and protection of fish and wildlife resources …" 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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" (National Wildlife Refuge System Administration Act of 1996, as amended [16 U.S.C. 668dd et seq.]).

Description of Use:

With the spread of mosquito-borne diseases across the country, national wildlife refuges have come under increasing pressure to manage mosquito populations that are bred or harbored within refuge boundaries. The Service has produced interim guidance for refuges (USFWS 2005b) to be used until the Service policy document is finalized. Tualatin River National Wildlife Refuge would adhere to the interim guidance, and our mosquito management program would follow the response matrix presented in the following table. The refuge currently has sufficient staff and funding to support this use.

Example of Mosquito-borne Disease Health Threat and Response Matrix

Current Conditions		Threat Level	Refuge Response
Health Threat Category[1]	**Refuge Mosquito Populations[2]**		
No documented existing or historical health threat/emergency	No action threshold	1	Remove/manage artificial mosquito breeding sites such as tires, tanks, or similar debris/containers. Allow compatible monitoring.
Documented human health threat/emergency	Below action threshold	2	Response as in threat level 1, plus: evaluate compatible nonpesticide management options such as water level management and vegetation removal to reduce mosquito production.
	Above action threshold	3	Response as in threat level 2, plus: allow compatible site-specific larviciding of infested areas as determined by monitoring.
Officially determined existing human health emergency	Below action threshold	4	Response as in threat level 2, plus: increase monitoring and disease surveillance.
	Above action threshold	5	Response as in threat levels 3 and 4, plus: allow compatible site-specific larviciding, pupaciding, or adulticiding of infested areas as determined by monitoring data. Identify ways to minimize treatment area to avoid non-target effects

[1] Health threat/emergency as determined by Federal and/or state/local public health or wildlife management authorities with jurisdiction inclusive of refuge boundaries and/or neighboring public health authorities.
[2] Action thresholds represent mosquito population levels that may require intervention measures. Thresholds would be developed in collaboration with Federal and/or state/local public health or wildlife management authorities and vector control districts. They must be species- and life stage-specific.

Annual precipitation and water management fill many wetlands on the refuge. This water and vegetation provides egg-laying sites for mosquitoes. When high water levels recede, the eggs hatch, larvae grow rapidly, and adults feed for two weeks or more until they breed, lay eggs, and then die. Under certain conditions the refuge may provide suitable habitat for multiple hatches of mosquitoes in a single summer.

Arboviral (arthropod-borne viral) diseases are a potential concern. These include West Nile virus, western equine encephalitis, and St. Louis encephalitis. Between 1964 and 2010 there has only been

one reported case of human infection by western equine encephalitis in Oregon (Centers for Disease Control [CDC] 2012a). St. Louis encephalitis in a human was documented in Oregon in 2003, the first case in more than 30 years (Oregon Department of Human Services 2012).

Although West Nile virus was first documented in the eastern states, it has been moving west since that time. West Nile virus first appeared in Oregon in 2004. The first human, avian, and equine West Nile virus cases in Oregon were all diagnosed in August 2004. In 2010, no humans were diagnosed with West Nile virus infection (Oregon Health Authority Office of Disease Prevention and Epidemiology 2011). Moreover, less than 1 percent of humans who are exposed to and infected with West Nile virus become seriously ill. The fatality rate of those who do develop serious illness is 3 to 15 percent. Most human infections of West Nile virus are asymptomatic or characterized by mild flu-like symptoms. The elderly (persons over 50 years of age) are more likely to develop severe illness (CDC 2012b).

The refuge, in cooperation with Washington County Health and Human Services (HHS) and Yamhill County Public Health (YCPH), proposes to monitor and control larval mosquito species that have been determined to have a negative effect on public health adjacent to the refuge. Monitoring generally takes place between early April and late September.

The HHS/YCPH staff proposes to monitor and control mosquito larvae with *Bacillus thuringiensis* var. *israelensis*, which is frequently referred to as *B.t.i.* (EPA Registration No. 73049-10), when established thresholds are exceeded and human health risks exist as indicated through monitoring. Monitoring and larval treatments would be restricted to shallowly flooded (<8 inches) vegetation that represents mosquito breeding habitat. From 2005 through 2008, refuge staff conducted monitoring for mosquito larvae on the Atfálat'i, Tualatin River, and Riverboat Units of the refuge (Figure D-1), and the results were given to Washington County's vector control.

To protect sensitive resources such as eagle nesting and roosting areas and listed plant species, and to reduce the spread of invasive plant species, sampling periods and frequency as well as type of access (four-wheel-drive vehicle, ATV, foot traffic only) would be determined by the refuge in late winter/early spring. Because the locations of sensitive resources may change over time, the refuge would establish sampling and treatment stipulations on an annual basis through the SUP process.

The HHS/YCPH may also monitor adult mosquito populations from May to September using dry ice traps, or other approved methods, as part of the county-wide surveillance for the presence of mosquito-borne human health diseases.

The protocol for mosquito control when monitoring wetlands for mosquito larvae is to treat with the larvicide *B.t.i.* when the larvae reach established threshold levels and a human health threat has been documented. The treatment threshold used by the HHS/YCPH would be determined and specified in the annual SUP.

Mosquito larvae numbers within the refuge are affected by a number of factors such as weather conditions, precipitation, and time of year. The primary factor contributing to the production of mosquitoes, however, is the water level fluctuation along shorelines, where mosquitoes lay their eggs. Water level fluctuations are primarily due to precipitation and refuge water management activities. Due to the uncertainty of water levels resulting from the above factors, and subsequent mosquito hatches, the total amount of larvicide to be used and the times, dates, and exact locations of

application (magnitude and frequency) cannot be predicted. In some cases, certain areas may need repeated treatments.

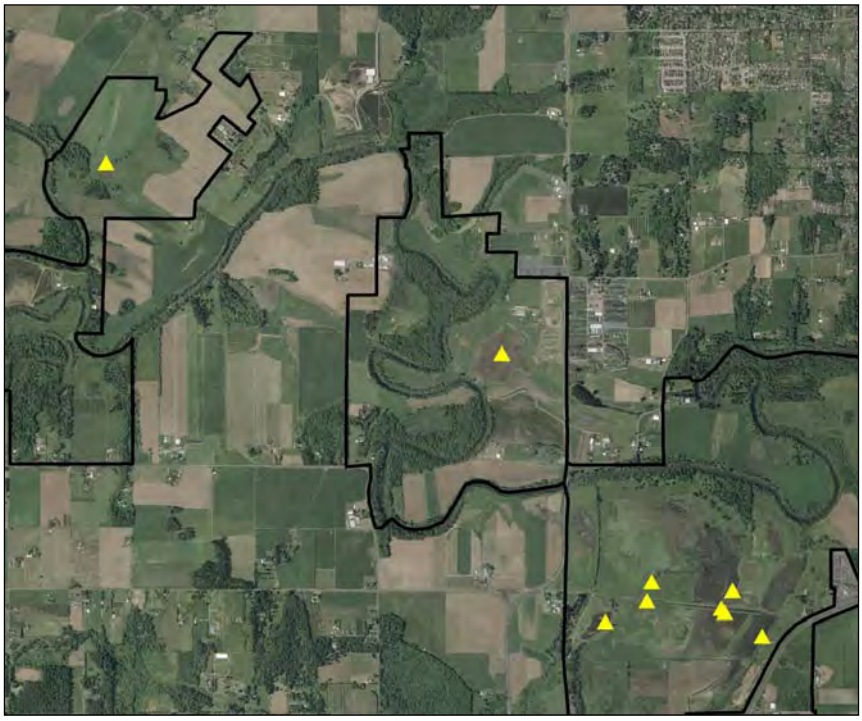

Figure D-1. Mosquito monitoring locations.

The refuge and the HHS/YCPH would establish larval abundance thresholds associated with human health threats through the SUP process to protect public health and reduce impacts to fish and wildlife populations. If mosquito larvae dip numbers reach threshold levels and a human health risk is present, HHS/YCPH staff would request approval from the refuge manager to apply *B.t.i*, at a rate of 2.5 to 5 lbs/acre; this would be done as soon as possible after a threat to human health is documented.

As proposed, *B.t.i* may be applied (2.5 to 5 lbs/acre) as often as once every two to three weeks until a human health threat is removed. The bacteria are grown on high-protein bases (fishmeal, soy flour), which are then formulated onto corncob pellets, enabling them to be broadcast over the treatment area by a handheld or ATV-mounted spreader. *B.t.i.* is a selective microbial insecticide targeting mosquito larvae; however, studies during the mid-1990s in the Midwest (Hershey et al. 1995) found that other Dipteran species (flies) can also be impacted, including chironomids, an important fish and wildlife food source. *B.t.i.* has practically no acute or chronic toxicity to mammals, fish, birds, or vegetation (EPA 1998a). It produces protein endo-toxins that, when ingested by the susceptible insect, cause paralysis of cells in the gut, interfering with normal digestion and feeding.

All applications are required to be reported to the refuge and included in an annual report submitted to the refuge by the HHS/YCPH. The extent and frequency of treatments is likely to vary annually in response to water levels, weather conditions, and larvae distribution.

In accordance with the 2005 Interim Mosquito Management Policy and the response matrix (see table titled *Example of Mosquito-borne Disease Health Threat and Response Matrix*), the Service

may also permit the use of approved adulticides and/or pupacides on refuge lands in response to a declaration of a human health threat or emergency by a Federal, state, or local public health agency. A health emergency indicates an imminent risk of serious human disease or death and represents the highest level of mosquito-associated health threats. Health emergencies would be determined by Federal, state, or local public health authorities and documented with local and current mosquito population and disease monitoring data. With the exception of vaccines to protect horses against West Nile virus and western equine encephalomyelitis, there are no vaccines that provide specific protection against these diseases. Mosquito control is the only practicable method currently available to protect the public from these diseases.

To date, refuge staff has not needed to permit the application of larvicides, pupacides, or adulticides due to public health concerns.

The refuge would continue to evaluate measures to control mosquitoes that pose a threat to human health while limiting the risk associated with the use of chemical control. Water level manipulation is possible in many refuge wetland basins where mosquito larvae have been found. In the event that a human health emergency is declared and the use of pesticides is authorized, the refuge would work with the HHS/YCPH to identify which portions of the refuge are supporting species of mosquitoes that may serve as disease vectors and reduce the treatment area to the extent practicable.

Availability of Resources:

The HHS/YCPH is responsible for staffing and expenditures for sampling and pesticide applications (mainly *B.t.i.*). Refuge staff resources are needed to review annual proposals, prepare SUPs, and monitor HHS/YCPH personnel to ensure compliance (see table below).

Costs to Administer and Manage Vector Control Programs at the Refuge.

Activity or Project	One-time Expenses ($)	Recurring Expenses ($/year)
Development and issuance of SUP		$500.00
Total		$500.00

Anticipated Impacts of Use:

This use has three principal, potential impacts on refuge lands, waters, or interests.

1. The disturbance of wildlife caused by monitoring efforts and application of pesticides.
2. The impacts on wildlife from periodic elimination of mosquito larvae from the wetland community.
3. The impacts of pesticides on non-target organisms.

Impacts Associated with Disturbance of Wildlife Caused by the Monitoring Efforts:

Disturbance of wildlife by HHS/YCPH staff is minimized to the extent practicable by restricting access to sensitive areas and by controlling the type of access (four-wheel-drive vehicle, ATV, or foot traffic). Impacts anticipated from the logistical activities resulting from proposed monitoring and

treatment actions on wildlife are minimal. One or two HHS/YCPH employees would conduct these activities, and they would be restricted to refuge service roads and a minimum of off-road areas. The speed limit for HHS/YCPH staff using vehicles on service roads is 15 miles per hour and ATVs are restricted to 5 miles per hour. Any necessary treatments would occur as soon as possible after monitoring activities. These activities cause short-term and temporary disturbance to wildlife. In the event of an identified public health threat or emergency by the Oregon Health Authority, the data from these monitoring efforts would be used by the refuge for determining an appropriate course of action.

Impacts Associated with Application of Pesticides:

Where necessary and in accordance with the response matrix (see table titled *Example of Mosquito-borne Disease Health Threat and Response Matrix*), pesticides (larvicides, pupacides, and adulticides) would only be used on refuge lands for mosquito control after approval of a Pesticide Use Proposal (PUP). The Service's Pest Control Policy (7 RM 14) requires preparation and approval of a PUP before pesticides can be applied on refuge lands. In general, proposed pesticide uses on refuge lands would only be approved where there would likely be minor, temporary, or localized effects to fish and wildlife as well as minimal potential to degrade environmental quality. Potential effects to listed and non-listed species would be evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality would be based upon pesticide characteristics of environmental fate (water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments as well as characteristics of environmental fate and potential to degrade environmental quality for pesticides would be documented in chemical profiles. These profiles would include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality. In general, only pesticide uses with appropriate best management practices on refuge lands that would potentially have minor, temporary, or localized effects on refuge biological and environmental quality (threshold values not exceeded) would be approved. However, pesticides may be used on refuge lands where substantial effects to species and the environment are possible (exceed threshold values) in order to protect human health and safety when a documented threat exists (e.g., mosquito-borne disease). The Service does not anticipate any short-term effects of the proposed use directly on non-target invertebrates or indirectly to fish.

The refuge has developed an integrated pest management (IPM) plan (see Appendix G) to manage mosquito populations. Based on adult mosquito control conducted in Washington County, pyrethroids such as Anvil are the most likely adulticides to be used to address a human health emergency. Pyrethroids are synthetic molecules that mimic natural pyrethrins that are extracted from plants in the chrysanthemum family. Pyrethroids are generally less toxic to terrestrial wildlife than other families of adulticides such as organophosphates. However, they are toxic to fish and aquatic invertebrates. The county has not used pupacides in recent years. Methoprene, a commonly used pupacide, is an insect growth regulator that prevents pupae from metamorphosing into adults. Methoprene has been found to be practically nontoxic to people and terrestrial vertebrates and poses minimal chronic and acute risk to fish, freshwater invertebrates (other than mosquitoes and closely related chironomids), and estuarine species at the doses tested (EPA 2001). Detailed mapping of areas where disease-carrying mosquitoes are present and the use of an ultra-low volume fogger would reduce the impacts to nontarget organisms. Other practices to reduce impacts to nontarget wildlife include application in the evening hours (when many insect pollinators are less active) and conducting applications when wind speeds are steady and low, and temperatures are lower.

Impacts on Wildlife from Periodic Elimination of Mosquito Larvae from the Wetland Community:

The Service does not anticipate long-term impacts to result from the proposed use. Hershey et al. (1995) conducted a 6-year study on 27 wetlands in Wright County, Minnesota, consisting of three years of pretreatment sampling of aquatic invertebrates and other parameters, followed by 3 years of treatment with *B.t.i.* Insect densities and diversity were reduced by 57 to 83 percent in the second and third years of treatment, respectively. During this study, 179 genera of aquatic insects were examined, with chironomids (primarily midges) representing about half of the insect genera present at the beginning of the study. By the end of the study, however, only one to six genera dominated the treatment sites. Adverse impacts were primarily observed in the invertebrate tribes Chironomini and Tanytarsini. These tribes are ubiquitous and are represented in almost every wetland with chironomids. Although Hershey et al. (1995) found negative effects of *B.t.i.* on nontarget invertebrates; this study is not applicable in the case of Tualatin River National Wildlife Refuge for the following reasons.

1. Entire wetlands were treated with *B.t.i.* multiple times within and over several consecutive years in the Minnesota study. In contrast, the treatment area at Tualatin River National Wildlife Refuge would likely only include wetland margins where vegetation interfaces with open water.
2. Because of fluctuating water levels changing the location of the shallow flooded shoreline, it is unlikely *B.t.i.* applications would occur in the same area more than three times in a single year, and most areas would receive a single application. Stipulations in the SUP would limit the number of applications in a specific location during one season.

Recently completed invertebrate and salmonid research along the south Franz Lake shoreline (Franz Lake National Wildlife Refuge in Washington) has provided valuable information regarding the cumulative impacts of mosquito treatment and control measures that are applicable to the program at this refuge. The invertebrate study was conducted during the latter part of the application period (July to September). During this study, stable water levels from July to September resulted in three applications of *B.t.i.* to the same locations. No impacts to non-target invertebrates were reported as a result of these applications. Consequently, it is unlikely there would be negative cumulative direct impact on the invertebrate community or indirectly on fish and wildlife. Because there were no impacts to non-target invertebrates from *B.t.i.* treatment at Franz Lake, it is unlikely that native fish would be impacted from applications at the Tualatin River National Wildlife Refuge.

Although mosquito larvae were reduced as a result of *B.t.i.* treatments at Franz Lake, there were no significant differences in the numbers of over 40 taxa of invertebrates, with 50 percent of the taxa being other insects that had been represented at shallow water sites. Based on results of the invertebrate survey, it would be expected that alternative prey would be available for native fishes (including salmonids), as well as other wildlife that depend on larval or adult mosquitoes as forage.

Consequently, the Service believes that the proposed monitoring and subsequent applications of *B.t.i.* would not have substantial short-term, long-term, or cumulative impacts on refuge fish and wildlife resources.

Impacts to Biological Integrity, Diversity, and Environmental Health:

Biological integrity, diversity, and environmental health can be simply defined as native fish, wildlife, plants, and their habitats as well as natural processes that support them. As described above,

the impacts from larvicide application to most fish, wildlife, and plants would be temporary and localized. Mosquito populations that are part of the biological integrity, diversity, and environmental health of the refuge would be impacted from control actions. Although numbers of mosquitoes would be temporarily and locally reduced, there would likely be no long-term or cumulative effects to mosquitoes and the species that feed upon them at the refuge. As part of the refuge's mosquito management plan, the refuge would assess the impacts of adulticide applications on biological integrity, diversity, and environmental health.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____ Use is Not Compatible

_X_Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- The HHS/YCPH must apply for and receive an SUP annually from the refuge manager. The permit would specify conditions including, but not limited to, access restrictions, timing of applications, and measures required to limit the spread of invasive plants.
- Mosquito management would follow an IPM approach, and any compatible cultural and/or mechanical control methods would be identified and implemented before chemical control is permitted.
- Larvae control is to be conducted only when the HHS/YCPH determines that breeding in specific units is widespread and poses a documented threat to human health.
- Only Service-approved pesticides may be applied on refuge wetlands and only after PUPs have been approved.
- The HHS/YCPH would contact the refuge manager at least one day in advance of each application. The refuge manager has final approval over all pesticide treatments.
- The HHS/YCPH would notify the refuge manager in the event that virus activity is detected within or near the refuge and would work with the refuge to determine whether additional surveillance or control actions are necessary.
- The HHS/YCPH must provide the refuge manager with a monthly report of all control activities on the refuge.
- The refuge may rescind this CD at any time based on future Service policy determinations or scientific studies of the effects of pesticides on the environment or nontarget organisms.
- This CD would be reviewed when the Service finalizes its pending policy on mosquito management, and a new CD would be issued if this CD is not in full compliance with the new policy.

Justification:

Several suburban communities exist near the refuge within the flight range of adult mosquitoes (5 to 10 miles). Mosquito species capable of transmitting diseases to people may be present on the refuge, though the risk of transmission is generally low. The refuge's mosquito control program is consistent with the Service's 2005 Interim Mosquito Management Policy and would help manage mosquito populations that pose a threat to human health.

The refuge would ensure that its mosquito management program is consistent with national policies for disease control and would work with the HHS/YCPH to continue to identify new ways to use compatible mechanical and cultural control methods, reduce larvicide applications, and avoid impacts to sensitive resources.

In the event that compatible mechanical and cultural control methods are not effective or practicable, the use of the larvicide *B.t.i.* would help avoid ecologically significant impacts to nontarget organisms and help the HHS/YCPH avoid the need to apply adulticides, which are generally more toxic to nontarget organisms. For the following reasons, mosquito monitoring and *B.t.i.* treatments for control of mosquitoes on the refuge would not materially interfere with or detract from fulfilling the Refuge System mission or achieving refuge purposes.

- Under the worst-case scenario, a maximum of 18 acres or less than 1 percent of the total refuge acreage would be impacted by mosquito monitoring and treatment activities annually from April 1 through September 30.
- The invertebrate *B.t.i.* study indicated that no impacts to nontarget invertebrates were associated with three *B.t.i.* treatments for control of mosquito larvae on the shallowly flooded south shoreline of Franz Lake National Wildlife Refuge.
- Although mosquito larvae would be reduced from *B.t.i.* treatments, over 40 taxa of invertebrates, with 50 percent of the taxa represented by other insects, were found at shallow water sites (where treatments would occur) after treatment. Therefore, alternative prey is likely available for fish and other wildlife species.
- Monitoring and treatment activities would likely result in only temporary and localized disturbance to fish and wildlife.

Mandatory 10- or 15-year Re-evaluation Date (provide month and year for "allowed" uses):

_____ Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

__2022__Mandatory 10-year re-evaluation date (for all uses other than wildlife-dependent public uses)

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Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

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B.6 Compatibility Determination for Fishing at Tualatin River National Wildlife Refuge

Use: Fishing

Station Name: Tualatin River National Wildlife Refuge

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S.C. § 742a. et seq.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purpose(s):

" …for the development, advancement, management, conservation, and protection of fish and wildlife resources …" 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

"… the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd et seq.]).

Description of Use:

Fishing is one of the priority public uses that promote traditional outdoor recreation opportunity for the surrounding community. Very few opportunities exist on the Tualatin River for public fishing, in particular for disabled anglers. Fishing in the Tualatin River would be implemented at the existing River Overlook on the Atfálat'i Unit of the refuge—a cantilevered platform would provide access to fishing on the river below.

A wide variety of fish inhabit the Tualatin River mainstem, including warm-water, cold-water, and anadromous species, and the river would support a fishery for these species. Fisheries in the Tualatin River could include cold-water species such as rainbow trout and cutthroat trout; anadromous species such as the upper Willamette River steelhead, Chinook salmon, and coho salmon; and warm-water species such as white crappie, bluegill, bullhead, and large-mouthed bass (Leader 2001). Generally, from May to August, under current Oregon Department of Fish and Wildlife (ODFW) regulations,

fishing could occur in the Tualatin River for trout species and coho salmon as identified in the special regulations for Tualatin River; a wide variety of warm-water species; crayfish; and bullfrogs. For purposes of regulations, ODFW considers rainbow trout over 20 inches to be steelhead (ODFW 2011d).

Recreational fishing would be allowed in accordance with all applicable laws and regulations of the State of Oregon; however, access would be limited to daylight hours only and cleaning of fish on-site would be prohibited. Access to the River Overlook from the public parking lot would be via the existing year-round trail. No other areas of the refuge would be open to fishing. The overlook and associated facilities would be provided during daylight hours and would be fully accessible to users under the guidelines of the Architectural Barriers Act. Limited removal or trimming of vegetation near the overlook would be necessary to minimize tangling of fishing lines. The overlook would comfortably accommodate three to four anglers at a time, plus up to 15 other visitors when fishing is not occurring. The maximum number of anglers anticipated annually would be 1,000, some of whom may be participants in special fishing events and clinics hosted by the refuge. Events would focus on fishing ethics and techniques, natural resource conservation, and environmental education.

Availability of Resources:

Direct annual recurring costs to administer and maintain a recreational fishing program are primarily in the form of staff time, publication of leaflets, and maintenance of overlook and trail facilities. Alternative 2 of the draft CCP/EA proposes that the desirability of a user fee be explored to help operate the fishing program and maintain and repair associated facilities. The refuge currently has sufficient staff and funding to offer the use.

Costs to Administer and Manage Fishing under the Preferred Alternative

Activity or Project	One-time Expenses ($)	Recurring Expenses ($/year)
Development of fishing plan	$5,000	
Administration and maintenance of program		$15,000
Total	$5,000	$15,000

Anticipated Impacts of Use:

General Impacts:

A general assessment of impacts resulting from fishing uses has been compiled from the literature and is briefly summarized below.

Disturbance to Wildlife: Fishing as a solitary and stationary activity tends to be less disturbing to wildlife than hunting or motorized boating (Tuite et al. 1983). Fishing has the potential to cause disturbance to birds and other wildlife using open waters and tributaries where fishing occurs. Fishing activities may influence the composition of bird communities as well as distribution, abundance, and productivity of waterbirds (Bell and Austin 1985; Bordignon 1985; Bouffard 1982; Bouffard and Hanson 1997; Cooke 1987; Edwards and Bell 1985; Tydeman 1977). Anglers often fish in shallow, sheltered bays and creeks that birds prefer, which can negatively impact distribution

and abundance of waterfowl, grebes, and coots (Cooke 1987). Increases in anglers and associated shoreline activity have been found to discourage waterfowl from using otherwise suitable habitat (Jahn and Hunt 1964). When compared to non-fishing days and/or non-fishing rivers, anglers influenced the numbers, behavior, and diurnal distribution of avian scavengers present at sites along the Skagit and Toutle Rivers in Washington, disrupted feeding, and increased energy expenditure through avoidance flights (Knight and Knight 1984; Knight et al. 1991).

Stream Fishing Impacts: Shoreline activities related to stream fishing, such as human noise, would cause some birds to flush and go elsewhere. Waterbirds and waterfowl in particular use shorelines seasonally for resting, feeding, and nesting. Furthermore, anglers frequently show long periods of inactivity interspersed with short periods of rapid movements, which has the potential to disturb nearby wildlife (Bell and Austin 1985).

Refuge-specific Impacts:

Anglers accessing and using the River Overlook may occasionally disturb resident mammals, but the impact would likely not exceed that which already occurs from other pedestrians using the trail. Neotropical migratory songbirds and resident birds may be disturbed, but would likely remain in the general area. Waterfowl and shorebirds would likely experience minimal disturbance due to the dense tree and shrub buffer planting that separates the trail and overlook area from seasonal wetlands.

Impacts to Listed Species:

Upper Willamette River steelhead and Chinook salmon were both listed as threatened species in August and March 1999, respectively (Federal Register 1999a, Federal Register 1999b), and critical habitat was designated in 2005 (Federal Register 2005) in the upper Tualatin River Basin (roughly defined as the Tualatin River and its tributaries upstream of Highway 219 near Hillsboro, excluding Rock Creek). The proposed use would not occur in designated critical habitat. No other listed species are known to exist in the area that would be designated for fishing. The recreational fishing program and associated facility are anticipated to have no effect on threatened species if anglers are held in compliance with ODFW and refuge regulations. The designated time for fishing for trout and coho salmon according to ODFW regulations is generally May 31 to October 31. During the winter, listed species are migrating upstream to spawn, and then in late winter and early spring, the smolts would be outmigrating. The spring-summer-early fall period proposed for fishing, especially at our location on the river, is too warm for these species to survive. By the end of April the temperature in our part of the river is reaching a lethal range for salmonids. Local rainbow and cutthroat trout move up into the tributaries that have cooler and oxygenated water for them to survive.

Impacts to Nonlisted Species:

The majority of fish species expected to be caught are nonlisted fish such as small-mouth bass and bluegill. It is anticipated that there would be some mortality of these nonnative species as a result from handling. However, with proper care and quick releases, these impacts are expected to be minimal.

Impacts to Other Priority Public Uses:

Fishing is expected to result in occasional disturbance to other visitors. In addition, anglers may inadvertently flush wildlife that are being observed by other visitors. Occasional crowding may occur on the overlook due to multiple public uses occurring simultaneously. No significant effects to roads, trails, and other infrastructure from the fishing program are foreseen. Normal facility maintenance would continue to be necessary.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____Use is Not Compatible

__X__Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- Fishing would be opened only after a fishing package is completed in coordination with ODFW and draft and final regulations are published in the Federal Register.
- Fishing would be allowed only during daylight hours.
- Fires, off-trail use, and littering are prohibited.
- Information signs and/or publications would be provided to ensure anglers have access to all regulations that apply to the refuge and to fishing activities.
- All persons fishing shall be required to have a valid Oregon State fishing license and follow all applicable state regulations.
- Law enforcement patrols would be conducted on a periodic basis to ensure compliance with state and refuge regulations.
- Access to fishing would be limited to foot traffic along the existing trail. Persons with disabilities who are unable to access the River Overlook to fish would be accommodated on a case-by-case basis. This would require prior notification to the refuge.
- If disturbance to wildlife or damage to habitat results in unacceptable levels, the refuge would limit fishing access to reduce impacts.
- If conflict with other priority public uses, or overcrowding by anglers occurs, the refuge may institute techniques to reduce negative impacts to visitor experience. These may include limiting fishing to specific days and/or times; developing signage to inform visitors of fishing program opportunities; developing a permit system for anglers; and/or other methods as appropriate to the situation.

Justification:

As a wildlife-dependent recreational use, fishing receives enhanced consideration in the CCP planning process. Despite direct and indirect impacts associated with fishing, refuge riparian and riverine species and their habitats are unlikely to be affected significantly by the fishing program on

the refuge at the levels of use anticipated in Preferred Alternative 2. Other riparian and stream areas not subject to fishing disturbance would be maintained on other portions of the refuge. State regulations, including bag limits, ensure that harvesting of fish does not harm long-term populations. It is anticipated that wildlife populations would find sufficient food resources and resting places, and their abundance and use of the refuge would not be measurably lessened from disturbance by fishing. The relatively limited number of individual animals and plants expected to be adversely affected would not cause wildlife populations to materially decline, the physiological condition and production of refuge species would not be impaired, their behavior and normal activity patterns would not be altered dramatically, and their overall welfare would not be negatively impacted. Thus, allowing fishing to occur under the stipulations described above would not materially detract from or interfere with the purposes for which the refuge was established or the Refuge System mission.

Mandatory 10- or 15-year Re-evaluation Date (provide month and year for "allowed" uses):

__2027_Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

_____Mandatory 10-year re-evaluation date (for all uses other than wildlife-dependent public uses)

References:

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Bordignon, L. 1985. Effetti del disturb antropico su una popolazinoe di germane reale Anas platyrhynchos (Effects of human disturbance on a population of mallard Anas platyrhynchos). Avocetta 9:87-88.

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Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

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B.7 Compatibility Determination for Environmental Education at Tualatin River National Wildlife Refuge

Use: Environmental education

Station Name: Tualatin River National Wildlife Refuge

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S.C. § 742a et seq.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purpose(s):

" … for the development, advancement, management, conservation, and protection of fish and wildlife resources …" 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd et seq.]).

Description of Use:

Environmental education refers to formal, curriculum-based education opportunities primarily for students and organizations. Environmental education fosters an aware and involved citizenry that takes an active role in conservation. The environmental education program at the refuge would be administered as described in Goal 13 of the draft CCP/EA. Environmental education could occur in any season at the refuge. In practice, most environmental education would occur between September and June, during the school year. The total number of people served by the environmental education program is expected to grow to 10,000 over the 15-year life of the CCP. The program would continue to rely on volunteers for full implementation.

Environmental education activities would take place primarily within designated facilities designed to support the program. These include the year-round and seasonal trails, including overlooks; five

trailside environmental education study sites; the environmental education shelter; an environmental education classroom, and the Wildlife Center. Refer to Section 5.2 of the draft CCP/EA for a complete description of current facilities. An off-trail study area proposed in Alternative 2 of the draft CCP/EA would only be used by students who are participating in refuge lesson plans that include off-trail activities. This area would be clearly marked for student use only, and the use would be overseen by trained refuge staff and/or volunteers. Additional off-trail use may include occasional refuge-led field trips to areas generally closed to the public that would provide educational value not available in the designated public use areas. Examples include activities such as, but not limited to, access for secondary or collegiate-level students studying hydric soils along wetland edges, students accompanying refuge staff on biological monitoring activities such as bird banding, and habitat surveys such as conducting vegetation transects. A nature explore area for young children proposed in Alternative 2 of the draft CCP/EA would be limited to less than 1 acre, be located adjacent to the year-round trail in an area where limited additional wildlife disturbance would occur, be bound by a barrier to contain the use, be primarily constructed with natural and/or sustainable materials, and be signed appropriately to guide the use.

Students and educators of all ages and grade levels would participate in curriculum-based education on the refuge. In addition to formal classroom participants, the environmental education program would serve home-school groups/families, pre-school groups, youth groups such as scouts, after-school clubs, and other informal organized groups such as summer youth programs. Generally, no more than 100 students (plus teachers and chaperones) would be visiting any given unit of the refuge at any given time, and advance reservations would be required. Educators wishing to bring K-8 students would be required to attend a teacher workshop prior to the field trip or have trained volunteers and/or refuge staff accompanying the group. Educators bringing high school and collegiate students would be required to consult with refuge staff prior to their visit to both register and to obtain approval for planned activities. In all cases, educators would be instructed in how to teach and are expected to enforce “field trip etiquette” that is designed to minimize wildlife and habitat disturbance. To the greatest extent possible, the refuge would provide staff and/or volunteers to welcome and accompany field trips to the refuge.

The refuge would provide approved curricula and guidance to all teachers conducting education on the refuge. Activities generally fall into the same guidelines that are expected of all other visitors (refer to CD for wildlife observation, photography, and interpretation). However, additional activities may occur as part of refuge-approved lesson plans and when conducted by a trained volunteer or refuge staff. These may include, but are not limited to, capture, study, and release of small animals such as macroinvertebrates, frogs, snakes, insects, worms, etc; handling and return of features such as leaves, scat, and feathers; and collection of water, seeds, and soil taken either to the classroom or off-site for further study and analysis.

Availability of Resources:

Estimated costs for operating the environmental education program as envisioned under Alternative 2 are displayed in the following table. With assistance from Friends of the Refuge, grants, volunteers, and other partners, the refuge currently has sufficient staff and funding to support these programs at their current levels. Additional resources would be needed to fully implement the uses and strategies described in the CCP.

Costs to Administer and Manage Environmental Education under the Preferred Alternative

Activity or Project	One-time Expenses ($)	Recurring Expenses ($/year)
Environmental Education Specialist		67,500
Environmental Education Intern		25,000
Develop curricula resources for educators	10,000	2,000
Conduct annual teacher workshops		5,000
Provide and maintain educational equipment and materials	10,000	5,000
Conduct annual volunteer training		2,000
Maintain environmental education facilities		20,000
Develop additional signage and publications	5,000	1,000
Design and construct nature explore area	50,000	2,000
Program oversight: Visitor Services Manager		20,000
Total		158,500

Anticipated Impacts of Use:

General Impacts:

A general assessment of impacts resulting from environmental education uses has been compiled from the literature and is briefly summarized below.

Disturbance Impacts: In general, impacts that could occur from environmental education programs would be similar to those expected from wildlife observation, photography, or interpretation activities. Such impacts would be expected to include temporary damage to vegetation resulting from trampling, disturbance to nesting birds, and disturbance to feeding or resting birds or other wildlife in the vicinity. Environmental education programs generally accommodate groups of participants, and studies have shown that increasing group size has an impact on wildlife (Beale and Monaghan 2004; Remacha et al. 2011). In addition to group size, loudness has also been found as an important variable to disturbance of wildlife, and loudness of people present can be more important than the number of people present (Burger and Gochfeld 1998). Studies showed that reducing group size, allowing safe distances, and reducing noise levels helps minimize negative impacts on wildlife (Beale and Monaghan 2004; Burger and Gochfeld 1998; Remacha et al. 2011). An unpublished study examined the effect of environmental education site activities at Blackhorse Lake on the Turnbull National Wildlife Refuge (Jose 1997). The study was designed to compare waterfowl presence and behavior patterns between the times when environmental education activities were occurring and when environmental education classes were not on-site. The study results indicated that fewer waterfowl were present in the study area when environmental education classes were on-site as compared to control times. The study also found more short flights undertaken by birds when classes were on-site. Redheads displayed the highest number of flight responses, followed by mallards.

Ruddy ducks almost never flew but had the highest increase in directional swimming away from classes. The study recommended that sites heavily used by smaller bodied birds, such as ruddy ducks, buffleheads, and teal, not be used as environmental education sites.

Conservation Benefits: Environmental education provides indirect beneficial impacts for visitors engaged in environmental education programs and activities. One study found that animal-oriented activities have an impact on the knowledge and attitudes of students involved in environmental education. Direct instruction methods in which children examined the anatomical and behavioral characteristics of live spiders and snakes promoted a positive attitude toward these animals (Kellert and Westervelt 1983; Kress 1975). Eighth graders engaged in wildlife-oriented activities were found to be more likely to recognize the importance of lower forms of animal life and preserving endangered species and to have greater tolerance for predators (LaHart 1974). Another study concluded, "if one were to try to change attitudes, education without an experiential component might not be very effective" (Baird and Tolman 1982:12).

Refuge-specific Impacts:

Environmental education activities would be more localized and would occur less frequently than general wildlife observation. Larger group sizes would likely result in greater magnitude of disturbance to feeding, resting, or nesting birds or other wildlife in the vicinity; however, having groups accompanied by staff or trained naturalists would help mitigate this disturbance. Most of the sites to be used by environmental education groups are already regularly used by other wildlife viewers, so the additional impact by the environmental education program would likely be small. However, to the extent that students are encouraged to conduct hands-on studies of vegetation, insects, water, or less mobile wildlife, more off-trail use would be expected for this activity than for any other non-consumptive use, with attendant impacts that could be higher than for more typical wildlife observation activity.

Participation in environmental education programs is growing throughout Oregon and Washington. With the growth of participation in environmental education programs and the emphasis on these programs under Preferred Alternative 2, future effects can be expected to be higher than present. Nonetheless, environmental education activities would occur outside of wintertime sanctuary areas and outside of fragile habitats.

Impacts to Listed Species:

No direct impact to listed species is anticipated to occur as a result of the environmental education program. Any unanticipated future impacts would be reduced by ensuring that environmental education groups avoid or severely limit activity in areas hosting rare species.

Impacts to Other Priority Public Uses:

Environmental education may result in disturbance to other visitors. School groups, especially those dominated by younger primary school children, may be loud and may flush wildlife being enjoyed by other visitors. This effect is expected to be fairly minimal, since the majority of other visitors use the refuge on weekends and school groups would generally be present on weekdays.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____Use is Not Compatible

__X__Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- Environmental education facilities and activity areas shall be designated and/or constructed in locations that consider the site's potential for contributing to a diverse and rich curriculum and minimizing impacts to sensitive resources, including listed species and wintering waterfowl.
- Advance reservations would be required for all groups participating in environmental education activities.
- Educators would be required to use refuge-approved curricula and/or lesson plans.
- Adult supervision would be required for students up to twelfth grade.
- All groups would be instructed in trail and off-trail etiquette and ways to reduce wildlife and habitat disturbance during a "welcome" session. During "teach the teachers" workshops, instructors would review trail etiquette and how to minimize wildlife disturbances.
- Generally, no more than 100 students (plus teachers and chaperones) would be allowed on any given unit of the refuge at any given time. Classes would be asked to break up into smaller groups averaging 15 students.
- Signs, pamphlets, and verbal instructions from refuge staff and volunteers would promote appropriate use of facilities to minimize wildlife and habitat disturbance.
- Periodic monitoring and evaluation of sites and programs would be conducted to assess if objectives are being met and ensure the resource is not being unacceptably degraded. If disturbance to wildlife or damage to habitat reaches unacceptable levels, the refuge would avoid or limit environmental education activities in areas where unacceptable impacts occur.

Justification:

As a wildlife-dependent recreational use, environmental education receives enhanced consideration in the CCP planning process. Environmental education can provide students with the joy of experiencing wildlife on their public lands, and as such, helps fulfill the mission of the Refuge System. Based on the analysis presented above, this use would be expected to have a minor direct impact on refuge resources. By limiting the size of groups and locating environmental education activities in areas that are already regularly used, the additional disturbance to wildlife, though larger than at present, is also expected to be minor. It is anticipated that wildlife populations would find sufficient food resources and resting places such that their abundance and use of the refuge would not be measurably lessened from education activities. The relatively limited number of individual animals and plants expected to be adversely affected would not cause wildlife populations to materially decline, the physiological condition and production of refuge species would not be

impaired, their behavior and normal activity patterns would not be altered dramatically, and their overall welfare would not be negatively impacted. Thus, allowing environmental education activities to occur on selected areas of the refuge under the stipulations described above would not materially detract from or interfere with the purposes for which the refuge was established or the Refuge System's mission.

Mandatory 10- or 15-year Re-evaluation Date (provide month and year for "allowed" uses):

__2027__Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

_____Mandatory 10-year re-evaluation date (for all uses other than wildlife-dependent public uses)

References:

Baird, D.D. and R.R. Tolman. 1982. Attitudes of high school students and biology teachers towards animals. Unpublished manuscript. Field Museum of Natural History, Division of Mammals. Chicago, IL.

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Jose, J. 1997. Evaluation of the effect of environmental education classes on waterfowl behavior. Unpublished report. Biology 454 class, Eastern Washington University. Cheney, WA.

Kellert, S.R. and M.O. Westervelt. 1983. Children's attitudes, knowledge, and behaviors towards animals. U.S. Fish and Wildlife Service. U.S. Government Printing Office 1983 0-405-522/1101.

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LaHart, D.E. 1974. The influence of knowledge on young people's perceptions about wildlife. Final project report to the National Wildlife Federation. College of Education, Florida State University. Tallahassee, FL.

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Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

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B.8 Compatibility Determination for Cooperative Farming at Tualatin River National Wildlife Refuge

Use: Cooperative farming

Station Name: Tualatin River National Wildlife Refuge

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S.C. § 742a. et seq.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purpose(s):

" … for the development, advancement, management, conservation, and protection of fish and wildlife resources …" 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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" (National Wildlife Refuge System Administration Act of 1966, as amended [16 U.S.C. 668dd et seq.]).

Description of Use:

Cooperative farming is an interim tool, and an effective one, that allows the refuge to manage invasive species while at the same time providing forage for wildlife. Prior to and during restoration of native habitats, invasive species can outcompete native plants, therefore reducing the success of native plants to become established. Cooperative farming would allow the refuge to control invasive plants, which would give native plants a greater chance of success when restoration occurs.

The refuge manages small grain croplands and pastures to:

- Provide wildlife habitat for migratory birds and other resident wildlife, and
- Prevent invasive plants from dominating the landscape prior to restoration of the land to native habitats.

Invasive plants have the potential to reduce habitat quality and forage opportunity and have been identified as one of the most serious threats to refuge habitats. Preventing infestation is the most effective strategy because if left without refuge intervention, agricultural lands acquired by the refuge would most likely convert to invasive weed parcels. Species such as reed canarygrass and Himalayan blackberry pose serious threats. The refuge continually monitors for new invasive plants as well. A variety of methods, including mechanical, herbicidal, and cultural treatments, are used to manage these invasive plant species. The refuge uses an IPM approach to control weeds (Appendix G), whereby management options are selected based on on-site conditions and not implemented until established thresholds are exceeded.

Various methods would continue to be evaluated for efficiency and appropriateness to treat invasive species. If one particular method is not expected to be effective or may have undesirable consequences (such as impacting grassland nesting birds), then the refuge would evaluate other methods until one is deemed appropriate for a particular situation.

Approximately 800 acres of the Wapato Lake and Onion Flats Units would be maintained in cooperative farming until restoration begins. The farming would occur through a cooperative farming program in which croplands would typically be planted and maintained by local area farmers who operate according to farming agreements. Farming typically occurs with planting in the late spring and early summer with harvesting in late summer and early fall. Cooperative farming agreements are a negotiated agreement between the refuge and the private farmer to manage the lands for both parties. To benefit wildlife, the refuge's share of 30 percent would be left in the field where it would be available to wildlife, primarily waterfowl. The types of small grain crops and pasture grasses proposed under the cooperative farming program include, but are not limited to, plantings of corn, spring and winter wheat, and clover. Implementation of cooperative farming is dependent on weather and other environmental conditions. Determination of location, small grain crop species or pasture grasses, and timing of farming are made annually dependent on refuge needs.

Availability of Resources:

Estimated costs for operating the cooperative farming program as envisioned under Preferred Alternative 2 are costs associated with administrative functions and are displayed in the following table. These administrative functions include the personnel required to review farming proposals, execute cooperative agreements, and monitor the program. The refuge currently has sufficient staff and funding to support this use.

Costs Associated with Operation of Cooperative Farming Program

Category and Itemization	One-time Expenses ($)	Recurring Expenses ($/year)
Administrative support	0	$5,000
Total expenses	0	$5,000

Anticipated Impacts of Use:

Approximately 800 acres of land would be cooperatively farmed under Preferred Alternative 2 at the Wapato Lake and Onion Flats Units. These units would be farmed to manage for invasive species until such time that restoration begins.

General Impacts:

Direct impacts of cropland management include exposure of soils to wind erosion and impacts from farm machinery. During tillage, the soil is left bare prior to planting. The bare soil is exposed for much of the year to environmental factors that may alter its quality. Wind, heat, and precipitation are the most damaging factors that may affect the soil. Wind and precipitation can both lead to displacement of soil, increasing the rate of erosion, and heat can effectively bake the soil, causing it to become inhospitable to seed banks; it may even cause the soil to become dry and compacted, making it impossible for any vegetation to grow if tillage is not performed.

Compaction of the soil can also result from the use of farming equipment for seeding, causing undesirable increases in bulk density, while tilling may prevent the accumulation or accelerate the decomposition of organic matter and diminish earthworm populations.

Farming may also result in the use and introduction into the environment of chemical agents from herbicide and pesticide use. Weed issues may greatly increase from ground disturbance and from movement of cultivating and harvesting equipment from field to field, therefore spreading invasive species' seeds. In addition, small mammals, reptiles, and amphibians may be subject to mortality from farm equipment, and nesting birds may be disrupted and have nests destroyed.

Refuge-specific Impacts:

There would be no loss of native habitats due to farming since areas proposed for farming were already in production prior to refuge acquisition. There would be some continued impact to soil quality, but Preferred Alternative 2 would reduce the acreage under cultivation; thus, there would be a minor beneficial impact on soil and water quality, compared to the present. There would be a minor negative impact on farming as the amount of land under cultivation would decrease.

The introduction and spread of weeds is expected to be minimal through proper decontamination practices such as equipment cleaning, mowing to prevent seed set and dispersal, and treatments to any source populations that have the potential to infect a field. Early detection and rapid response methods would be employed to ensure any new populations are treated and eradicated immediately. Cooperators would be required to clean their equipment prior to moving it both on to the refuge and across units of the refuge. This would help minimize the spread of undesirable plants. The refuge would continue to monitor farming sites for invasive weeds and would maintain an aggressive approach to invasive species control. In addition, the refuge would work with the County Weed Board to prevent, identify, and eradicate new infestations.

For weed species that are or become established, mechanical, cultural, and biological controls would be evaluated as methods of treatment. If these methods are not expected to be effective, then herbicidal applications may be necessary. Chemical applications would be subject to the provisions of the IPM plan. This plan directs the refuge to select the most effective herbicide that would have the least environmental degradation to soils, surface water, and groundwater, and the least impact to native wildlife and vegetation. Each approved herbicide used would undergo a chemical profile analysis; active ingredients would be analyzed for their risk quotient and this value compared to a Level of Concern for surrogate species, as established by the EPA. All applications of herbicides would conform to the specific pesticide label requirements.

Employment of this approach would provide for a moderate to minor risk from chemical exposure. However, some risks may still occur from factors not assessed under current protocols, such as intermingling of unlike chemicals in the field; species-specific sensitivity that differs from surrogate species; exposure through inhalation; exposure through ingestion of pesticide-contaminated soil; and other factors as described in the IPM plan.

Positive short-term effects are also anticipated. In addition to providing high-carbohydrate forage for wintering waterfowl, crop fields can benefit other bird species by providing some foraging habitat for a variety of seed-eating migratory bird species.

Impacts to Listed Species:

Currently there are no listed species inhabiting farm fields. Should conflicts occur in the future, measures such as erecting protective barriers and/or transplanting listed populations out of harm's way would be enacted. Additionally, if deemed necessary, the cooperative farming program would be halted until all protective measures can be evaluated and implemented as necessary.

Impacts to Other Priority Public Uses:

Farming on the refuge does not occur in areas that are open to the public; therefore, there are no impacts to public uses.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____ Use is Not Compatible

_X_Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

- Cooperative farming agreements would be established with the cooperator per agency policy.
- Genetically modified seeds and other organisms would not be permitted for use in the farming program.
- Weeds would be controlled in accordance with the refuge's IPM program using methods such as crop rotation, mechanical treatment, biological controls, and approved pesticides.
- Herbicide applications may only be applied with prior refuge approval, and applicators must meet all state, Federal, and agency requirements.
- Equipment of cooperating farmers would be cleaned prior to being moved onto the refuge and between fields when working in areas with weed infestations.
- Cooperators would provide a record of herbicides used, including chemical name, amount used, date, location, and method of application.
- Diligence shall be exercised in the control of county-listed invasive weeds.

- Best management practices would be used to avoid fertilizer runoff into wetlands or leaching into groundwater and to minimize sedimentation of streams and water bodies. For example, nitrogen fertilizer applications would be avoided in the fall to help avoid waste and prevent fertilizer from leaching into groundwater, and buffer strips of dense vegetation would be left between farmland and wetlands to filter runoff and prevent sedimentation.
- Monitoring of the cropland farming program would be performed by qualified refuge staff.

Justification:

Cropland farming has been shown to be an effective habitat management practice performed to prevent invasive species from infesting a highly disturbed area until restoration of native vegetation can occur. Additionally, cropland farming provides high-quality food for wildlife species at the refuge. Wintering and migratory birds readily use agricultural crop fields to help meet their energy needs.

Although these large monocultures of planted grasses are not native, and do not support the diversity of species that native habitats do, it is critical to maintain these areas in production to keep them from becoming infested with noxious weeds. By conducting the farming program under the practices and stipulations above, it is anticipated that the program would contribute to the enhancement, protection, conservation, and management of native wildlife populations and their habitats on the refuge. As a result, cooperative farming contributes to achieving refuge purpose(s), contributes to the mission of the Refuge System, and helps maintain the biological integrity, diversity, and environmental health of the refuge. Allowing the use as described above would not materially detract from or interfere with the purposes for which the refuge was established or the mission of the Refuge System.

Mandatory 10- or 15-year Re-evaluation Date (provide month and year for “allowed” uses):

_____Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

__2022__Mandatory 10-year reevaluation date (for all uses other than wildlife-dependent public uses)

Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

B.9 Compatibility Determination for Commercial Visitor Services at Tualatin River National Wildlife Refuge

Use: Commercial visitor services

Station Name: Tualatin River National Wildlife Refuge

Date Established: 1992

Establishing and Acquisition Authority(ies):

Fish and Wildlife Act of 1956 (16 U.S.C. § 742a. et seq.)

Emergency Wetlands Resources Act of 1986 (16 U.S.C. § 3901-3932)

Refuge Purpose(s):

" … for the development, advancement, management, conservation, and protection of fish and wildlife resources …" 16 U.S.C. § 742f(a)(4) (Fish and Wildlife Act of 1956)

" … for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude …" 16 U.S.C. § 742f(b)(1) (Fish and Wildlife Act of 1956)

" … the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" 16 U.S.C. § 3901(b) (Emergency Wetlands Resources Act of 1986)

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." (National Wildlife Administration Act of 1966, as amended [16 U.S.C 668dd et seq.]

Description of Use:

This CD addresses nonconsumptive commercial uses related to wildlife observation, wildlife photography, interpretation, and environmental education. This CD does not address consumptive uses such as commercial guiding for hunting and fishing, nor activities that are not related to natural, historical, or cultural subjects. Additionally, a variety of nonprofit and for-profit organizations, educational institutions, and individuals engage in leading natural resource- and environmental education-based activities on the refuge. Some of these organizations may request to charge fees for services they intend to provide. This CD covers the fee collection and program quality aspects of commercial visitor services. Refer to the CDs for wildlife observation, wildlife photography, and interpretation and for environmental education for a complete compatibility examination of the wildlife-dependent activities that apply to commercial visitor services.

By regulation, the Service may only authorize public or private economic use of the natural resources of any national wildlife refuge, where it is determined that the use contributes to the achievement of the refuge's purpose or the Refuge System mission. Refuge System policy on management of specialized uses states that when monetary gain (profit) is the objective of a refuge recreational use, the use is to be managed as an economic and commercial use.

Commercial visitor services on the refuge cover a broad range of wildlife-dependent recreation and education activities that are led by any organization or individual that charges a fee to participate in the activity. Activities could include, but are not limited to, birding tours, plant identification, wildlife photography, art, interpretive programs, guided trail walks, training workshops, summer youth camp, nature classes, and other similar nonconsumptive uses. These uses would occur in areas and facilities that are open to the public and would support the identified wildlife-dependent public uses of the refuge. Organizations conducting commercial visitor services would require an SUP, except for the Friends of the Refuge commercial activities, which are governed by statute under an existing MOU.

Commercial visitor services most often would be expected to occur in groups. These uses may occur year-round on the refuge. They may be conducted on existing public use trails and overlooks and at times inside the Wildlife Center. It is not expected that uses would occur on closed areas of the refuge, unless specifically authorized and approved by the refuge manager.

An SUP would be required for all uses by organizations and/or individuals wishing to collect fees for services, regardless of for-profit or nonprofit status, with the exception of Friends of the Refuge. Friends of the Refuge fundraising and/or fee collection for providing programs would be governed by existing the MOU and/or partnership agreements between the Service and the Friends of the Refuge, except when the refuge manager determines that a proposed use falls outside the scope of any agreement. In such a case, an SUP would be required. In all cases, the refuge manager would require that any organization (including Friends of the Refuge) and/or individual requesting to charge a fee for visitor services complete a written request that includes the activity type, date(s) and time(s) requested, group size, purpose of visit, proposed fee structure, where the activity would occur, and other details determined necessary by the refuge manager.

The refuge would have the option to accompany any group on their activity to assess program quality, adherence to refuge regulations and SUP stipulations, and safety guidelines. The refuge may also provide training and/or materials to requestors to ensure that program participants and visitors are receiving high-quality information and services.

Refer to the Stipulations Necessary to Ensure Compatibility section in this document for more information.

Availability of Resources:

Estimated costs for operating the commercial visitor services program as envisioned under Alternative 2 are displayed in the following table. These costs are to perform, review, and administer proposals and SUPs, and monitor those SUPs during the proposed action. With assistance from Friends of the Refuge, volunteers, and other partners, the refuge currently has sufficient staff and funding to support this use.

Costs to Administer and Manage Commercial Visitor Services

Activity or Project	One-time Expenses ($)	Recurring Expenses ($/year)
Visitor Services Manager and management of SUPs		$5,000

Anticipated Impacts of Use:

The anticipated impacts of use are fully discussed in the CDs for wildlife observation, wildlife photography, and interpretation, and for environmental education.

Refuge-specific Impacts:

Disturbances to wildlife and their habitats would be the same as those discussed in the CDs for wildlife observation, wildlife photography, and interpretation and for environmental education. If disturbance to wildlife or damage to habitat reaches unacceptable levels, the refuge would limit access to areas where unacceptable impacts occur (see stipulations).

It is expected that many organizations could offer high-quality wildlife-dependent recreation and education activities on the refuge. These services may enhance visitor experience, learning, and appreciation of the refuge and its natural and cultural resources. These types of services, if provided in a high-quality manner, would likely reach more people than the refuge can.

Impacts to Listed Species:

No direct impact to listed species is anticipated to occur as a result of commercial visitor services. Any unanticipated future impacts would be reduced by ensuring that the public avoids or severely limits activity in areas hosting rare species.

Impacts to Other Priority Public Uses:

Both refuge visitation and the number of facilities and emphasis devoted to wildlife observation, wildlife photography, interpretation, and education are projected to increase under Preferred Alternative 2. Conflict between commercial visitor services groups would be expected to increase. If conflict between user groups reaches unacceptable levels, the refuge would limit access to areas where unacceptable impacts occur (see stipulations).

No significant effects to roads, trails, or other infrastructure from commercial visitor services are expected. Normal road, trail, and facility maintenance would continue to be necessary. Additional facility construction or upgrade, if needed, is addressed in the Availability of Resources section.

Public Review and Comment:

Various opportunities were provided for the public to engage with the planning process. Appendix K details public involvement undertaken during development of the CCP/EA. Written comments on this draft compatibility determination are welcome during the public comment period.

Determination (check one below):

____Use is Not Compatible

_X_Use is Compatible with Following Stipulations

Stipulations Necessary to Ensure Compatibility:

General Stipulations

- Stipulations in the CDs for wildlife observation, wildlife photography, and interpretation and for environmental education apply to commercial visitor services.
- Visitors are restricted to designated trails, sites, or facilities as determined by refuge staff. Use is open daily from dawn to dusk.
- All refuge rules and regulations apply, including group size and management, and safety guidelines.
- Commercial photographers/videographers should ensure proper credit is given to the refuge and the Service.
- Collection of natural objects such as plants, animals, minerals, antlers, and cultural resources is prohibited.
- If disturbance to wildlife or damage to habitat reaches unacceptable levels, the refuge would limit uses in areas where unacceptable impacts occur. Monitoring would be conducted to ensure that high-quality habitat for wildlife feeding, resting, and breeding is maintained.
- The refuge may provide training and/or materials to requestors to ensure that program participants and visitors are receiving high-quality information and services.

Special Use Permit

- An SUP would be required for all commercial visitor services. Guiding for hunting and fishing is not allowed on the refuge.
- Fee-based activities conducted by Friends of the Refuge would require approval by the refuge manager as governed by MOUs and/or partnership agreements.
- A standard permit form stipulating dates, times, and locations of use would be made available prior to the visit.
- SUPs for areas open to the public may be granted on a case-by-case basis or for up to 1 year, at the refuge manager's discretion.
- Special permission requests to closed habitat/wildlife sanctuary areas or other special considerations (e.g., access to the refuge after normal public visitation hours, setting up temporary equipment, requiring additional resources or staff) would require an SUP and permit fee, and may be granted on a case-by-case basis with no renewal.
- The SUP would be required to be readily available while conducting the permitted use on the refuge.
- Requests must demonstrate a means to enhance education, appreciation, and/or understanding of the refuge and the Refuge System. Failure to abide by any part of the SUP or regulations would be considered grounds for immediate revocation of the permit and could result in denial of future permit requests.

- Refuge can deny use for any reason such as to minimize crowding, avert conflict with other activities/visitors, and, if disturbance is excessive, the refuge reserves the right to scale the use appropriately.
- The refuge would have the option of accompany any group on their activity to assess program quality, adherence to refuge regulations and SUP stipulations, and safety guidelines.

Justification:

By allowing commercial visitor services as an economic use to occur under the stipulations described above, it is anticipated that wildlife species, which could be disturbed during the use, would find sufficient resources and resting places such that their abundance and use of the refuge would not be measurably lessened. Additionally, it is anticipated that use of SUPs would provide the refuge a tool for managing uses; protecting natural and cultural resources; reducing user conflicts; and mitigating disturbance impacts. The SUPs would also create an opportunity for communication and outreach between the refuge staff and users to increase knowledge and awareness of refuge regulations and ethical behavior. Commercial visitor services would provide visitors an organized and educational opportunity to view wildlife safely under the use stipulations. Additionally, providers of commercial visitor services may create end products that would provide an educational opportunity to a much broader distribution of people. Thus, the use would not materially interfere with or detract from the Refuge System mission, or the purposes for which the refuge was established.

Mandatory 10- or 15-year Re-evaluation Date (provide month and year for "allowed" uses):

_____Mandatory 15-year re-evaluation date (for wildlife-dependent public uses)

__2022_Mandatory 10-year re-evaluation date (for all uses other than wildlife-dependent public uses)

Signatures:

Prepared by: _____
(Signature) (Date)

Refuge Manager/
Project Leader
Approval: _____
(Signature) (Date)

Concurrence:
Refuge Supervisor: _____
(Signature) (Date)

Regional Chief,
National Wildlife
Refuge System: _____
(Signature) (Date)

Appendix C
Implementation

USFWS

Appendix A
Appropriate Use Findings

Appendix B
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Appendix D
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Appendix C. Implementation

C.1 Overview and Historical Funding Picture

A comprehensive conservation plan (CCP) provides long-term guidance for management decisions, sets forth goals, objectives, and strategies needed to accomplish refuge purposes, and identifies the U.S. Fish and Wildlife Service's (Service's; USFWS's) best estimate of future needs. Often, a CCP provides detailed program planning levels that are substantially above current budget allocations and, as such, are primarily for Service strategic planning and program prioritization purposes. A CCP does not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.

Implementation of the preferred alternative of the CCP requires increased funding, which would be sought through an increase in base funding (Congressional allocations), partnerships (both private and public), and grants. Activities and projects identified would be implemented as funds become available.

C.1.1 Operating Funds History

Operational management of refuge lands is accomplished by permanent and temporary staffing, volunteers, and partnerships. Operational management includes managing public use, law enforcement, cultural resources, biology, fire, maintenance, administration, and habitat/wildlife restoration/maintenance management programs.

In fiscal year 2011, the majority of the station's operating funds came from Congressional allocated base funding. This funds salaries and benefits for six permanent full-time employees, annual maintenance, and overhead expenses associated with maintaining public use and administrative facilities.

Other funding sources include the Bonneville Power Administration's (BPA's) Fish and Wildlife Program, Migratory Birds Program, and Refuge Roads Program, and American Recovery and Reinvestment Act (ARRA) youth programs. Without these additional funds, the majority of work in the habitat restoration and environmental education program that is accomplished each year would not happen.

C.1.2 Revenue Sharing

In lieu of property taxes, the Tualatin River National Wildlife Refuge (the refuge) annually provides revenue-sharing payments to Yamhill and Washington Counties. The U.S. Congress each year determines what percent of funds will be appropriated for all appraised Federal lands. Counties are not restricted in the use of these funds. If the refuge expands through the purchase of inholdings (privately owned lands within the current approved boundary) or through an expanded refuge boundary, additional payments in lieu of tax would be made to the counties.

C.2 Step-Down Plans

The Comprehensive Conservation Plan is one of several plans necessary for refuge management. The CCP provides guidance in the form of goals, objectives, and strategies for several refuge program areas but may lack some of the specifics needed for implementation. Step-down management plans will be developed for individual program areas within approximately 5 years after CCP completion. All step-down plans require appropriate NEPA compliance; implementation may require additional permits. Step-down plans for the refuge follow. Project-specific plans, with appropriate NEPA compliance, may be prepared outside of these step-down plans.

Table C-1. Refuge Step-Down Plans

Step-Down Management Plans	Status (Date Completed and/or Date to be Prepared/Updated
Wapato Lake Unit Habitat Management Plan	Contingent on acquisition and results of planning study
Cultural Resources Museum Management Plan	2015
Visitor Services Plan update	2017
Hunt Plan – youth waterfowl	2015
Hunt Plan – adult waterfowl	Contingent on Wapato Lake Unit restoration
Fishing Plan	2016
Integrated Pest Management Plan	2012 (prepared concurrently with CCP, Appendix G)
Wildland Fire Management Plan	2012 (prepared concurrently with CCP, Appendix O)
Elk Management Plan	Will be prepared concurrently with Willamette Valley NWR Complex
Disease Contingency Plan	2015
Facilities Management Plan	2017
Inventorying and Monitoring Plan	2015

C.3 Future Needs

C.3.1 Future Sources of Funds

Projects listed below were drawn from the goals, objectives, and strategies and could be implemented during the next 15 years. Many of these projects would be included in either the Refuge Operational Needs System (RONS) or the Refuge Management Information System (RMIS). Both are used to request funding from Congress.

Currently, a large backlog of maintenance needs exists on the refuge. In 2010, the deferred maintenance backlog for the Tualatin River National Wildlife Refuge was $1,450,347. Reduction of the backlog is an ongoing goal and is included here in the analysis of funding needs. The RONS documents proposed new projects to implement the CCP to meet refuge goals and objectives and legal mandates.

Several infrastructure and facility projects would be eligible for funding through construction, deferred maintenance, or Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) funds (i.e., Refuge Roads program).

Funds for other "one-time costs" (see below) would be sought through increases in refuge base funding, special project funds, grants, Refuge Roads, or Federal Highway Administration funding.

C.3.2 Spending Priorities

Priorities are designated in Table C-1 for one-time and ongoing (recurring) projects (strategies) identified in the CCP. Priorities are designated as High (H), Medium (M), or Low (L). The rankings were determined according to the following criteria:

- A "high"-ranked project/strategy is ongoing, needed immediately, or should be considered in the near future to successfully manage habitat and public use on refuges. It should directly support the "refuge purpose" or a "big six" public use activity, and/or restore a "threatened or endangered" species or rare/unique habitat (oak savanna, wet prairie, etc.).
- A "medium"-ranked project/strategy is of a lesser degree of urgency, but also directly supports the "refuge purpose" or a "big six" public use activity, and/or maintains and restores a "threatened or endangered" species or rare/unique habitat (oak savanna, wet prairie, etc.).
- A "low"-ranked project/strategy maintains restored habitat or species and/or addresses a "big six" public use activity that is not as widely sought out by the public as other "big six" public use activities.

C.3.3 Operational Costs to Implement CCP by Alternative

The following sections detail both one-time and recurring costs for various projects by alternative. Recurring costs reflect the future operational and maintenance costs associated with the project.

One-time Costs: One-time costs are project costs that have a startup cost associated with them, such as purchasing a new vehicle for wildlife and habitat monitoring or designing and installing an interpretive sign. Some are full project costs for those projects that can be completed in 3 years or less. These projects do not include permanent operational costs (staff salary and support). They can, however, include the cost of temporary or term salary associated with a short-term project. Salary for new positions and operational costs are reflected in operational or "recurring" costs. Table C-1 compares both one-time and recurring costs across the three alternatives.

Operational and Maintenance (Recurring) Costs: Operational and maintenance costs reflect refuge spending of base funds allocated each year. These are also known as recurring costs and are usually associated with day-to-day operations and projects that last longer than 3 years. Operational costs use base funding in Service codes 1261, 1262, 1263, and 1264.

Maintenance includes preventive maintenance; cyclic maintenance; repairs; replacement of parts, components, or items of equipment; adjustments, lubrication, and cleaning (nonjanitorial) of equipment; painting; resurfacing; rehabilitation; special safety inspections; and other actions to ensure continuing service and to prevent breakdown. Maintenance also includes maintaining public use, administrative, historical, and shop buildings and facilities. Due to normal use and weather conditions, buildings and facilities need annual maintenance and repairs. Maintenance of habitat

throughout the refuge as a result of the threat of invasive plants and animals and succession, and protection of threatened and endangered species is an annual occurrence.

Operational costs includes all costs associated with the operation of all programs including supplies and materials need to support these programs, such as field supplies, brochures, media, and other interpretative materials, volunteer supplies, herbicide, fuel, overhead costs (electricity, phone, natural gas, office supplies, alarm systems for security and fire monitoring), training for staff and volunteers, and safety materials. These costs do reflect salaries for temporary positions, but do not include permanent staff salary.

Table C-1 displays estimated operating and maintenance costs by alternative for the major project items identified in the CCP. Alternative 1 is based on an estimate of costs for implementing the CCP under current management. Alternatives 2 and 3 reflect increased funding needs for proposed increases in public uses and facilities, increased habitat restoration and conservation activities, and other strategies proposed in Chapter 2.

Table C-2. Estimated Operating and Maintenance Costs by Alternative for the Major Project Items Identified in the CCP

Goal/Objective	Strategy	One-time Cost	Recurring Cost (annual)	Priority	Cost/Unit	Units/Total Cost	Alternative 1	Alternative 2	Alternative 3
1/1.1	Maintenance of riparian forest (integrated pest management [IPM], monitoring)		X	M	$100	Acres	349	322	338
						Cost	$34,900	$32,200	$33,800
1/1.2	Restore riparian forest (pretreatment, planting, seeding, mechanical methods)	X		H	*$6,400	Acres	39	140	368
						Cost	$249,600	$896,000	$2.4 million
2/2.1	Maintenance of mixed forest (IPM, prescribed fire, monitoring, snag creation)		X	L	$250	Acres	49	46	49
						Cost	$12,250	$11,500	$12,250
2/2.2	Restore mixed forest (pretreatment, planting, seeding, mechanical methods)	X		L	*$3,000	Acres	0	153	203
						Cost	$0	$459,000	$609,000
3/3.1	Maintain oak savanna (prescribed fire, IPM, mowing, tree thinning, monitoring)		X	H	$250	Acres	149	115	109
						Cost	$37,250	$28,750	$27,250
3/3.2	Restore oak savanna (pretreatment, plantings, seeding, prescribed fire)	X		H	*$910	Acres	0	111	32
						Cost	$0	$101,010	$29,120
4/4.1	Maintain wet prairie (planting, IPM, prescribed fire, mowing/haying, monitoring)		X	M	$200	Acres	27	15	15
						Cost	$5,400	$3,000	$3,000

Table C-2. Estimated Operating and Maintenance Costs by Alternative for the Major Project Items Identified in the CCP

Goal/Objective	Strategy	One-time Cost	Recurring Cost (annual)	Priority	Cost/Unit	Units/Total Cost	Alternative 1	Alternative 2	Alternative 3
4/4.2	Restore wet prairie (pretreatment, planting, seeding, monitoring)	X		H	$1,000	Acres	0	114	30
						Cost	$0	$114,000	$3,000
5/5.1	Maintain herbaceous wetlands (irrigation, water manipulation, mowing/discing, IPM, contouring of wetlands, pest management, prescribed fire)		X	M	$250	Acres	294	187	64
						Cost	$73,500	$46,750	$16,000
5/5.2	Enhance scrub-shrub wetlands (IPM, mowing/discing, pest management, planting, seeding)	X		H	$2,000	Acres	0	Approx. 700 acres max.	Approx. 700 acres max.
						Cost	$0	$1.4 million	$1.4 million
5/5.3	Maintain scrub-shrub wetlands (IPM, prescribed fire, logs/trees for basking and resting structures, monitoring)		X	M	$150	Acres	20	20	20
						Cost	$3,000	$3,000	$3,000
5/5.3	Restore scrub-shrub wetlands (pretreatment, creating swales, plantings, fish passageways)	X		H	**$2,350	Acres	0	180	176
						Cost	$0	$80,252 average	$80,252 average
6/6.1	Maintain streams and sloughs (install fish passageways, remove fish		X	L	$1,000	Miles	7.2	7.2	7.2
						Cost	$7,200	$7,200	$7,200

Table C-2. Estimated Operating and Maintenance Costs by Alternative for the Major Project Items Identified in the CCP

Goal/Objective	Strategy	One-time Cost	Recurring Cost (annual)	Priority	Cost/Unit	Units/Total Cost	Alternative 1	Alternative 2	Alternative 3
	barriers, plantings, erosion control, IPM, best management practices [BMPs])								
6/6.2 and 6.3	Restore streams and sloughs (topographical surveys, heavy equipment work, removal of barriers, plantings, erosion control)	X		H	$10,000	Miles	0	4.3	4.3
						Cost	$0	$43,000	$43,000
7/7.1	Cooperative farming (administration)		X	L		Acres	909	0	0
						Cost	$2,000	$0	$0
8/8.1	Inventorying and monitoring surveys (develop and continue surveys for refuge)		X	H		Cost	$100,000	$200,000	$200,000
8/8.2	Conduct research (studies and investigations toward water quality, soils, IPM techniques, fishery resources, climate change)	X		L		Cost	$300,00	$200,000	$200,000
9/9.1	Inventory, evaluate, monitor, and protect cultural resources		X	L		Cost	$2,500	$35,000	$35,000
9/9.2	Cultural resources interpretation (tribal partnerships,	X		M		Cost	$0	$10,000	$10,000

Table C-2. Estimated Operating and Maintenance Costs by Alternative for the Major Project Items Identified in the CCP

Goal/Objective	Strategy	One-time Cost	Recurring Cost (annual)	Priority	Cost/Unit	Units/Total Cost	Alternative 1	Alternative 2	Alternative 3
	interpretative media and exhibits)								
10/10.1	Provide interpretive information to visitors (media, brochures, signs)	X		H		Cost	$0	$120,000	$120,000
10/10.2	Outreach and special events		X	M		#Events	4	4	4
						Cost	$6,500	$6,500	$6,500
10/10.3	Evaluation of visitor services	X		M		Cost	$0	$25,000	$25,000
10/10.4	Public access (partnership on trails, safe highway access)		X	L		Cost	$0	$2,500	$2,500
10/10.5	Volunteer program (develop/provide manuals, bunkhouse, and recreational vehicle [RV pads)	X		M		Cost	$0	$50,000	$50,000
11—all	Environmental education (develop curricula, materials, and install nature explore area)	X		H		Cost	$0	$75,000	$0
	Environmental education (programs/workshops and materials)		X	H		Cost	$40,000	$158,000	$158,000
12/12.1 and 12.2	Wildlife observation, photography, and	X		M		Cost	$0	$327,000	$327,000

Table C-2. Estimated Operating and Maintenance Costs by Alternative for the Major Project Items Identified in the CCP

Goal/Objective	Strategy	One-time Cost	Recurring Cost (annual)	Priority	Cost/Unit	Units/Total Cost	Alternative 1	Alternative 2	Alternative 3
	interpretation (kiosks, signs, photo blinds, bunkhouse for volunteers)								
	Wildlife observation, photography, and interpretation (new positions, facilities maintenance)		X	H		Cost	$30,000	$258,000	$258,000
12/12.3 and 12.5	Waterfowl hunting—complete hunting package	X		M		Cost	$0	$90,000	$0
	Waterfowl hunting—manage program		X	M		Cost	$0	$50,000	$0
12/12.4	Fishing—complete fishing package	X		L		Cost	$0	$5,000	$0
	Fishing—manage fishing program		X	L		Cost	$0	$15,000	$0
All	Develop step-down plans	X		M	$15,000	# Plans	0	5	5
						Cost	$0	$75,000	$75,000

*Cost was estimated from previous restoration contracts that included labor, plants (trees and grass), protective tree coverings, and other supplies.

**Since the acreage is undetermined for restoration at the Wapato Lake Unit due to a pending hydrological study, cost was estimated based on mean acreage.

C.3.4 Staffing Needs To Implement CCP by Alternative

Personnel are needed to manage and enhance the quality and diversity of indigenous wildlife habitats on the Tualatin River National Wildlife Refuge. With the proper staffing to implement this plan, habitat management practices can be implemented and monitoring of flora and fauna responses to management can be applied, which would allow us to apply adaptive management strategies so crucial for long-term success in meeting the mission, goals, and objectives of the refuge. Staff would interact with the public for education purposes and to provide for public safety. Maintenance staff would maintain facilities and equipment. Training of staff and coordination among staff, volunteers, and refuge partners would ensure that the mission and guiding principles of the National Wildlife Refuge System endure.

Table C-2 shows costs for permanent and seasonal staff needed each year. It does not include staff costs associated with special projects; these are summarized in Table C-1. Table C-2 is related to the Refuge Annual Performance Plan. The section of the table titled “Present Core Staff” shows permanent full-time staff and temporary staff funded with base budgets and other Federal funding. It is important to note that partnerships with other organizations are crucial to achieving baseline objectives as described under Alternative 1. Alternative 2 and 3 staffing positions demonstrate additional staff needed to succeed with the proposed goals for those alternatives.

The proposed full development-level staffing plan would achieve optimum refuge outputs within this planning period (15 years). The rate at which this station achieves its full potential to fulfill the objectives and strategies contained in the CCP is dependent upon receiving adequate funding and staffing.

Table C-3. Staffing Needs by Alternative for Major Project Items in CCP

Staff-Refuge Operations	Status*	Position*	Justifying Objective	Alternative 1	Alternative 2	Alternative 3
Present core staff						
Project Leader	PFT	GS-0485-13	Current	X	X	X
Deputy Project Leader	PFT	GS-0485-12	Current	X	X	X
Wildlife Biologist	PFT	GS-0486-11	Current	X	X	X
Visitor Services Manager	PFT	GS-0025-11	Current	X	X	X
Maintenance Worker	PFT	WG-4749-8	Current	X	X	X
Administrative Officer	PFT	GS-0399-5 SCEP	Current	X	X	X
Biological Technician	TEMP	GS-0401-5	Current	X	X	X

Table C-3. Staffing Needs by Alternative for Major Project Items in CCP

Staff-Refuge Operations	Status*	Position*	Justifying Objective	Alternative 1	Alternative 2	Alternative 3
Alternative 2 and 3 staffing positions						
Biological Technician	PFT	GS-0401-6/7	1.1		X	X
Refuge Operations Specialist	PFT	GS-0485-7/9/11	5.3		X	X
Park Ranger (law enforcement)	PFT	GS-0025-9	10.1		X	X
Volunteer Coordinator	PFT	GS-0025-6/7	10.5		X	X
Environmental Education Specialist	PFT	GS-0025-7/9	11.1		X	X
Engineering Equipment Operator	PFT	WG-5716-8	1.2		X	X

*Status and Position definitions:
PFT: Permanent full time
TEMP: Temporary position
GS: General schedule Federal employees
WG: Wage grade scale

Volunteer Program: The Tualatin River National Wildlife Refuge has a very active volunteer program that supports all programs of the refuge. During fiscal year 2011, more than 225 volunteers donated over 14,640 hours of their time to accomplishing the goals of refuge programs, including maintenance, public use, biological support, environmental education, habitat restoration and management, and administrative duties (Table C-3). The refuge provides transportation, training, supplies, equipment, and housing as needed in support of the volunteer program. The number of hours donated in 2010 was equivalent to $21.79 per hour as estimated by the Independent Sector (2011). The value of time donated equated to $327,000, or seven full-time employees.

Table C-3. Volunteer Contributions over a 5-year Time Frame (2007-2011)

Year	2007	2008	2009	2010	2011
Volunteers	340	558	477	205	226
Hours	6,629	13,178	14,309	15,065	14,641

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Appendix D. Wilderness Review

D.1 Background

The Wilderness Act (Act) became Federal law in 1964 (16 U.S. Code [U.S.C.] 1131-1136). In Section 2(a) of the Act, the U.S. Congress expressed concern that " … an increasing human population, accompanied by expanding settlement and growing mechanization … [should not be allowed to] … occupy and modify all areas within the United States and its possessions, leaving no lands designated for preservation and protection in their natural condition …." The Act also established the National Wilderness Preservation System (Wilderness System) and stated that areas in the Wilderness System " … shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness…."

Section 2(c) of the Act defined a wilderness area as one that " … in contrast with those areas where man and his own 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 chapter 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 five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and (4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Section 3 of the Act required a review of Federal lands to determine their suitability for designation as a unit(s) of the Wilderness System. The U.S. Congress reserved to itself the authority to officially designate wilderness areas.

A wilderness review is the process used by the Service to determine whether to recommend lands or waters in the National Wildlife Refuge System to Congress for designation as wilderness. A wilderness review is required for refuges as part of the comprehensive conservation plan (CCP) planning process. Lands or waters that meet the minimum criteria for wilderness (610 FW 4) are identified in the CCP and further evaluated to determine whether they merit recommendation for inclusion in the Wilderness System.

For a refuge to be considered for wilderness designation, all or part of the refuge must:

- Be affected primarily by the forces of nature, with the human imprint substantially unnoticeable;
- Have outstanding opportunities for solitude or primitive and unconfined type of recreation;
- Have at least 5,000 contiguous acres or be sufficient in size to make practical its preservation and use in an unimpaired condition, or be capable of restoration to wilderness character through appropriate management, at the time of review; or
- Be a roadless island.

D.2 Conclusion

Tualatin River National Wildlife Refuge (the refuge) is not recommended for further study for inclusion in the Wilderness System because it does not meet the above criteria. The refuge is only 2,137 acres in size and the largest roadless block is approximately 800 acres. The size of this block is insufficient to make practicable its preservation and use as wilderness. The refuge also has considerable evidence of past human use, does not have outstanding opportunities for solitude or primitive and unconfined type of recreation, and is not a roadless island.

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USFWS

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Appendix E. Biological Resources of Concern

E.1 Introduction and Background

Management direction of individual refuges is driven by refuge purposes and statutory mandates, coupled with species and habitat priorities. Management on a refuge should first and foremost address the individual refuge purposes. Additionally, management should address maintenance, follow policy and, where appropriate, restore biological integrity, diversity, and environmental health (BIDEH) (Table E-1) and manage for National Wildlife Refuge System (Refuge System) Resources of Concern (ROCs). With this approach, the refuge contributes to the goals of the Refuge System and achievement of its mission.

In concert with this approach, and as an initial step in planning, the comprehensive conservation plan (CCP) planning team for the Tualatin River National Wildlife Refuge (the refuge) identified ROCs for the refuge. As defined in the policy on Habitat Management Plans (620 FW 1G) ROCs are:

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

To provide a framework for development of goals and objectives in the CCP, the planning team identified ROCs following the process outlined in the handbook *Identifying Refuge Resources of Concern and Management Priorities: A Handbook* (U.S. Fish and Wildlife Service 2009c).

E.2 Comprehensive Resources of Concern

A comprehensive list of potential ROCs was created early in the planning process. The planning team identified species, species groups, and communities of concern, based upon a review of the refuge's establishing history and purposes, a description of the key habitat types existing at the refuge, and a review of numerous conservation plans (see Sections 1.6, 1.7, and 1.8 of the draft CCP/Environmental Assessment), many of which highlight priority species or habitats for conservation. The comprehensive ROCs list is contained in Table E-2.

Table E-1. Summary of BIDEH for Tualatin River National Wildlife Refuge

Habitats (plant communities) that Represent Existing BIDEH	Population/Habitat Attributes (age class, structure, seral stage, species composition)	Natural Processes Responsible for These Conditions	Limiting Factors
Forest—Bottomland Riparian	Native overstory trees include Oregon ash, grand fir, big-leaf maple, Douglas-fir, and black cottonwood. Native subcanopy trees include black hawthorn, vine maple, cascara, Pacific ninebark, hazel, red alder, and Pacific yew. Native shrub layer includes snowberry, rose, red-osier dogwood, Douglas spirea, blue and red elderberry, red-flowering currant, Carex, and sword fern. Generally within the 100-year floodplain. *Potential Conservation Species: beaver, mink, downy woodpecker, northern red-legged frog, pileated woodpecker, Swainson's thrush, western wood peewee, wood duck, and yellow warbler.*	Functioning floodplain: infrequent major flood events (flood heavily once every 3-5 years), scouring of trees/herbaceous layers, deposition of silts. Frequent short-term flooding (may flood for a few days two to three times per year). Deposition of large woody debris in both the forest floor and river/stream channel. Flooding is the primary natural disturbance regime in Tualatin River Basin bottomland riparian forest.	Non-functioning floodplain and altered hydrology in refuge watershed. Floodplain alterations including ditching and tile drains associated with agricultural practices, urban and rural development leading to increased runoff, and summer water withdrawals for agriculture, industrial, and urban uses. Climate change may cause further changes in weather and/or flooding patterns. Invasive species such as reed canary grass, Himalayan blackberry, English hawthorn, English ivy, and holly.
Forest—Mixed Coniferous/deciduous Upland	Native overstory trees include Douglas-fir, western red-cedar, big-leaf maple, western hemlock, Garry oak, Pacific Madrone, and some grand fir. Native subcanopy trees include black hawthorn, vine maple, cascara, hazel,	Relatively undisturbed forest with openings caused by wind storms. Infrequent fires. Cool, wet winters and mild summers.	Habitat fragmentation from agricultural and urban development. Invasive species such as Himalayan blackberry, English hawthorn, English ivy, and holly. Species composition

Table E-1. Summary of BIDEH for Tualatin River National Wildlife Refuge

Habitats (plant communities) that Represent Existing BIDEH	Population/Habitat Attributes (age class, structure, seral stage, species composition)	Natural Processes Responsible for These Conditions	Limiting Factors
	serviceberry, Pacific dogwood, and red alder. Native shrub layer includes snowberry, Oregon grape, Indian plum, Mock orange, red-flowering currant, and sword fern. Generally occurs above the 100-year floodplain. *Potential Conservation Species: brown creeper, chestnut-backed chickadee, Pacific slope flycatcher, black-tailed deer, olive-sided flycatcher, Swainson's thrush, and pileated woodpecker.*		may change with changes in precipitation or temperature due to climate change. Forest diseases such as Swiss needle cast may also increase due to climate change.
Prairie—Wet Meadow	Few to no woody shrubs and trees. Native herbaceous species include sedges, rushes, tufted hairgrass, popcorn flower, Nelson's checker-mallow, and other forbs. *Potential Conservation Species: American kestrel, northern harrier, common yellowthroat, Nelson's checker-mallow, western meadowlark, Wilson's snipe, and sora.*	Periodic fire, poorly drained soils, and seasonal flooding. Typically a transition area between upland and wetland. Periodic grazing by large ungulates.	Invasive species especially reed canary grass and Himalayan blackberry. Fire suppression facilitates encroachment of woody species especially Oregon ash. With elk being removed from Willamette Valley habitats, no grazing by large ungulates. Draining and conversion to agriculture and urban development.
Oak Savanna	Widely scattered Garry oaks and/or Willamette	Frequent (approximately every	Agricultural and urban developments.

Table E-1. Summary of BIDEH for Tualatin River National Wildlife Refuge

Habitats (plant communities) that Represent Existing BIDEH	Population/Habitat Attributes (age class, structure, seral stage, species composition)	Natural Processes Responsible for These Conditions	Limiting Factors
	Valley ponderosa pine. Very few shrubs. Dominated by native grasses and forbs including Roemer's fescue, California oatgrass, California brome, blue wildrye, and meadow barley. *Potential Conservation Species: downy woodpecker, white-breasted nuthatch, western bluebird, western gray squirrel, and coyote.*	5 years) low-intensity fire; absence of ground disturbance; presence of acorn-dispersing animals (squirrels, jays, acorn woodpeckers); light grazing/browsing by native ungulates. Oak habitats were formerly maintained by Native Americans with fires of various frequencies.	Fire suppression causing conifer encroachment and competition by native trees and shrubs. Invasive species such as Himalayan blackberry and non-native grasses.
Wetland—Herbaceous	Seasonal, semipermanent, and permanent wetlands characterized by annual vegetation and perennial emergent and submerged aquatic wetland plants. Few trees and shrubs. *Potential Conservation Species: waterfowl, canvasback, dusky and cackling Canada geese, tundra swans, shorebirds, sora, northern pintail, northwestern pond turtle, American bittern, and pied-billed grebe.*	Hydric soils flooded at least part of the year from rainfall accumulation or overflow from rivers and streams in the floodplain. Fluctuating water levels and deposition of sediments from flood waters. Infrequent fire. Consumption of vegetation by large concentrations of waterfowl. Functioning floodplain: infrequent major flood events (flood heavily once every 3-5 years), scouring of woody species, deposition of silts, and reduction of emergents.	Non-functioning floodplain and altered hydrology in the refuge watershed. Floodplain alterations including ditching and tile drains associated with agricultural practices, urban and rural development leading to increased runoff, and summer water withdrawals for agriculture, industrial, and urban uses. Encroachment of woody species. Invasive species including reed canary grass, velvetleaf, knotgrass (Bermuda grass), common

Table E-1. Summary of BIDEH for Tualatin River National Wildlife Refuge

Habitats (plant communities) that Represent Existing BIDEH	Population/Habitat Attributes (age class, structure, seral stage, species composition)	Natural Processes Responsible for These Conditions	Limiting Factors
			cocklebur, and nutria. Urban development with draining and filling of wetlands.
Wetland—Scrub-shrub	Dominated by willow species, red-osier dogwood, rose, and spirea generally less than 20 ft. tall. Herbaceous plants include common cattail, sedges, and rushes. Typically characterized by deep organic peat soils. *Potential Conservation Species: willow flycatcher, common yellowthroat, American bittern, northern red-legged frog, and sora.*	Hydric soils flooded for a large part of the year from rainfall accumulation or functional floodplain causing overflow from rivers and streams.	Urban development with draining and filling of wetlands. Many of these habitat types were drained and converted to agriculture through draining, ditching, and tiling. Invasive species such as reed canary grass outcompete native plants.
Rivers, Streams, and Backwater Sloughs	Lower Tualatin River mainstem is characterized as low-gradient (about 1 foot/mile drop) and slow-flowing with riparian vegetation along the banks. Tributary streams may be low- to high-gradient. Sloughs may be inundated year-round or seasonally. Vegetation may include native riparian plant species such as Oregon ash, red-osier dogwood, willows, snowberry, twinberry, and Pacific ninebark.	Periodic flooding, scouring and movement of river/stream channel, inputs of coarse woody debris and leafy detritus, and occasional catastrophic flooding.	Dams; water removal for agricultural, industrial, urban, and rural uses; and ditching, tiling, and draining of adjacent lands. Changes in frequency, duration, and intensity of flood events. Poor water quality, such as water with low dissolved oxygen, high phosphorus, and high temperature. Climate change may exacerbate flooding frequency and/or water quality issues.

Table E-1. Summary of BIDEH for Tualatin River National Wildlife Refuge

Habitats (plant communities) that Represent Existing BIDEH	Population/Habitat Attributes (age class, structure, seral stage, species composition)	Natural Processes Responsible for These Conditions	Limiting Factors
	Potential Conservation Species: anadromous fish, beaver, mink, northwestern pond turtle, and wood duck.		Tualatin River channel is deeply incised and some tributary streams are highly modified into channelized sections with steep banks. Artificial fish passage barriers such as culverts and water diversion structures. Invasive species such as reed canary grass outcompete native plants.

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Acorn Woodpecker			FS						X		X									X		
Aleutian Canada Goose	X																			X		
Allen's Hummingbird					X	X																
American Acetropis Grass Bug			FS																			
American Bittern	X															X						
American Coot	X																					
American Kestrel	X	X									X										X	
American Wigeon	X						GBBDC															
Anadromous Fish	X																					
Backwater Streams and Sloughs	X																					

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Bald Eagle	X	X		ST	X				X											X		
Band-tailed Pigeon			FS			X	GBBDC			X	X											
Barn Owl	X																					
Beaver	X	X																				
Belted Kingfisher	X																					
Bewick's Wren											X											
Black-capped Chickadee	X																					
Black-headed Grosbeak	X																					
Black-tailed Deer	X	X																				
Black-throated Gray Warbler										X												
Bradshaw's Lomatium			FE	SE					X													X
Brown Creeper	X	X									X											

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Bullock's Oriole											X											
Bushtit										X	X											
Cackling Canada Goose	X						GBBDC							X								
California Myotis									X													
Canvasback	X						GBBDC															
Chestnut-backed Chickadee		X							X													
Chinook Salmon (Upper Willamette Evolutionarily Significant Unit [ESU])	X		FT						X												X	
Chipping Sparrow									X		X											

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Chorus Frog	X	X																				
Coho Salmon	X																					
Common Garter Snake	X																					
Common Yellowthroat	X																					
Cooper's Hawk		X								X	X											
Coyote		X																				
Cropland/Pasture	X																					
Cutthroat Trout (coastal)	X		FS																			
Downy Woodpecker	X										X											
Dunlin	X														X							

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Dusky Canada Goose	X	X					GBBDC		X								X			X		
Fender's Blue Butterfly		X	FE	SE					X											X		X
Forest—Bottomland Riparian	X	X							X		X										X	
Forest—Mixed Coniferous/Deciduous Upland	X	X																				
Fringed Myotis			FS																			
Garry Oak	X	X																			X	
Golden Paintbrush			FT	SE					X													X
Grasshopper Sparrow									X		X									X		

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Great Blue Heron	X	X							X													
Great Egret	X																					
Greater Scaup							GBBDC										X					
Greater Yellowlegs	X														X							
Green-winged Teal	X																					
Hermit Warbler						X																
Hooded Merganser	X																					
Horned Lark (*strigata* ssp. only)		X	FC		X		BCC/BCR		X		X									X	X	
House Wren											X											
Hutton's Vireo										X												

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Killdeer	X			ST											X						X	
Kincaid's Lupine	X		FT	ST					X													X
Least Sandpiper															X							
Lesser Goldfinch										X												
Lesser Scaup	X						GBBDC										X					
Lesser Yellowlegs					X										X							
Lewis's Woodpecker		X	FS		X	X	BCC/N			X	X									X	X	
Long-billed Curlew					X		BCC/N								X							
Long-billed Dowitcher															X							
Long-legged Myotis			FS																			

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Mallard	X						GBBDC															
Mink	X	X																				
Mourning Dove							GBBDC															
Nelson's Checker-mallow	X	X	FT	ST					X													X
Neotropical Landbirds—Breeding	X																					
Northern Flicker	X																					
Northern Harrier	X	X					BCC/N				X										X	
Northern Pintail	X	X					GBBDC										X					
Northern Pygmy Owl										X												
Northern Red-legged Frog	X	X	FS						X											X	X	

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Northern Saw-whet Owl										X												
Northern Spotted Owl			FT	ST			FT			X										X		
Northwestern Pond Turtle	X	X	FS						X										X	X		
Northwestern Salamander	X																					
Olive-sided Flycatcher	X	X	FS		X	X				X	X									X		
Orange-crowned Warbler											X											
Oregon Ash	X	X																				
Oregon Chub			FE	SE				X	X											X		
Pacific Lamprey	X		FS						X											X		

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Pacific-slope Flycatcher		X								X	X											
Pale Larkspur (*Delphinium leucophaeum*)			FS	SE																		X
Peacock Larkspur (*Delphinium pavonaceum*)	X		FS	SE					X													X
Peregrine Falcon	X	X			X		BCC/N		X											X		
Pied-billed Grebe	X															X						
Pileated Woodpecker	X	X																				
Ponderosa Pine (Willamette)	X																					
Prairie—Dry Meadow	X																					

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Prairie—Wet Meadow	X	X							X												X	X
Purple Finch					X					X												
Purple Martin		X	FS						X		X									X		
Red Crossbill										X												
Red-breasted Sapsucker										X												
Red-eyed Vireo	X										X											
Red-naped Sapsucker							BCC/N			X												
Red-shouldered Hawk											X											
Red-tailed Hawk	X	X																				
Red-winged Blackbird	X																					

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Ring-necked Duck	X						GBBDC															
Ring-necked Pheasant	X																					
River Otter	X	X																				
Rufous Hummingbird					X	X	BCC/N				X											
Sandhill Crane																				X		
Savanna—Oak/Pine	X	X							X		X										X	X
Sharp-shinned Hawk		X																				
Shorebirds—Migrating	X																			X	X	
Short-billed					X		BCC/N															

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Dowitcher																						
Short-eared Owl						X			X											X		
Silver-haired Bat			FS																			
Solitary Sandpiper					X																	
Song Sparrow	X																					
Sora	X	X														X						
Spotted Sandpiper	X																					
Steelhead (Upper Willamette ESU)	X	X	FT						X										X		X	
Steller's Jay										X												
Swainson's Thrush	X	X									X											

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Taylor's Checkerspot Butterfly			FC						X													X
Thin-leaved Peavine (*Lathyrus holochlorus*)			FS																			
Townsend's Western Big-eared Bat			FS						X											X		
Tree Swallow											X											
Tricolored Blackbird			FS			X														X		
Trumpeter Swan							GBBDC													X		
Tundra Swan	X	X											X								X	
Varied Thrush	X	X								X	X											

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Vaux's Swift	X									X	X											
Vesper Sparrow (*affinis* ssp. only)			FS		X		BCC/BCR		X		X									X	X	
Virginia Rail	X															X						
Wapato	X	X																				
Warbling Vireo	X																					
Water Howellia			FT																			
Waterfowl—Cavity Nesting	X																					
Waterfowl—Migrating	X																					
Waterfowl—Wintering	X	X							X												X	
Wayside Aster (*Eucephalus*			FS						X													

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
vialis)																						
Western Bluebird	X	X							X											X		
Western Brook Lamprey									X													
Western Canada Goose												X										
Western Gray Squirrel		X							X													
Western Meadowlark	X	X							X		X									X		
Western Painted Turtle									X											X		
Western Screech Owl	X									X	X											
Western Toad																				X		

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Western Wood Pewee	X										X											
Wetland	X								X				X	X	X	X	X	X		X	X	
Wetland—Forested	X	X																			X	
Wetland—Herbaceous	X	X																				
Wetland—Scrub-shrub	X	X																		X		
White Rock Larkspur	X			SE					X													
White-breasted Nuthatch		X							X		X											
White-fronted Goose	X						GBBDC															

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
White-topped Aster				ST					X													X
Willamette Daisy			FE	SE					X													X
Willamette Floater (*Anodonta wahlametensis*)									X											X		
Willamette Valley Larkspur (*Delphinium oreganum*)			FS	SC																		X
Willow Flycatcher	X	X	FS		X	X			X		X											
Wilson's Snipe	X	X													X							
Wood Duck—Breeding	X	X					GBBDC															

Table E-2. Potential Resources of Concern for Tualatin River National Wildlife Refuge

Species	Refuge Purpose Species	BIDEH	Federal Threatened and Endangered	State Threatened and Endangered	Bird Conservation Region 5 (2008)	Partners in Flight (PIF) Watch List	Birds of Management Concern (BMC) Region 1 Status 2005	Oregon Chub Recovery Plan	Oregon Conservation Strategy	PIF—Oregon/BCR 5, 2004	PIF: Conservation Strategy—Landbirds 1999, 2000	Pacific Flyway Management Plan: Western Canada Geese	Pacific Flyway Management Plan: Western Population Tundra Swans	Pacific Flyway Mgt. Plan: Cacklers	Shorebird Plan [1]	Waterbird Plan [2]	Waterfowl Plan [3]	Flyway Depredation[4]	Three Rivers Conservation Plan 2006	Nature Conservancy—WVPTGSEA	Pacific Coast Joint Venture (PCJV) Willamette Valley Implementation Plan	Recovery Plan for Prairie Species
Yellow Warbler	X										X											
Yellow-billed Cuckoo			FC		X		BCC/R				X									X	X	
Yellow-breasted Chat	X		FS						X		X											
Yellow-rumped Warbler	X																					
Yuma Myotis			FS																			

Possible Focal Species

Key:

Federal Threatened and Endangered Species

FE = Federal Endangered
FT = Federal Threatened
FC = Federal Candidate
FS = Federal Species of Concern

State Threatened and Endangered Species

SE = State Endangered
ST = State Threatened
SC = State Candidate
SS = State Sensitive

BMC Region 1 Designation Codes:

BCC/N = Birds of Conservation Concern/National
BCC/R = Birds of Conservation Concern/Regional
BCC/BCR = Birds of Conservation Concern/Bird Conservation Region
GBBDC = Gamebirds Below Desired Condition
GBADC = Game Birds Above Desired Condition
T/E = Threatened or Endangered under the Endangered Species Act

[1] U.S. Shorebird Conservation Plan (Brown et al. 2001)

[2] Waterbird Conservation for the Americas: the North American Waterbird Conservation Plan (Kushlan et al. 2002)

[3] North American Waterfowl Management Plan (North American Waterfowl Management Plan Committee 2004)

[4] Pacific Flyway Management Plan (Pacific Flyway Council 1998)

E.3 Priority Resources of Concern

The Comprehensive Resources of Concern list was further culled in developing a more targeted assemblage of Priority Resources of Concern (Table E-3). The Priority Resources of Concern table is comprised of 14 focal species, including birds and fish that were selected as representatives or indicators for the overall condition of important refuge habitats. Most of the biological emphasis of the CCP is focused on maintaining and restoring these priority resources.

Several different conservation focal species may be listed for specific habitats to cover the variety of habitat structures and plant associations. In addition, species with specific "niche" ecological requirements may be listed as a focal species. Other species utilizing the habitat will generally be expected to benefit as a result of management for the focal species.

Definitions for the column headings in Table E-3 are as follows:

- **Focal Species**: Species selected as representatives or indicators for the overall condition of the conservation target. In situations where the conservation target may include a broad variety of habitat structures and plant associations, several different conservation focal species may be listed. In addition, species with specific "niche" ecological requirements may be listed as a focal species. Management will be focused on attaining conditions required by the focal species. Other species utilizing the conservation target will generally be expected to benefit as a result of management for the focal species.
- **Habitat Type:** The general habitat description utilized by the focal species.
- **Habitat Structure:** The specific and measurable habitat attributes considered necessary to support the focal species.
- **Life History Requirement:** The general season of use for the focal species.
- **Other Benefiting Species:** Other species that are expected to benefit from management for the selected focal species. The list is not comprehensive; see the *Table of Potential Resources of Concern for the Refuges* for a more complete list.

Table E-3. Priority Resources of Concern for Tualatin River National Wildlife Refuge

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefitting Species
Pacific slope flycatcher	Forest—bottomland riparian	Early to mid-successional forest with shrub understory (Sakai and Noon 1991) associated with deciduous trees (Pearson and Manuwal 2001). Canopy trees >12 ft. tall with <20% tree canopy cover, where canopy is Oregon ash-dominated, with willow, red-osier dogwood, bigleaf maple, and hazel (Altman 2000). Shrub cover 30-80%.	Breeding	Yellow warbler, song sparrow, willow flycatcher, and rufous hummingbird
Swainson's thrush		Mid- to late-successional forest with shrub understory. Oregon ash, Douglas-fir, bigleaf maple, cascara as overstory species with >50% canopy closure. Swamp rose, snowberry, elderberry, and salmonberry; >50% shrub cover with >60% native species (PIF 2000).	Breeding, year-round for benefitting species	Beaver, northern red-legged frog, anadromous fish (coho and steelhead), yellow-breasted chat, and black-capped chickadee
Brown creeper		Old-growth and mature forest types (Anthony et al. 1996). Oregon ash, bigleaf maple, Douglas-fir with canopy height >33 ft. and canopy closure >50%. Subcanopy cover >10% by snowberry, Pacific yew, cascara, some grand fir. Habitat patches >50 meter wide (PIF 2000).	Breeding and year-round	Chestnut-backed chickadee, anadromous fish, western wood pewee, downy woodpecker, and pileated woodpecker
Orange-crowned warbler	Forest—mixed coniferous/ deciduous upland	Douglas-fir-dominated canopy with mixtures of grand fir, western red-cedar, western hemlock, bigleaf maple, Garry oak, Pacific dogwood, Pacific yew, and red alder. Understory consists of snowberry, hazel, sword fern, and other shrubs. Understory trees <15 ft. and >30% cover (Altman 1999).	Breeding and year-round for benefitting species	Bewick's wren, spotted towhee, downy woodpecker, olive-sided flycatcher, and pileated woodpecker
Wilson's snipe	Prairie—wet meadow	Dominated by sedges and native grasses with very few shrubs or trees (NatureServe 2010). Grasses may be >3 ft. tall (e.g., *Deschampsia* sp.). A wide variety	Breeding, wintering for waterfowl species	American bittern, savanna sparrow, western meadowlark, northern harrier,

Table E-3. Priority Resources of Concern for Tualatin River National Wildlife Refuge

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefitting Species
		of sedges and rushes should be represented. May retain water at the soil surface more than 6 months during the year.		dusky Canada goose, migrating and wintering waterfowl, and Nelson's checker-mallow
Western bluebird	Oak savanna	Early successional stages (restoration areas) dominated by native grasses and forbs with scattered sapling Garry oak trees. Trees may range from <3 ft. tall to >15 ft.	Breeding, year-round	Chipping sparrow, coyote, grasshopper sparrow, mourning dove, and rufous hummingbird
White-breasted nuthatch		Trees dominated by widely spaced (Vesely and Tucker 2004) mature Garry oak >25 inches diameter at breast height (DBH) with cavities. Some areas with scattered ponderosa pine large enough (>25 inches) to provide nest cavities, and <1 snags/acre >1 ft. DBH. Native grass and forb understory <30 inches with few to no shrubs. Tree and shrub cover <10% with variable grass heights. Patch size >200 acres (PIF 2000).	Breeding, year-round	Western gray squirrel, acorn woodpecker, western bluebird, black-tailed deer, and lesser goldfinch
Northern pintail	Herbaceous wetland	Shallow water depths averaging 4-18 inches over 75% of wetland basins. Dominated by seed-producing annual plants (e.g., smartweeds, plantain), and native emergent plant species (e.g., sedges, rushes), with few encroaching trees.	Wintering, migrating	Tundra swan, cackling Canada goose, wintering waterfowl, river otter, mink, northwestern pond turtle; bald eagle and peregrine falcon (foraging)
Greater yellowlegs		Declining water depths producing saturated mud flats to mostly drained during summer.	Migrating and year-round or breeding for benefitting species	Least sandpiper, dunlin, killdeer, lesser yellowlegs, long-billed dowitcher, spotted sandpiper, tree swallow, and great blue heron
Virginia rail		Water depths averaging 12-30 inches over 25-75%. Dominated	Breeding and year-round for	Wintering waterfowl,

Table E-3. Priority Resources of Concern for Tualatin River National Wildlife Refuge

Focal Species	Habitat Type	Habitat Structure	Life History Requirement	Other Benefitting Species
		by emergent plant species such as spike rush, wapato, softstem bulrush, and common cattail.	benefitting species	American bittern, sora, common yellowthroat, common garter snake, and chorus frog
Pied-billed grebe		Water depths averaging 24-48 inches over 50-75%. Open water >50%. Plant species dominated by submergent plants such as *Potamogeton* sp., *Callitriche* sp., and emergent plants such as *Scirpus* sp., softstem bulrush, and common cattail.	Breeding and year-round for benefitting species	Diving ducks, red-winged blackbird, wood duck, Vaux's swift, mink, purple martin, northwestern pond turtle, and northwestern salamander
Willow flycatcher	Wetland—scrub-shrub	Water depths typically 3-10 ft. with some water remaining during most of the year. Vegetation dominated by willow, rose, and Douglas spirea with some Oregon ash, redosier dogwood, and black cottonwood.	Breeding and year-round	American bittern, sora, Virginia rail, red-winged blackbird, common yellowthroat, northern red-legged frog, and northwestern salamander
Coastal cutthroat trout, winter steelhead	Rivers, streams, and backwater sloughs	Barrier-free river, stream channels, and sloughs. Shaded along the banks, and with coarse woody debris for in-stream structure.	Migration corridor for migrating fish, off-channel winter refuge for juvenile fish	Northwestern pond turtle, mink, beaver, belted kingfisher, spring Chinook, coho, and Pacific lamprey
Cackling Canada goose	Cropland	Cultivated cereal grains including corn, barley, wheat, oats, etc. Green browse pastures with annual/perennial ryegrass, fescue, legumes, etc. Mowed to <4 inches before October 1.	Migrating and wintering waterfowl, year-round for benefitting species	Tundra swan, dusky Canada goose, northern pintail, American wigeon, northern harrier, and western meadowlark

Appendix F
Statement of Compliance

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Appropriate Use Findings

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Appendix F. Statement of Compliance

Statement of Compliance for Implementation of the Tualatin River National Wildlife Refuge Comprehensive Conservation Plan, Washington County, Oregon

The following executive orders and legislative acts have been reviewed as they apply to implementation of the Tualatin River National Wildlife Refuge comprehensive conservation plan (CCP).

National Environmental Policy Act (1969), as Amended (42 U.S.C. § 4321 et seq.)

The planning process has been conducted in accordance with National Environmental Policy Act (NEPA) implementing procedures, with U.S. Department of the Interior and U.S. Fish and Wildlife Service (Service) procedures, and in coordination with the affected public. The requirements of NEPA (42 U.S. Code [U.S.C.] § 4321 et seq.) and its implementing regulations in 40 Code of Federal Regulations (CFR) 1500-1508 have been satisfied in the procedures used to reach decisions. These procedures included the development of a range of alternatives for the CCP; analysis of the likely effects of each alternative; and public involvement throughout the planning process. The start of the scoping period was announced through a Federal Register notice, news releases to local newspapers, the Service's refuge planning website, and a planning update. The draft CCP/environmental assessment (EA) was released for a 30-day public comment period. The affected public was notified of the availability of the document through a Federal Register notice, news releases to local newspapers, the Service's refuge planning website, and a planning update. Copies of the draft CCP/EA and/or planning updates were distributed to an extensive mailing list. In addition, the Service participated in a variety of public outreach efforts throughout the planning process (see Appendix K).

The CCP is programmatic in many respects and specific details of certain projects and actions cannot be determined until a later date depending on funding and implementation schedules. Certain projects or actions may require additional NEPA compliance.

National Historic Preservation Act (1966), as Amended (16 U.S.C. § 470 et seq.)

The management of the archaeological and cultural resources of the refuge would comply with the regulations of Section 106 of the National Historic Preservation Act. Under the proposed action, historic properties would be maintained and repaired as funding becomes available. Maintenance and improvement of historic resources would result in positive impacts to cultural resources; however, determining whether a particular action has the potential to affect cultural resources is an ongoing process that occurs as step-down and site-specific project plans are developed. Should additional historic properties be identified or acquired in the future, the Service would comply with the National Historic Preservation Act if any management actions have the potential to affect these properties.

Executive Order 12372. Intergovernmental Review

Coordination and consultation with affected Tribal, local, and state governments, other Federal agencies, and the landowners has been completed through personal contact by refuge staff or supervisors, and/or by inclusion of the appropriate entities on the CCP mailing list.

Executive Order 13175. Consultation and Coordination with Indian Tribal Governments

As required under the Secretary of the Interior Order 3206—American Indian Tribal Rights, Federal Tribal Trust Responsibilities, and the Endangered Species Act—the project leader notified and consulted interested Tribes.

Executive Order 12898. Federal Actions to Address Environmental Justice in Minority and Low-income Populations

All Federal actions must address and identify, as appropriate, disproportionally high and adverse human health or environmental effects of their programs, policies, and activities on minority populations, low-income populations, and Indian Tribes in the United States. Actions in all alternatives were evaluated and no adverse human health or environmental effects were identified for minority or low-income populations, Indian Tribes, or anyone else.

Wilderness Preservation Act of 1964 (16 U.S.C. § 1131 et seq.)

The Service has evaluated the suitability of the refuge for wilderness designation through the "inventory" phase according to the guidelines of the Wilderness Review process as described in 610 FW 4. In this inventory, no areas on the refuge were found to meet the minimum wilderness criteria for size, naturalness, or outstanding opportunities for solitude and primitive/unconfined recreation (see Appendix D for additional details).

Architectural Barriers Act of 1968, as Amended (42 U.S.C. § 4151 et seq.)

The Architectural Barriers Act requires access to Federal facilities for people with disabilities. Access for persons with disabilities has been considered during the planning process, and actions related to access are found in Chapter 2 of the CCP/EA.

National Wildlife Refuge SystemAdministration Act of 1966, as Amended (16 U.S.C. § 668dd-668ee)

This Act requires the Service to develop and implement a CCP for each refuge. The CCP identifies and describes refuge purposes; the vision and goals for the refuge; fish, wildlife, and plant populations and related habitats on the refuge; archaeological and cultural values of the refuge; issues that may affect populations and habitats of fish, wildlife, and plants; actions necessary to restore and improve biological diversity on the refuge; and opportunities for wildlife-dependent recreation, as required by the Act.

During the CCP development process, the refuge manager evaluated all existing and proposed uses at the Tualatin River National Wildlife Refuge. Priority wildlife-dependent uses (hunting, fishing, wildlife observation and photography, environmental education, and interpretation) are considered automatically appropriate under Service policy and are thus exempt from appropriate uses review.

Compatibility determinations have been prepared for all uses found appropriate (see Appendices A and B of the CCP/EA).

Executive Order 13186. Responsibilities of Federal Agencies to Protect Migratory Birds

This Order directs agencies to take certain actions to further implement the Migratory Bird Treaty Act. A provision of the Order directs Federal agencies to consider the impacts of their activities, especially in reference to birds on the Service's list of Birds of Conservation Concern. It also directs agencies to incorporate conservation recommendations and objectives in the North American Waterbird Conservation Plan and bird conservation plans developed by Partners in Flight into agency planning as described in Chapter 1. The effects to refuge habitats used by migratory birds from habitat, public use, and cultural resources actions were assessed within the CCP/EA.

Endangered Species Act (1973), as Amended (16 U.S.C. § 1531 et seq.)

This Act provides for the conservation of threatened and endangered species of fish, wildlife, and plants by Federal action and by encouraging the establishment of state programs. Documentation is required under Section 7 of the Act. Refuge policy requires the refuge manager to document issues that affect or may affect endangered species before initiating projects. Consultation on specific projects would be conducted prior to implementation to avoid any adverse impacts to these species and their habitats. See section 4-5 for discussion of federally listed species.

Executive Order 11990. Protection of Wetlands

The CCP is consistent with Executive Order 11990 because CCP implementation would protect any existing wetlands.

Executive Order 11988. Floodplain Management

Under this Order, Federal agencies "shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health and welfare, and to restore and preserve the natural and beneficial values served by floodplains." The CCP is consistent with Executive Order 11988 because CCP implementation would maintain and enhance riverine, riparian, wetland, and wet prairie habitats located within floodplains on the refuge, which would minimize flood impacts and continue to contribute to the natural and beneficial fish and wildlife resource values unique to the area.

Integrated Pest Management, 517 DM 1 and 7 RM 14

In accordance with 517 DM 1 and 7 RM 14, an integrated pest management (IPM) approach has been adopted to eradicate, control, or contain pest and invasive species on the refuge. In accordance with 517 DM 1, only pesticides registered with the U.S. Environmental Protection Agency (EPA) in full compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and as provided in regulations, orders, or permits issued by the EPA may be applied on lands and waters under refuge jurisdiction.

Chief, Division of Planning, Visitor Services, and Transportation	Date

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Appendix G Integrated Pest Management Program

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Appendix G. Integrated Pest Management Program

G.1 Background

Integrated pest management (IPM) is an interdisciplinary approach using methods to prevent, eliminate, contain, and/or control pest and invasive species (herein collectively referred to as pests) in concert with other management activities on refuge lands and waters to achieve wildlife and habitat management goals and objectives. IPM is a scientific adaptive management process where available scientific information and best professional judgment of the refuge staff and other resource experts would be used to identify and implement appropriate management strategies that can be modified and/or changed over time to ensure effective, site-specific management of pest species to achieve desired outcomes. In accordance with 43 Code of Federal Regulations (CFR) 46.145, adaptive management would be particularly relevant where long-term impacts may be uncertain, and future monitoring would be needed to make adjustments in subsequent implementation decisions. After a tolerable pest population (threshold) is determined considering achievement of refuge resource objectives and the ecology of pest species, one or more methods, or combinations thereof, would be selected that are feasible, efficacious, and most protective of nontarget resources, including native species (fish, wildlife, and plants) and U.S. Fish and Wildlife Service (Service) personnel, Service-authorized agents, volunteers, and the public. Staff time and available funding would be considered when determining feasibility/practicality of various treatments.

IPM techniques to address pests are presented as comprehensive conservation plan (CCP) strategies (see Chapter 2 of this CCP/Environmental Assessment [EA]) in an adaptive management context to achieve resource objectives of the Tualatin River National Wildlife Refuge (the refuge). To satisfy requirements for IPM planning as identified in the Service director's memo (dated September 9, 2004) titled *Integrated Pest Management Plans and Pesticide Use Proposals: Updates, Guidance, and an Online Database*, the following elements of an IPM program have been incorporated into this CCP:

- Habitat and/or wildlife objectives that identify pest species and appropriate thresholds to indicate the need for and successful implementation of IPM techniques; and
- Monitoring before and/or after treatment to assess progress toward achieving objectives including pest thresholds.

Where pesticides would be necessary to address pests, this appendix provides a structured procedure to evaluate potential effects of proposed uses involving ground-based applications to refuge biological resources and environmental quality in accordance with effects analyses presented in Chapter 6 (Environmental Consequences) of this CCP/EA. Only pesticide uses that likely would cause minor, temporary, or localized effects to refuge biological resources and environmental quality with appropriate best management practices (BMPs), where necessary, would be allowed for use on the refuge.

This appendix does not describe the more detailed process of evaluating potential effects associated with aerial applications of pesticides. However, the basic framework to assess potential effects to refuge biological resources and environmental quality from aerial application of pesticides would be similar to the process described in this appendix for ground-based treatments of other pesticides.

G.2 Pest Management Laws and Policies

In accordance with Service policy 569 FW 1 (Integrated Pest Management), plant, invertebrate, and vertebrate pests on units of the National Wildlife Refuge System (Refuge System) can be controlled to ensure balanced wildlife and fish populations in support of refuge-specific wildlife and habitat management objectives. Pest control on Federal (refuge) lands and waters also is authorized under the following legal mandates:

- National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S. Code [U.S.C.] 668dd-668ee);
- Plant Protection Act of 2000 (7 U.S.C. 7701 et seq.);
- Noxious Weed Control and Eradication Act of 2004 (7 U.S.C. 7781-7786, Subtitle E);
- Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) of 1996 (7 U.S.C. 136-136y);
- National Invasive Species Act of 1996 (16 U.S.C. 4701);
- Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (16 U.S.C. 4701);
- Food Quality Protection Act of 1996 (7 U.S.C. 136);
- Executive Order 13148, Section 601(a);
- Executive Order 13112; and
- Animal Damage Control Act of 1931 (7 U.S.C. 426-426c, 46 Stat. 1468).

Pests are defined as "… living organisms that may interfere with the site-specific purposes, operations, or management objectives or that jeopardize human health or safety" according to Department Policy 517 DM 1 (Integrated Pest Management Policy), published by the U.S. Department of the Interior. Similarly, 569 FW 1 defines pests as " … invasive plants and introduced or native organisms, that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety." 517 DM 1 also defines an invasive species as "a species that is non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health." Throughout the remainder of this CCP/EA, the terms pest and invasive species are used interchangeably because both can prevent/impede achievement of refuge wildlife and habitat objectives and/or degrade environmental quality.

In general, control of pests on the refuge would conserve and protect the nation's fish, wildlife, and plant resources as well as maintain environmental quality. From 569 FW 1, animal or plant species that are considered pests may be managed if the following criteria are met:

- There is threat to human health and well being or private property, the acceptable level of damage by the pest has been exceeded, or state or local government has designated the pest as noxious;
- It is detrimental to resource objectives as specified in a refuge resource management plan (e.g., CCP, habitat management plan), if available; and
- Control would not conflict with attainment of resource objectives or the purposes for which the refuge was established.

The specific justifications for pest management activities on the refuge are the following:

- Protect human health and well being;
- Prevent substantial damage to important refuge resources;

- Protect newly introduced or reestablished native species;
- Control nonnative (exotic) species to support existence of populations of native species;
- Prevent damage to private property; and
- Provide the public with quality, compatible wildlife-dependent recreational opportunities.

In accordance with Service policy 620 FW 1 (Habitat Management Plans), there are additional management directives regarding invasive species found on the refuge:

- "We are prohibited by Executive Order, law, and policy from authorizing, funding, or carrying out actions that are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere."
- "Manage invasive species to improve or stabilize biotic communities to minimize unacceptable change to ecosystem structure and function and prevent new and expanded infestations of invasive species. Conduct refuge habitat management activities to prevent, control, or eradicate invasive species …."

Animal species damaging/destroying Federal property and/or detrimental to the management program of a refuge may be controlled as described in 50 CFR 31.14 (Official Animal Control Operations). For example, the incidental removal of beaver damaging refuge infrastructure (e.g., clogging with subsequent damaging of water control structures) and/or negatively affecting habitats (e.g., removing woody species from existing or restored riparian areas) managed on refuge lands may be conducted without a pest control proposal. We recognize beavers are a native species and most of their activities on refuge lands represent a natural process beneficial for maintaining wetland habitats. Exotic nutria, whose denning and burrowing activities in wetland dikes causes cave-ins and breaches, can also be controlled using the most effective techniques considering site-specific factors without a pest control proposal. Along with the loss of quality wetland habitats associated with breaching of impoundments, the safety of refuge staff, volunteers, contractors, and public driving on structurally compromised levees and dikes can be threatened by sudden and unexpected cave-ins. Disposed wildlife specimens may be donated or loaned to public institutions. Donation or loans of resident wildlife species would only be made after securing state approval (50 CFR 31.11 [Donation and Loan of Wildlife Specimens]). Surplus wildlife specimens may be sold alive or butchered, dressed, and processed subject to Federal and state laws and regulations (50 CFR 31.12 [Sale of Wildlife Specimens]).

Trespass and feral animals also may be controlled on refuge lands. Based upon 50 CFR 28.43 (Destruction of Dogs and Cats), dogs and cats running at large on a national wildlife refuge and observed in the act of killing, injuring, harassing, or molesting humans or wildlife may be disposed of in the interest of public safety and protection of wildlife. Feral animals should be disposed of by the most humane method available and in accordance with relevant Service directives (including Executive Order 11643).

G.3 Strategies

To fully embrace IPM as identified in 569 FW 1, the following strategies, where applicable, would be carefully considered on the refuge for each pest species:

- **Prevention.** This would be the most effective and least expensive long-term management option for pests. It encompasses methods to prevent new introductions or the spread of the

established pests to uninfested areas. It requires identifying potential routes of invasion to reduce the likelihood of infestation. Hazard Analysis and Critical Control Points (HACCP) planning can be used to determine if current management activities on a refuge may introduce and/or spread invasive species in order to identify appropriate BMPs for prevention. See http://www.haccp-nrm.org/ for more information about HACCP planning.

Prevention may include source reduction, using pathogen-free or weed-free seeds or fill, exclusion methods (e.g., barriers), and/or sanitation methods (e.g., wash stations) to prevent reintroductions by various mechanisms including vehicles and personnel. Because invasive species are frequently the first to establish newly disturbed sites, prevention would require a reporting mechanism for early detection of new pest occurrences with quick response to eliminate any new pest populations. Prevention would require consideration of the scale and scope of land management activities that may promote pest establishment within uninfested areas or promote reproduction and spread of existing populations. Along with preventing initial introduction, prevention would involve halting the spread of existing infestations to new sites (Mullin et al. 2000). The primary reason for prevention would be to keep pest-free lands or waters from becoming infested. Executive Order 11312 emphasizes the priority for prevention with respect to managing pests.

The following would be methods to prevent the introduction and/or spread of pests on refuge lands:

- Before beginning ground-disturbing activities (e.g., discing, scraping), inventory and prioritize pest infestations in project operating areas and along access routes. Refuge staff would identify pest species on-site or within reasonably expected potential invasion vicinity. Where possible, the refuge staff would begin project activities in uninfested areas before working in pest-infested areas.
- Refuge staff would locate and use pest-free project staging areas. They would avoid or minimize travel through pest-infested areas, or restrict travel to those periods when the spread of seed or propagules of invasive plants would be least likely.
- Refuge staff would determine the need for, and when appropriate identify, sanitation sites where equipment can be cleaned of pests. Where possible, refuge staff would clean equipment before entering lands at on-refuge approved cleaning site(s). This practice does not pertain to vehicles traveling frequently in and out of the project area that would remain on roadways. Refuge staff would remove mud, dirt, and plant parts from project equipment before moving it into a project area.
- Refuge staff would clean all equipment before leaving the project site, if operating in areas infested with pests. Refuge staff would determine the need for, and when appropriate identify, sanitation sites where equipment can be cleaned.
- Refuge staff, their authorized agents, and refuge volunteers would, where possible, inspect, remove, and properly dispose of seed and parts of invasive plants found on their clothing and equipment. Proper disposal means bagging the seeds and plant parts and then properly disposing of them.
- Refuge staff would evaluate options, including closure, to restrict traffic on sites with ongoing restoration of desired vegetation. Refuge staff would revegetate disturbed soil (except travelways on surfaced projects) to optimize native plant establishment for each specific site. Revegetation may include topsoil replacement, planting, seeding, fertilization, liming, and weed-free mulching as necessary. The refuge staff would use native material where appropriate and feasible. They would also use

certified weed-free or weed-seed-free hay or straw where certified materials are reasonably available.
  - Refuge staff would provide information, training, and appropriate pest identification materials to permit holders and recreational visitors. They would educate them about pest identification, biology, impacts, and effective prevention measures.
  - Refuge staff would require grazing permittees to use preventative measures for their livestock while on refuge lands.
  - Refuge staff would inspect borrow material for invasive plants prior to use and transport onto and/or within refuge lands.
  - Refuge staff would consider invasive plants in planning for road maintenance activities.

The following methods would be used to prevent the introduction and/or spread of pests into refuge waters:

  - Refuge staff would inspect boats, trailers, other boating equipment, and waders or boots. Where possible, refuge staff would remove any visible plants, animals, or mud before leaving any waters or boat launching facilities. Where possible, the refuge staff would drain water from motor, live well, bilge, and transom wells while on land before leaving the site. If possible, the refuge staff would wash and dry boats, anchors, nets, floors of boats, propellers, axles, trailers, and other boating equipment to kill pests not visible at the boat launch. Waders and boots would be cleaned and disinfected as necessary.
  - Where feasible, the refuge staff would maintain a l00-foot buffer of aquatic pest-free clearance around boat launches and docks or quarantine areas when cleaning around culverts, canals, or irrigation sites. Where possible, refuge staff would inspect and clean equipment before moving to new sites or from one project area to another.

- **Mechanical/Physical Methods.** These methods would remove and destroy, disrupt the growth of, or interfere with the reproduction of pest species. For plants species, these treatments can be accomplished by hand, hand tools (manual), or power tools (mechanical) and include pulling, grubbing, digging, tilling/discing, cutting, swathing, grinding, shearing, girdling, mowing, and mulching of the pest plants.

  For animal species, Service employees or their authorized agents could use mechanical/physical methods (including trapping) to control pests as a refuge management activity. Based upon 50 CFR 31.2, trapping can be used on a refuge to reduce surplus wildlife populations for a "balanced conservation program" in accordance with Federal or state laws and regulations. In some cases, non-lethally trapped animals would be relocated to off-refuge sites with prior approval from the state.

  Each of these tools would be efficacious to some degree and applicable to specific situations. In general, mechanical controls can effectively control annual and biennial pest plants. However, to control perennial plants, the root system has to be destroyed or it would resprout and continue to grow and develop. Mechanical controls are typically not capable of destroying a perennial plant's root system. Although some mechanical tools (e.g., discing, plowing) may damage root systems, they may also stimulate regrowth producing a denser plant population that may aid in the spread depending upon the target species (e.g., Canada

thistle). In addition, steep terrain and soil conditions would be major factors that can limit the use of many mechanical control methods.

Some mechanical control methods (e.g., mowing), which would be used in combination with herbicides, can be very effective at controlling perennial species. For example, mowing perennial plants followed sequentially by treating the plant regrowth with a systemic herbicide often would improve the efficacy of the herbicide compared to herbicide treatment alone.

- **Cultural Methods.** These methods would involve manipulating habitat to increase pest mortality by reducing its suitability to the pest. Cultural methods would include water-level manipulation, mulching, planting winter cover crops, changing planting dates to minimize pest impact, prescribed burning (which facilitates revegetation, increases herbicide efficacy, and removes litter to assist in emergence of desirable species), flaming with propane torches, trap crops, crop rotations that include nonsusceptible crops, moisture management, addition of beneficial insect habitat, reducing clutter, proper trash disposal, planting or seeding desirable species to shade or outcompete invasive plants, applying fertilizer to enhance desirable vegetation, prescriptive grazing, and other habitat alterations.

- **Biological Control Agents.** Classical biological control would involve the deliberate introduction and management of natural enemies (parasites, predators, or pathogens) to reduce pest populations. Many of the most ecologically or economically damaging pest species in the United States originated in foreign countries. These newly introduced pests, which are free from natural enemies found in their country or region of origin, may have a competitive advantage over cultivated and native species. This competitive advantage often allows introduced species to flourish, and they may cause widespread economic damage to crops or outcompete and displace native vegetation. Once the introduced pest species population reaches a certain level, traditional methods of pest management may be cost-prohibitive or impractical. Biological controls typically are used when these pest populations have become so widespread that eradication or effective control would be difficult or no longer practical.

  Biological control has advantages as well as disadvantages. Benefits include reducing pesticide use, host specificity for target pests, long-term self-perpetuating control, low cost per acre, capacity for searching and locating hosts, synchronizing biological control agents to hosts' life cycles, and the unlikelihood that hosts would develop resistance to agents. Disadvantages include limited availability of agents from their native lands, the dependence of control on target species' density, the slow rate at which control occurs, biotype matching, the difficulty and expense of conflicts over control of the target pest, and host specificity when host populations are low.

  A reduction in target species populations from biological controls is typically a slow process, and efficacy can be highly variable. It may not work well in a particular area although it does work well in other areas. Biological control agents would require specific environmental conditions to survive over time. Some of these conditions are understood, whereas others are only partially understood or not understood at all.

  Biological control agents would not eradicate a target pest. When using biological control agents, residual levels of the target pest typically are expected; the agent's population level or

survival would be dependent upon the density of its host. After the pest population decreases, the population of the biological control agent would decrease correspondingly. This is a natural cycle. Some pest populations (e.g., invasive plants) tend to persist for several years after a biological control agent becomes established due to seed reserves in the soil, inefficiencies in the agent's search behavior, and the natural lag in population buildup of the agent.

The full range of pest groups potentially found on refuge lands and waters includes diseases, invertebrates (insects, mollusks), vertebrates, and invasive plants (the most common group). Often it is assumed that biological control would address many if not most of these pest problems. There are several well-documented success stories of biological control of invasive weed species in the Pacific Northwest including Mediterranean sage, St. John's wort (Klamath weed), and tansy ragwort. Emerging success stories include Dalmatian toadflax, diffuse knapweed, leafy spurge, purple loosestrife, and yellow star thistle. However, historically, each new introduction of a biological control agent in the United States has only about a 30 percent success rate (Coombs et al. 2004).

Introduced species without desirable close relatives in the United States would generally be selected as biological controls. Natural enemies that are restricted to one or a few closely related plants in their country of origin are targeted as biological controls (Center et al. 1997; Hasan and Ayres 1990).

Refuge staff would ensure introduced agents are approved by the applicable authorities. Except for a small number of formulated biological control products registered by the U.S. Environmental Protection Agency (EPA) under FIFRA, most biological control agents are regulated by the U.S. Department of Agriculture (USDA)-Animal Plant Health Inspection Service, Plant Protection and Quarantine (APHIS-PPQ). State departments of agriculture and, in some cases, county agricultural commissioners or weed districts have additional approval authority.

Federal permits (USDA-APHIS-PPQ Form 526) are required to import biocontrol agents from another state. Form 526 may be obtained through the Internet at: http://www.aphis.usda.gov/ppq/permits/bioligical/weedbio.html.

The Service strongly supports the development and legal and responsible use of appropriate, safe, and effective biological control agents for nuisance and nonindigenous or pest species.

State and county agriculture departments may also be sources for biological control agents or they may have information about where biological control agents may be obtained. Commercial sources should have an Application and Permit to Move Live Plant Pests and Noxious Weeds to release specific biological control agents in a state and/or county. Furthermore, certification regarding the biological control agent's identity (genus, specific epithet, subspecies, and variety) and purity (e.g., parasite-free, pathogen-free, and biotic and abiotic contaminants) should be specified in purchase orders.

Biological control agents are subject to 7 Refuge Manual (RM) 8 (Exotic Species Introduction and Management). In addition, refuge staff would follow the International Code of Best Practice for Classical Biological Control of Weeds (http://invasives.wsu.edu/Code.htm) as ratified by delegates to the Tenth International

Symposium on Biological Control of Weeds in Bozeman, Montana, on July 9, 1999. This code states the following:

- Release only approved biological control agents,
- Use the most effective agents,
- Document releases, and
- Monitor for impact to the target pest, non-target species, and the environment.

Biological control agents formulated as pesticide products and registered by the EPA (e.g., *Bacillus thuringiensis* var. *israelensis [B.t.i.]*) are also subject to pesticide use proposal (PUP) review and approval (see below).

A record of all releases would be maintained with date(s), location(s), and environmental conditions of the release site(s); the identity, quantity, and condition of the biological control agents released; and other relevant data and comments such as weather conditions. Systematic monitoring to determine the establishment and effectiveness of the release is also recommended.

National Environmental Policy Act (NEPA) documents regarding biological and other environmental effects of biological control agents prepared by another Federal agency, where the scope is relevant to evaluation of releases on refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management, U.S. Forest Service (USFS), the National Park Service, the USDA-APHIS, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s) from the review. Incorporating by reference (43 CFR 46.135) is a technique used to avoid redundancies in analysis. It also can reduce the bulk of a Service NEPA document, which only must identify the documents that are incorporated by reference. In addition, relevant portions must be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of the relevance of the referenced material to the current analysis.

- **Pesticides.** The selective use of pesticides would be based upon pest ecology (including mode of reproduction), the size and distribution of pest populations, site-specific conditions (e.g., soils, topography), known efficacy under similar site conditions, and the capability to use BMPs to reduce/eliminate potential effects to nontarget species and sensitive habitats, and prevent contamination of surface and groundwater. All pesticide use (pesticide, target species, application rate, and method of application) would comply with the applicable Federal (FIFRA) and state regulations pertaining to pesticide use, safety, storage, disposal, and reporting. Before pesticides can be used to eradicate, control, or contain pests on refuge lands and waters, PUPs would be prepared and approved in accordance with 569 FW 1. PUP records would provide a detailed, time-, site-, and target-specific description of the proposed use of pesticides on the refuge. All PUPs would be created, approved or disapproved, and stored in the Pesticide Use Proposal System (PUPS), which is a centralized database only accessible on the Service's intranet (https://systems.fws.gov/pups). Only Service employees would be authorized to access PUP records for a refuge in this database.

  Application equipment would be selected to provide site-specific delivery to target pests while minimizing/eliminating direct or indirect (e.g., drift) exposure to non-target areas and degradation of surface and groundwater quality. Where possible, target-specific equipment

(e.g., backpack sprayer, roller, wiper) would be used to treat target pests. Other target-specific equipment used to apply pesticides include soaked wicks or paint brushes for wiping vegetation and lances, hatchets, or syringes for direct injection into stems. Granular pesticides may be applied using seeders or other specialized dispensers. In contrast, aerial spraying (e.g., fixed-wing or helicopter) would only be used where access is difficult (due to remoteness) and/or the size and distribution of infestations precludes practical use of ground-based methods.

Because repeated use of one pesticide may allow resistant organisms to survive and reproduce, multiple pesticides with variable modes of action would be considered for treatments on refuge lands and waters. This is especially important if multiple applications within years and/or over a growing season likely would be necessary for habitat maintenance and restoration activities to achieve resource objectives. Integrated chemical and non-chemical controls also are highly effective, where practical, because pesticide-resistant organisms can be removed from the site.

Cost may not be the primary factor in selecting a pesticide for use on a refuge. If the least expensive pesticide would potentially harm natural resources or people, then a different product would be selected, if available. The most efficacious pesticide available with the least potential to degrade environmental quality (soils, surface water, and groundwater) as well as the least potential effect to native species and communities of fish, wildlife, plants, and their habitats would be acceptable for use on refuge lands in the context of an IPM approach.

- **Habitat Restoration/Maintenance.** Restoration and/or proper maintenance of refuge habitats associated with achieving wildlife and habitat objectives would be essential for long-term prevention, eradication, or control (at or below threshold levels) of pests. Promoting desirable plant communities through the manipulation of species composition, plant density, and growth rate is an essential component of invasive plant management (Brooks et al. 2004; Masters et al. 1996; Masters and Sheley 2001). The following three components of succession could be manipulated through habitat maintenance and restoration: site availability, species availability, and species performance (Cox and Anderson 2004). Although a single method (e.g., herbicide treatment) may eliminate or suppress pest species in the short term, the resulting gaps and bare soil create niches that are conducive to further invasion by the species and/or other invasive plants. On degraded sites where desirable species are absent or in low abundance, revegetation with native/desirable grasses, forbs, and legumes may be necessary to direct and accelerate plant community recovery, and achieve site-specific objectives in a reasonable time frame. The selection of appropriate species for revegetation would be dependent on a number of factors including resource objectives and site-specific, abiotic factors (e.g., soil texture, precipitation/temperature regimes, and shade conditions). Seed availability and cost, ease of establishment, seed production, and competitive ability also would be important considerations.

G.4 Priorities for Treatments

For many refuges, the magnitude (number, distribution, and sizes of infestations) of pest problems is too extensive and beyond the available capital resources to effectively address during any single field season. To manage pests on a refuge, it is essential to prioritize treatment of infestations. Highest

priority treatments are focused on early detection and rapid response to eliminate infestations of new pests, if possible. This is especially important for aggressive pests potentially impacting species, species groups, communities, and/or habitats associated with the refuge purpose(s), Refuge System resources of concern (federally listed species, migratory birds, and interjurisdictional fish), and native species important for maintaining/restoring biological integrity, diversity, and environmental health.

The next priority would be treating established pests that appear in one or more previously uninfested areas. Moody and Mack (1988) demonstrated through modeling that small, new outbreaks of invasive plants eventually would infest an area larger than the established source population. They also found that control efforts focusing on the large, main infestation rather than the new, small satellites reduced the chances of overall success.

The lowest priority would be treating large infestations (sometimes monotypic stands) of well-established pests. In this case, initial efforts would focus upon containment of the perimeter followed by work to control/eradicate the established infested area. If containment and/or control of a large infestation is not effective, then efforts would focus upon halting pest reproduction or managing source populations. Maxwell et al. (2009) found that treating fewer populations that are sources represents an effective long-term strategy to reduce total number of invasive populations and decreasing population growth rates.

Although state-listed noxious weeds would always be of high priority for management, other pest species known to cause substantial ecological impact would also be considered. For example, reed canarygrass may not be listed by a state as noxious, but it can greatly alter wetland plant composition by forming monotypic stands. Pest control would likely require a multiyear commitment from refuge staff. Essential to the long-term success of pest management would be pretreatment and posttreatment monitoring, assessment of the successes and failures of treatments, and development of new approaches when proposed methods do not achieve desired outcomes.

G.5 Best Management Practices

BMPs can minimize or eliminate possible effects associated with pesticide usage to non-target species and/or sensitive habitats as well as degradation of water quality from drift, surface runoff, or leaching. Based upon the Department of Interior Pesticide Use Policy (517 DM 1) and the Service Pest Management Policy and Responsibilities (30 AM 12), the use of applicable BMPs also would likely ensure that pesticide uses do not adversely affect federally listed species and/or their critical habitats through determinations made using the process described in 50 CFR 402.

The following are BMPs pertaining to mixing/handling and applying pesticides for all ground-based treatments of pesticides, which would be considered and used, where feasible, based upon target- and site-specific factors and time-specific environmental conditions.

G.5.1 Pesticide Handling and Mixing

- As a precaution against spilling, spray tanks would not be left unattended during filling.
- All pesticide containers would be triple-rinsed and the rinsate would be used as water in the sprayer tank and applied to treatment areas.
- All pesticide spray equipment would be properly cleaned. Where possible, rinsate would be used as part of the make-up water in the sprayer tank and applied to treatment areas.

- The refuge staff would triple-rinse and recycle (where feasible) pesticide containers.
- All unused pesticides would be properly discarded at a local “safe send” collection.
- Pesticides and pesticide containers would be lawfully stored, handled, and disposed of in accordance with the label and in a manner safeguarding human health and fish and wildlife, and preventing soil and water contamination.
- Refuge staff would consider the water quality parameters (e.g., pH, hardness) that are important to ensure greatest efficacy where specified on the pesticide label.
- All pesticide spills would be addressed immediately using procedures identified in the refuge spill response plan.

G.5.2 Applying Pesticides

- Pesticide treatments would only be conducted by or under the supervision of Service personnel and non-Service applicators with the appropriate state certification to safely and effectively conduct these activities on refuge lands and waters.
- Refuge staff would comply with all Federal, state, and local pesticide use laws and regulations as well as Departmental, Service, and Refuge System pesticide-related policies.
- Before each treatment season and prior to mixing or applying any product for the first time each season, all applicators would review the labels, material safety data sheets (MSDS), and PUPs for each pesticide, determining the target pest, appropriate mix rate(s), required personal protective equipment (PPE), and other requirements listed on the pesticide label.
- Low-impact herbicide application techniques (e.g., spot treatment, cut stump, oil basal, Thinvert system applications) would be used rather than broadcast foliar applications (e.g., boom sprayer other larger tank wand applications), where practical.
- Low-volume rather than high-volume foliar applications would be used where low-impact methods described above are not feasible or practical, to maximize herbicide effectiveness and ensure correct and uniform application rates.
- Applicators would use and adjust spray equipment to apply the coarsest droplet size spectrum with optimal coverage of the target species while reducing drift.
- Applicators would use the largest droplet size that results in uniform coverage.
- Applicators would use drift reduction technologies such as low-drift nozzles, where possible.
- Where possible, spraying would occur during low (average <7 miles per hour [mph] and preferably 3 to 5 mph) and consistent direction wind conditions with moderate temperatures (typically <80°F).
- Where possible, applicators would avoid spraying during inversion conditions (often associated with calm and very low wind conditions), which can cause large-scale herbicide drift to nontarget areas.
- Equipment would be calibrated regularly to ensure that the proper rate of pesticide is applied to the target area or species.
- Spray applications would be made at the lowest height for uniform coverage of target pests to minimize/eliminate potential drift.
- If windy conditions frequently occur during afternoons, spraying (especially boom treatments) would typically be conducted during early morning hours.
- Spray applications would not be conducted on days with >30 percent forecast for rain within 6 hours, except for pesticides that are rapidly rain fast (e.g., glyphosate in 1 hour) to minimize/eliminate potential runoff.

- Where possible, applicators would use drift retardant adjuvants during spray applications, especially adjacent to sensitive areas.
- Where possible, applicators would use a non-toxic dye to aid in identifying target area treated as well as potential overspray or drift. A dye can also aid in detecting equipment leaks. If a leak is discovered, the application would be stopped until repairs can be made to the sprayer.
- For pesticide uses associated with cropland and facilities management, buffers, as appropriate, would be used to protect sensitive habitats, especially wetlands and other aquatic habitats.
- When drift cannot be sufficiently reduced through altering equipment setup and application techniques, buffer zones may be identified to protect sensitive areas downwind of applications. Refuge staff would only apply pesticide adjacent to sensitive areas when the wind is blowing in the opposite direction.
- Refuge staff would consider timing of application so native plants are protected (e.g., senescence) while effectively treating invasive plants.
- Rinsate from cleaning spray equipment after application would be recaptured and reused or applied to an appropriate pest plant infestation.
- Application equipment (e.g., sprayer, all-terrain vehicle [ATV], tractor) would be thoroughly cleaned and PPE would be removed/disposed of on-site by applicators after treatments to eliminate the potential spread of pests to uninfested areas.

G.6. Safety

G.6.1 Personal Protective Equipment

All applicators would wear the specific PPE identified on the pesticide label. The appropriate PPE would be worn at all times during handling, mixing, and application. PPE can include the following: disposable (e.g., Tyvek) or laundered coveralls; gloves (latex, rubber, or nitrile); rubber boots; and/or a National Institute for Occupational Safety and Health (NIOSH)-approved respirator. Because exposure to concentrated product is usually greatest during mixing, extra care should be taken while preparing pesticide solutions. Persons mixing these solutions can be best protected if they wear long gloves, an apron, footwear, and a face shield.

Coveralls and other protective clothing used during an application would be laundered separately from other laundry items. Transporting, storing, handling, mixing, and disposing of pesticide containers would be consistent with label requirements, EPA and Occupational Safety and Health Administration (OSHA) requirements, and Service policy.

If a respirator is necessary for a pesticide use, then the following requirements would be met in accordance with Service safety policy: a written Respirator Program, fit testing, physical examination (including pulmonary function and blood work for contaminants), and proper storage of the respirator.

G.6.2 Notification

The restricted entry interval (REI) is the time period required after application after which someone may safely enter a treated area without PPE. Refuge staff, authorized management agents of the Service, volunteers, and members of the public who could be in or near a pesticide-treated area within the stated re-entry time period on the label would be notified about treatment areas. Posting

would occur at any site where individuals might inadvertently become exposed to a pesticide during other activities on the refuge. Where required by the label and/or state-specific regulations, signs would also be posted on the perimeter of treatment areas and at other likely locations of entry. Refuge staff would also notify appropriate private property owners of an intended application, including any private individuals who have requested notification. Special efforts would be made to contact nearby individuals who are beekeepers or who have expressed chemical sensitivities.

G.6.3 Medical Surveillance

Medical surveillance may be required for Service personnel and approved volunteers who mix, apply, and/or monitor use of pesticides (see 242 FW 7 [Pesticide Users] and 242 FW 4 [Medical Surveillance]). In accordance with 242 FW 7.12A, Service personnel would be medically monitoring if one or more of the following criteria is met: exposed or may be exposed to concentrations at or above the published permissible exposure limits or threshold limit values (see 242 FW 4); pesticide use is considered "frequent pesticide use"; or pesticide use requires a respirator (see 242 FW 14 for respirator use requirements). According to 242 FW 7.7A, "frequent pesticide use means when a person applying pesticide handles, mixes, or applies pesticides, with a Health Hazard rating of 3 or higher, for 8 or more hours in any week or 16 or more hours in any 30-day period." Under some circumstances, individuals who use pesticides infrequently, experience an acute exposure (sudden, short term), or use pesticides with a health hazard ranking of 1 or 2 may also be medically monitored. This decision would consider the individual's health and fitness level, the pesticide's specific health risks, and the potential risks from other pesticide-related activities. Refuge cooperators (e.g., cooperative farmers) and other authorized agents (e.g., state and county employees) would be responsible for their own medical monitoring needs and costs.

Standard examinations (at refuge expense) of appropriate refuge staff would be provided by the nearest certified occupational health and safety physician as determined by Federal Occupational Health.

G.6.4 Certification and Supervision of Pesticide Applicators

Appropriate refuge staff or approved volunteers handling, mixing, and/or applying, or directly supervising others engaged in pesticide use activities, would be trained and state or federally licensed to apply pesticides to refuge lands or waters. In accordance with 242 FW 7.18A and 569 FW 1.10B, certification is required to apply restricted use pesticides based upon EPA regulations. For safety reasons, all individuals participating in pest management activities with general use pesticides also are encouraged to attend appropriate training or acquire pesticide applicator certification. New staff unfamiliar with proper procedures for storing, mixing, handling, applying, and disposing of pesticides and containers would receive orientation and training before handling or using any products. Documentation of training would be kept in the files at the refuge office.

G.6.5 Record Keeping

G.6.5.1 Labels and Material Safety Data Sheets

Pesticide labels and MSDSs would be maintained at the refuge shop. A written reference (e.g., note pad, chalk board, dry erase board) for each tank to be mixed would be kept in the mixing area for quick reference while mixing is in progress. In addition, approved PUPs stored in the PUPS database typically contain website links to pesticide labels and MSDSs.

G.6.5.2 Pesticide Use Proposals

A PUP would be prepared for each proposed pesticide use associated with annual pest management on refuge lands and waters. A PUP would include specific information about the proposed pesticide use including the common and chemical names of the pesticide(s), target pest species, size and location of treatment site(s), application rate(s) and method(s), and federally listed species determinations, where applicable.

In accordance with Service guidelines (Service Director's memo [December 12, 2007]), refuge staff may receive up to 5-year approvals for Service Washington Office and field-reviewed proposed pesticide uses based upon meeting identified criteria including an approved IPM plan, where necessary (see http://www.fws.gov/contaminants/Issues/IPM.cfm). For a refuge, an IPM plan (requirements described herein) can be completed independently or in association with a CCP or a habitat management plant (HMP) if IPM strategies and potential environmental effects are adequately addressed within appropriate NEPA documentation.

G.6.5.3 Pesticide Usage

In accordance with 569 FW 1, the refuge project leader would be required to maintain records of all pesticides annually applied on lands or waters under refuge jurisdiction. This would encompass pesticides applied by other Federal agencies, state and county governments, and nongovernment applicators including cooperators and their pest management service providers with Service permission. For clarification, pesticide means all insecticides, insect and plant growth regulators, desiccants, herbicides, fungicides, rodenticides, acaricides, nematicides, fumigants, avicides, and piscicides.

The following usage information can be reported for approved PUPs in the PUPS database:

- Pesticide trade name(s)
- Active ingredient(s)
- Total acres treated
- Total amount of pesticides used (lbs or gallons)
- Total amount of active ingredient(s) used (lbs)
- Target pest(s)
- Efficacy (% control)

To determine whether treatments are efficacious (eradicating, controlling, or containing the target pest) and achieving resource objectives, habitat and/or wildlife response would be monitored both pretreatment and posttreatment, where possible. Considering available annual funding and staffing, appropriate monitoring data regarding characteristics (attributes) of pest infestations (e.g., area, perimeter, degree of infestation density, percent cover, density) as well as habitat and/or wildlife response to treatments may be collected and stored in a relational database (e.g., Refuge Habitat Management Database), preferably a georeferenced data management system (e.g., Refuge Lands Geographic Information System [GIS]) to facilitate data analyses and subsequent reporting. In accordance with adaptive management, data analysis and interpretation would allow treatments to be modified or changed over time, as necessary, to achieve resource objectives considering site-specific conditions in conjunction with habitat and/or wildlife responses. Monitoring could also identify short- and long-term impacts to natural resources and environmental quality associated with IPM treatments in accordance with adaptive management principles identified in 43 CFR 46.145.

G.7 Evaluating Pesticide Use Proposals

Pesticides would only be used on refuge lands for habitat management and croplands/facilities maintenance after approval of a PUP. In general, proposed pesticide uses on refuge lands would only be approved where there would likely be minor, temporary, or localized effects to fish and wildlife species as well as minimal potential to degrade environmental quality. Potential effects to listed and nonlisted species would be evaluated with quantitative ecological risk assessments and other screening measures. Potential effects to environmental quality would be based upon pesticide characteristics of environmental fate (water solubility, soil mobility, soil persistence, and volatilization) and other quantitative screening tools. Ecological risk assessments and characteristics of environmental fate and potential of pesticides to degrade environmental quality would be documented in chemical profiles (see Section G.7.6). These profiles would include threshold values for quantitative measures of ecological risk assessments and screening tools for environmental fate that represent minimal potential effects to species and environmental quality. In general, only pesticide uses with appropriate BMPs (see Section G.5) for habitat management and cropland/facilities maintenance on refuge lands that would potentially have minor, temporary, or localized effects on refuge biological and environmental quality (threshold values not exceeded) would be approved.

G.7.1 Overview of Ecological Risk Assessment

An ecological risk assessment process would be used to evaluate potential adverse effects to biological resources as a result of a pesticide proposed for use on refuge lands. It is an established quantitative and qualitative methodology for comparing and prioritizing risks of pesticides and conveying an estimate of the potential risk for an adverse effect. This quantitative methodology provides an efficient mechanism to integrate best available scientific information regarding hazards, patterns of use (exposure), and dose-response relationships in a manner that is useful for ecological risk decision making. It would provide an effective way to evaluate potential effects where there is missing or unavailable scientific information (data gaps) to address reasonable, foreseeable adverse effects in the field as required under 40 CFR 1502.22. Protocols for ecological risk assessment of pesticide uses on the refuge were developed through research and established by the EPA (2004).

The toxicological data used in ecological risk assessments are typically results of standardized laboratory studies provided by pesticide registrants to the EPA to meet regulatory requirements under FIFRA. These studies assess the acute (lethality) and chronic (reproductive) effects associated with short- and long-term exposure to pesticides on representative species of birds, mammals, freshwater fish, aquatic invertebrates, and terrestrial and aquatic plants. Other effects data publicly available would also be used for risk assessment protocols described herein. Toxicity endpoint and environmental fate data are available from a variety of resources. Some of the more useful resources can be found in Section G.7.6.

G.7.2 Determining Ecological Risk to Fish and Wildlife

The potential for pesticides used on the refuge to cause direct adverse effects to fish and wildlife would be evaluated using the EPA's ecological risk assessment process (EPA 2004). This deterministic approach, which is based upon a two-phase process involving estimation of environmental concentrations and then characterization of risk, would be used for ecological risk assessments. This method integrates exposure estimates (estimated environmental concentration

[EEC] and toxicological endpoints [e.g., LC_{50} and oral LD_{50}]) to evaluate the potential for adverse effects to species groups (birds, mammals, and fish) representative of legal mandates relevant for managing units of the Refuge System. This integration is achieved through risk quotients (RQs) calculated by dividing the EEC by acute and chronic toxicity values selected from standardized toxicological endpoints or published effects (Table G-1).

$$RQ = EEC/Toxicological\ Endpoint$$

Table G-1. Ecotoxicity Tests Used to Evaluate Potential Effects to Birds, Fish, and Mammals to Establish Toxicity Endpoints for Risk Quotient Calculations

Species Group	Exposure	Measurement Endpoint
Bird	Acute	Median Lethal Concentration (LC_{50})
	Chronic	No Observed Effect Concentration (NOEC) or No Observed Adverse Effect Concentration (NOAEC)[1]
Fish	Acute	LC_{50}
	Chronic	NOEC or NOAEC[2]
Mammal	Acute	Oral Lethal Dose (LD_{50})
	Chronic	NOEC or NOAEC[3]

[1]Measurement endpoints typically include a variety of reproductive parameters (e.g., number of eggs, number of offspring, eggshell thickness, and number of cracked eggs).

[2]Measurement endpoints for early life stage/life cycle typically include embryo hatch rates, time to hatch, growth, and time to swim-up.

[3]Measurement endpoints include maternal toxicity, teratogenic effects or developmental anomalies, evidence of mutagenicity or genotoxicity, and interference with cellular mechanisms such as DNA synthesis and DNA repair.

The level of risk associated with direct effects of pesticide use would be characterized by comparing calculated RQs to the appropriate Level of Concern (LOC) established by the EPA (1998b) (Table G-2). The LOC represents a quantitative threshold value for screening potential adverse effects to fish and wildlife resources associated with pesticide use. The following are four exposure-species group scenarios that would be used to characterize ecological risk to fish and wildlife on the refuge: acute-listed species, acute-nonlisted species, chronic-listed species, and chronic-nonlisted species.

Table G-2. Presumption of Unacceptable Risk for Birds, Fish, and Mammals (EPA 1998b)

Risk Presumption		Level of Concern	
		Listed Species	Nonlisted Species
Acute	Birds	0.1	0.5
	Fish	0.5	0.5
	Mammals	0.1	0.5
Chronic	Birds	1.0	1.0

Table G-2. Presumption of Unacceptable Risk for Birds, Fish, and Mammals (EPA 1998b)

Risk Presumption		Level of Concern	
		Listed Species	Nonlisted Species
	Fish	1.0	1.0
	Mammals	1.0	1.0

Acute risk would indicate the potential for mortality associated with short-term dietary exposure to pesticides immediately after an application. For characterization of acute risks, median values from LC_{50} and LD_{50} tests would be used as toxicological endpoints for RQ calculations. In contrast, chronic risks would indicate the potential for adverse effects associated with long-term dietary exposure to pesticides from a single application or multiple applications over time (within a season and over years). For characterization of chronic risks, the no observed adverse effect concentration (NOAEC) or no observed effect concentration (NOEC) for reproduction would be used as toxicological endpoints for RQ calculations. Where available, the NOAEC would be preferred over a NOEC value.

Listed species are those federally designated as threatened, endangered, or proposed in accordance with the Endangered Species Act of 1973. For listed species, potential adverse effects would be assessed at the individual level because loss of individuals from a population could detrimentally impact a species. In contrast, risks to nonlisted species would consider effects at the population level. A RQ<LOC would indicate the proposed pesticide use “may affect, not likely to adversely affect” individuals (listed species) and it would not pose an unacceptable risk for adverse effects to populations (nonlisted species) for each taxonomic group (Table G-2). In contrast, an RQ>LOC would indicate a “may affect, likely to adversely affect” for listed species, and it would also pose unacceptable ecological risk for adverse effects to nonlisted species.

G.7.2.1 Environmental Exposure

Following release into the environment through application, pesticides would experience several different routes of environmental fate. Pesticides that would be sprayed can move through the air (e.g., particle or vapor drift) and may eventually end up in other parts of the environment such as nontarget vegetation, soil, or water. Pesticides applied directly to the soil may be washed off the soil into nearby bodies of surface water (e.g., surface runoff) or may percolate through the soil to lower soil layers and groundwater (Baker and Miller 1999; Butler et al. 1998; Extension Toxicology Network [EXTOXNET] 1993; Pope et al. 1999; Ramsay et al. 1995). Pesticides that would be injected into the soil may also be subject to the latter two fates. The aforementioned possibilities are by no means complete, but do indicate that movement of pesticides in the environment is very complex, with transfers occurring continually among different environmental compartments. In some cases, these exchanges occur not only between areas that are close together, but may also involve transportation of pesticides over long distances (Barry 2004; Woods 2004).

G.7.2.1.1 Terrestrial Exposure

The ECC for exposure to terrestrial wildlife would be quantified using an EPA screening-level approach (EPA 2004). This screening-level approach is not affected by product formulation because

it evaluates pesticide active ingredient (a.i.). This approach would vary depending upon the proposed pesticide application method: spray or granular.

G.7.2.1.1.1 Terrestrial—spray application

For spray applications, exposure would be determined using the Kanaga nomogram method (EPA 2004, 2005a; Pfleeger et al. 1996) through the EPA's Terrestrial Residue Exposure model (T-REX) version 1.2.3 (EPA 2005b). To estimate the maximum (initial) pesticide residue on short grass (<20 centimeter [cm] tall) as a general food item category for terrestrial vertebrate species, T-REX input variables would include the following from the pesticide label: maximum pesticide application rate (pounds a.i. [acid equivalent]/acre) and pesticide half-life (days) in soil. Although there are other food item categories (tall grasses; broadleaf plants and small insects; and fruits, pods, seeds and large insects), short grass was selected because it would yield maximum EECs (240 parts per million [ppm] per lb a.i./acre) for worst-case risk assessments. Short grass is not representative of forage for carnivorous species (e.g., raptors), but it would characterize the maximum potential exposure through the diet of avian and mammalian prey items. Consequently, this approach would provide a conservative screening tool for pesticides that do not biomagnify.

For RQ calculations in T-REX, the model would require the weight of surrogate species and Mineau scaling factors (Mineau et al. 1996). Body weights of bobwhite quail and mallard are included in T-REX by default, but body weights of other organisms (Table G-3) would be entered manually. The Mineau scaling factor accounts for small-bodied bird species that may be more sensitive to pesticide exposure than would be predicted only by body weight. Mineau scaling factors would be entered manually with values ranging from 1 to 1.55 that are unique to a particular pesticide or group of pesticides. If specific information to select a scaling factor is not available, then a value of 1.15 would be used as a default. Alternatively, zero would be entered if it is known that body weight does not influence toxicity of pesticide(s) being assessed. The upper bound estimate output from the T-REX Kanaga nomogram would be used as an EEC for calculation of RQs. This approach would yield a conservative estimate of ecological risk.

Table G-3. Average Body Weight of Selected Terrestrial Wildlife Species Frequently used in Research to Establish Toxicological Endpoints (Dunning 1984)

Species	Body Weight (kilogram [kg])
Mammal (15 g)	0.015
House sparrow	0.0277
Mammal (35 g)	0.035
Starling	0.0823
Red-winged blackbird	0.0526
Rock dove (aka pigeon)	0.542
Mammal (1,000 g)	1.000
Mallard	1.082
Ring-necked pheasant	1.135

G.7.2.1.1.2 Terrestrial—granular application

Granular pesticide formulations and pesticide-treated seed would pose a unique route of exposure for avian and mammalian species. The pesticide is applied in discrete units, which birds or mammals might ingest accidentally with food items or intentionally as in the case of some bird species that actively seek and pick up gravel or grit to aid digestion or seed as a food source. Granules may also be consumed by wildlife foraging on earthworms, slugs, or other soft-bodied soil organisms to which the granules may adhere.

Terrestrial wildlife RQs for granular formulations or seed treatments would be calculated by dividing the maximum milligrams of a.i. exposed (e.g., EEC) on the surface of an area equal to 1 square foot by the appropriate LD_{50} value multiplied by the surrogate's body weight (Table G-3). An adjustment to surface area calculations would be made for broadcast, banded, and in-furrow applications. An adjustment also would be made for applications with and without incorporation of the granules. Without incorporation, it would be assumed that 100 percent of the granules remain on the soil surface available to foraging birds and mammals. Press wheels push granules flat with the soil surface, but the granules are not incorporated into the soil. If granules are incorporated in the soil during band or T-band applications or after broadcast applications, it would be assumed only 15 percent of the applied granules remain available to wildlife. It would be assumed that only 1 percent of the granules are available on the soil surface following in-furrow applications.

EECs for pesticides applied in granular form and as seed treatments would be determined considering potential ingestion rates of avian or mammalian species (e.g., 10-30% body weight/day). This would provide an estimate of maximum exposure that may occur as a result of granule or seed treatment spills such as those that commonly occur at end rows during application and planting. The availability of granules and seed treatments to terrestrial vertebrates would also be considered by calculating the loading per unit area (LD_{50}/feet^2) for comparison to the EPA LOC (EPA 1998b). The T-REX version 1.2.3 (EPA 2005b) contains a submodel that automates Kanaga exposure calculations for granular pesticides and treated seed.

The following formulas would be used to calculate EECs depending upon the type of granular pesticide application:

- In-furrow applications assume a typical value of 1 percent granules, bait, or seed remain unincorporated.

$$mg\ a.i./feet^2 = [(lbs.\ product/acre)(\%\ a.i.)(453{,}580\ mg/lbs)(1\%\ exposed))] / \{[(43{,}560\ feet^2/acre)/(row\ spacing\ (feet))] / (row\ spacing\ (feet)\}$$

or

$$mg\ a.i./feet^2 = [(lbs\ product/1{,}000\ foot\ row)(\%\ a.i.)(1{,}000\ foot\ row)(453{,}580\ mg/lb.)(1\%\ exposed)$$

$$EEC = [(mg\ a.i./feet^2)(\%\ of\ pesticide\ biologically\ available)]$$

- Incorporated banded treatments assume that 15 percent of granules, bait, and seeds are unincorporated.

$$mg\ a.i./feet^2 = [(lbs.\ product/1{,}000\ row\ feet)(\%\ a.i.)(453{,}580\ mg/lb.)(1 - \%\ incorporated)]/(1{,}000\ feet)(band\ width\ (feet))$$

$$EEC = [(mg\ a.i./feet^2)(\%\ of\ pesticide\ biologically\ available)]$$

- Broadcast treatment without incorporation assumes 100 percent of granules, bait, and seeds are unincorporated.

$$mg\ a.i./feet^2 = [(lbs.\ product/acre)(\%\ a.i.)(453{,}590\ mg/lb.)]/(43{,}560\ feet^2/acre)$$

$$EEC = [(mg\ a.i./feet^2)(\%\ of\ pesticide\ biologically\ available)]$$

Where:

- % of pesticide biologically available = 100 percent without species-specific ingestion rates
- Conversion for calculating mg a.i./feet^2 using ounces: 453,580 mg/lb./16 = 28,349 mg/oz.

The following equation would be used to calculate an RQ based on the EEC calculated by one of the above equations. The EEC would be divided by the surrogate LD_{50} toxicological endpoint multiplied by the body weight (Table G-3) of the surrogate.

$$RQ = EEC / [LD50\ (mg/kg) * body\ weight\ (kg)]$$

As with other risk assessments, an RQ>LOC would be a presumption of unacceptable ecological risk. An RQ<LOC would be a presumption of acceptable risk with only minor, temporary, or localized effects to species.

G.7.2.1.2 Aquatic Exposure

Exposures to aquatic habitats (e.g., wetlands, meadows, ephemeral pools, water delivery ditches) would be evaluated separately for ground-based pesticide treatments of habitats managed for fish and wildlife compared with cropland/facilities maintenance. The primary exposure pathway for aquatic organisms from any ground-based treatments likely would be particle drift during the pesticide application. However, different exposure scenarios would be necessary as a result of contrasting application equipment and techniques as well as pesticides used to control pests on agricultural lands (especially those cultivated by cooperative farmers for economic return from crop yields) and facilities maintenance (e.g., roadsides, parking lots, trails) compared with other managed habitats on the refuge. In addition, pesticide applications may be done <25 feet of the high water mark of aquatic habitats for habitat management treatments, whereas no-spray buffers (≥25 feet) would be used for croplands/facilities maintenance treatments.

G.7.2.1.2.1 Habitat treatments

For the worst-case exposure scenario to non-target aquatic habitats, EECs (Table G-4) would be derived from Urban and Cook (1986), which assumes an intentional overspray to an entire, non-target water body (1 foot depth) from a treatment <25 feet from the high water mark using the maximum application rate (acid basis). However, use of BMPs for applying pesticides (see Section

G.5.2) would likely minimize/eliminate potential drift to non-target aquatic habitats during actual treatments. If there would be unacceptable (acute or chronic) risk to fish and wildlife with the simulated 100 percent overspray (RQ>LOC), then the proposed pesticide use may be disapproved or the PUP may be approved at a lower application rate to minimize/eliminate unacceptable risk to aquatic organisms (RQ = LOC).

Table G-4. Estimated Environmental Concentrations of Pesticides in Aquatic Habitats (1 foot depth) Immediately after Direct Application (Urban and Cook 1986)

Lbs/acre	EEC (parts per billion (ppb)
0.10	36.7
0.20	73.5
0.25	91.9
0.30	110.2
0.40	147.0
0.50	183.7
0.75	275.6
1.00	367.5
1.25	459.7
1.50	551.6
1.75	643.5
2.00	735.7
2.25	827.6
2.50	919.4
3.00	1,103.5
4.00	1,471.4
5.00	1,839
6.00	2,207
7.00	2,575
8.00	2,943
9.00	3,311
10.00	3,678

G.7.2.1.2.2 Cropland/facilities maintenance treatments

Field drift studies conducted by the Spray Drift Task Force (SDTF), which is a joint project of several agricultural chemical businesses, were used to develop a generic spray drift database. From this database, the AgDRIFT computer model was created to satisfy EPA pesticide registration spray drift data requirements and as a scientific basis to evaluate off-target movement of pesticides from particle drift and assess potential effects of exposure to wildlife. The SDTF AgDRIFT model version 2.01 (AgDRIFT 2001; SDTF 2003) would be used to derive EECs resulting from drift of pesticides to refuge aquatic resources from ground-based pesticide applications >25 feet from the high water mark. The SDTF AgDRIFT model is publicly available at http://www.agdrift.com. At this website, click "AgDRIFT 2.0," followed by "Download Now," and follow the instructions to obtain the computer model.

The AgDRIFT model is composed of submodels called tiers. Tier I Ground submodel would be used to assess ground-based applications of pesticides. Tier outputs (EECs) would be calculated with AgDRIFT using the following input variables: maximum application rate (acid basis), low boom (20 inches), fine to medium droplet size, EPA-defined wetland, and a ≥25-foot distance (buffer) from treated area to water.

G.7.2.2 Use of Information on Effects of Biological Control Agents, Pesticides, Degradates, and Adjuvants

NEPA documents regarding biological and other environmental effects of biological control agents, pesticides, degradates, and adjuvants prepared by another Federal agency, where the scope would be relevant to evaluation of effects from pesticide uses on refuge lands, would be reviewed. Possible source agencies for such NEPA documents include the Bureau of Land Management, USFS, National Park Service, USDA-APHIS, and the military services. It might be appropriate to incorporate by reference parts or all of existing document(s). Incorporating by reference (40 CFR 1502.21) is a technique used to avoid redundancies in analysis. It also would reduce the bulk of a Service NEPA document, which only would identify the documents that are incorporated by reference. In addition, relevant portions would be summarized in the Service NEPA document to the extent necessary to provide the decision maker and public with an understanding of relevance of the referenced material to the current analysis.

In accordance with the requirements set forth in 43 CFR 46.135, the Service would specifically incorporate through reference ecological risk assessments prepared by the USFS (http://www.fs.fed.us/r6/invasiveplant-eis/Risk-Assessments/Herbicides-Analyzed-InvPlant-EIS.htm) and Bureau of Land Management (http://www.blm.gov/wo/st/en/prog/more/veg_eis.html). These risk assessments and associated documentation also are available in total with the administrative record for the final environmental impact statement titled *Pacific Northwest Region Invasive Plant Program – Preventing and Managing Invasive Plants* (USFS 2005) and *Vegetation Treatments Using Herbicides on Bureau of Land Management Lands in 17 Western States Programmatic EIS (PEIS)* (Bureau of Land Management 2007). In accordance with 43 CFR 46.120(d), use of existing NEPA documents by supplementing, tiering to, incorporating by reference, or adopting previous NEPA environmental analyses would avoid redundancy and unnecessary paperwork.

As a basis for completing chemical profiles for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide and adjuvant uses prepared by the USFS would be incorporated by reference:

- 2,4-D
- Chlorosulfuron
- Clopyralid
- Dicamba
- Glyphosate
- Imazapic
- Imazapyr
- Metsulfuron methyl
- Picloram
- Sethoxydim
- Sulfometuron methyl
- Triclopyr
- Nonylphenol polyethoxylate (NPE)-based surfactants

As a basis for completing chemical profiles for approving or disapproving refuge PUPs, ecological risk assessments for the following herbicide uses as well as evaluation of risks associated with pesticide degradates and adjuvants prepared by the Bureau of Land Management would be incorporated by reference:

- Bromacil
- Chlorosulfuron
- Diflufenzopyr
- Diquat
- Diuron
- Fluridone
- Imazapic
- Overdrive (diflufenzopyr and dicamba)
- Sulfometuron methyl
- Tebuthiuron
- Pesticide degradates and adjuvants

G.7.2.3 Assumptions for Ecological Risk Assessments

There are a number of assumptions involved with the ecological risk assessment process for terrestrial and aquatic organisms associated with use of the EPA's (2004) process. These assumptions may be risk neutral or may lead to an over- or under-estimation of risk from pesticide exposure depending upon site-specific conditions. The following describes these assumptions, their application to the conditions typically encountered, and whether they may lead to recommendations that are risk neutral, or that underestimate or overestimate ecological risk from potential pesticide exposure.

- Indirect effects would not be evaluated by ecological risk assessments. These effects include the mechanisms of indirect exposure to pesticides: consuming prey items (fish, birds, or

small mammals), reductions in the availability of prey items, and disturbance associated with pesticide application activities.

- Exposure to a pesticide product can be assessed based upon the active ingredient. However, exposure to a chemical mixture (pesticide formulation) may result in effects that are similar or substantially different compared to only the active ingredient. Nontarget organisms may be exposed directly to the pesticide formulation or only various constituents of the formulation as they dissipate and partition in the environment. If toxicological information for both the active ingredient and formulated product are available, then data representing the greatest potential toxicity would be selected for use in the risk assessment process (EPA 2004). As a result, this conservative approach may lead to an overestimation of risk characterization from pesticide exposure.
- Because toxicity tests with listed or candidate species or closely related species are not available, data for surrogate species would be most often used for risk assessments. Specifically, bobwhite quail and mallard duck are the most frequently used surrogates for evaluating potential toxicity to federally listed avian species. Bluegill sunfish, rainbow trout, and fathead minnow are the most common surrogates for evaluating toxicity for freshwater fishes. Sheep's head minnow can be an appropriate surrogate marine species for coastal environments. Rats and mice are the most common surrogates for evaluating toxicity to mammals. Interspecies sensitivity is a major source of uncertainty in pesticide assessments. As a result of this uncertainty, data are selected for the most sensitive species tested within a taxonomic group (birds, fish, and mammals) given the quality of the data is acceptable. If additional toxicity data for more species of organisms in a particular group are available, the selected data would not be limited to the species previously listed as common surrogates.
- The Kanaga nomogram outputs maximum EEC values that may be used to calculate an average daily concentration over a specified interval of time, which is referred to as a time-weighted-average (TWA). The maximum EEC would be selected as the exposure input for both acute and chronic risk assessments in the screening-level evaluations. The initial or maximum EEC derived from the Kanaga nomogram represents the maximum expected instantaneous or acute exposure to a pesticide. Acute toxicity endpoints are determined using a single exposure to a known pesticide concentration typically for 48 to 96 hours. This value is assumed to represent ecological risk from acute exposure to a pesticide. On the other hand, chronic risk to pesticide exposure is a function of pesticide concentration and duration of exposure to the pesticide. An organism's response to chronic pesticide exposure may result from either the concentration of the pesticide or the length of exposure, or some combination of both factors. Standardized tests for chronic toxicity typically involve exposing an organism to several different pesticide concentrations for a specified length of time (days, weeks, months, years, or generations). For example, avian reproduction tests include a 10-week exposure phase. Because a single length of time is used in the test, time response data are usually not available for inclusion in risk assessments. Without time response data it is difficult to determine the concentration that elicits a toxicological response.
- Using maximum EECs for chronic risk estimates may result in an overestimation of risk, particularly for compounds that dissipate rapidly. Conversely, using TWAs for chronic risk estimates may underestimate risk if it is the concentration rather than the duration of exposure that is primarily responsible for the observed adverse effect. The maximum EEC would be used for chronic risk assessments although it may result in an overestimation of risk. TWAs may be used for chronic risk assessments, but they would be applied judiciously considering the potential for underestimation or overestimation of risk. For example, the number of days exposure exceeds an LOC may influence the suitability of a pesticide use.

The greater the number of days the EEC exceeds the LOC, the greater the ecological risk. This is a qualitative assessment, and is subject to reviewers' expertise in ecological risk assessment and tolerance for risk.

- The length of time used to calculate the TWA can have a substantial effect on the exposure estimates, and there is no standard method for determining the appropriate duration for this estimate. The T-REX model assumes a 21-week exposure period, which is equivalent to avian reproductive studies designed to establish a steady-state concentration for bioaccumulative compounds. However, this does not necessarily define the true exposure duration needed to elicit a toxicological response. Pesticides that do not bioaccumulate may achieve a steady-state concentration earlier than 21 weeks. The duration of time for calculating TWAs would require justification and would not exceed the duration of exposure in the chronic toxicity test (approximately 70 days for the standard avian reproduction study). An alternative to using the duration of the chronic toxicity study is to base the TWA on the application interval. In this case, increasing the application interval would suppress both the estimated peak pesticide concentration and the TWA. Another alternative to using TWAs would be to consider the number of days that a chemical is predicted to exceed the LOC.
- Pesticide dissipation is assumed to be first-order in the absence of data suggesting alternative dissipation patterns such as biphasic. Field dissipation data would generally be the most pertinent for assessing exposure in terrestrial species that forage on vegetation. However, these data are often not available and can be misleading, particularly if the compound is prone to "wash-off." Soil half-life is the most common degradation data available. Dissipation or degradation data that would reflect the environmental conditions typical of refuge lands would be used, if available.
- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column.
- Actual habitat requirements of any particular terrestrial species are not considered, and it is assumed that species exclusively and permanently occupy the treated area, or adjacent areas receiving pesticide at rates commensurate with the treatment rate. This assumption would produce a maximum estimate of exposure for risk characterization. This assumption would likely lead to an overestimation of exposure for species that do not permanently and exclusively occupy the treated area (EPA 2004).
- Exposure through incidental ingestion of pesticide-contaminated soil is not considered in the EPA risk assessment protocols. Research suggests <15 percent of the diet can consist of incidentally ingested soil depending upon species and feeding strategy (Beyer et al. 1994). An assessment of pesticide concentrations in soil compared to food item categories in the Kanaga nomogram indicates incidental soil ingestion would not likely increase dietary exposure to pesticides. Inclusion of soil into the diet would effectively reduce the overall dietary concentration compared to the present assumption that the entire diet consists of a contaminated food source (Fletcher et al. 1994). An exception to this may be soil-applied pesticides in which exposure from incidental ingestion of soil may increase. Potential for pesticide exposure under this assumption may be underestimated for soil-applied pesticides and overestimated for foliar-applied pesticides. The concentration of a pesticide in soil would likely be less than predicted on food items.
- Exposure through inhalation of pesticides is not considered in the EPA risk assessment protocols. Such exposure may occur through three potential sources: spray material in droplet form at time of application, vapor phase with the pesticide volatilizing from treated surfaces, and airborne particulates (soil, vegetative matter, and pesticide dusts). The EPA (1990)

reported exposure from inhaling spray droplets at the time of application is not an appreciable route of exposure for birds. According to research on mallards and bobwhite quail, respirable particle size (particles reaching the lung) in birds is limited to maximum diameter of 2 to 5 microns. The spray droplet spectra covering the majority of pesticide application scenarios indicate that less than 1 percent of the applied material is within the respirable particle size. This route of exposure is further limited because the permissible spray drop size distribution for ground pesticide applications is restricted to American Society of Agricultural Engineers (ASAE) medium or coarser drop size distribution.

- Inhalation of a pesticide in the vapor phase may be another source of exposure for some pesticides under certain conditions. This mechanism of exposure to pesticides occurs post-application, and it would pertain to those pesticides with a high vapor pressure. The EPA is currently evaluating protocols for modeling inhalation exposure from pesticides including near-field and near-ground air concentrations based upon equilibrium and kinetics-based models. Risk characterization for exposure with this mechanism is unavailable.
- The effect from exposure to dust contaminated with the pesticide cannot be assessed generically as partitioning issues related to application site soils and chemical properties of the applied pesticides render the exposure potential from this route highly situation-specific.
- Dermal exposure may occur through three potential sources: direct application of spray to terrestrial wildlife in the treated area or within the drift footprint, incidental contact with contaminated vegetation, or contact with contaminated water or soil. Interception of spray and incidental contact with treated substrates may pose risk to avian wildlife (Driver et al. 1991). However, available research related to wildlife dermal contact with pesticides is extremely limited, with the exception of dermal toxicity values for some mammals used as human surrogates (rats and mice), which are common. The EPA is currently evaluating protocols for modeling dermal exposure. Risk characterization may be underestimated for this route of exposure, particularly with high-risk pesticides such as some organophosphates or carbamate insecticides. If protocols are established by the EPA for assessing dermal exposure to pesticides, they would be considered for incorporation into pesticide assessment protocols.
- Exposure to a pesticide may occur from consuming surface water, dew, or other water on treated surfaces. Water-soluble pesticides have the potential to dissolve in surface runoff, and puddles in a treated area may contain pesticide residues. Similarly, pesticides with lower organic carbon partitioning characteristics and higher solubility in water have a greater potential to dissolve in dew and other water associated with plant surfaces. Estimating the extent to which such pesticide loadings to drinking water occurs is complex and would depend upon the partitioning characteristics of the active ingredient, soil types in the treatment area, and the meteorology of the treatment area. In addition, the use of various water sources by wildlife is highly species-specific. Currently, risk characterization for this exposure mechanism is not available. The EPA is actively developing protocols to quantify drinking water exposure from puddles and dew. If and when protocols are formally established by the EPA for assessing exposure to pesticides through drinking water, these protocols would be incorporated into pesticide risk assessment protocols.
- Risk assessments are based upon the assumption that the entire treatment area would be subject to pesticide application at the rates specified on the label. In most cases, there is potential for uneven application of pesticides through such plausible incidents such as changes in calibration of application equipment, spillage, and localized releases at specific areas in or near the treated field that are associated with mixing and handling and application equipment as well as applicator skill. Inappropriate use of pesticides and the occurrence of

spills represent a potential underestimation of risk. It is likely not an important factor for risk characterization. All pesticide applicators are required to be certified by the state in which they apply pesticides. Certification training includes the safe storage, transport, handling, and mixing of pesticides; equipment calibration; and proper application with annual continuing education.

- The EPA relies on Fletcher et al. (1994) for setting the assumed pesticide residues in wildlife dietary items. The EPA (2004) "believes that these residue assumptions reflect a realistic upper-bound residue estimate, although the degree to which this assumption reflects a specific percentile estimate is difficult to quantify." Fletcher et al.'s (1994) research suggests that the pesticide active ingredient residue assumptions used by the EPA represent a ninety-fifth percentile estimate. However, research conducted by Pfleeger et al. (1996) indicates EPA residue assumptions for short grass were not exceeded. Baehr and Habig (2000) compared the EPA residue assumptions with distributions of measured pesticide residues for the EPA's Uptake, Translocation, Accumulation, and Biotransformation (UTAB) database. Overall residue selection levels would tend to overestimate risk characterization. This is particularly evident when wildlife individuals are likely to have selected a variety of food items acquired from multiple locations. Some food items may be contaminated with pesticide residues whereas others are not contaminated. However, it is important to recognize differences in species feeding behavior. Some species may consume whole aboveground plant material, but others preferentially select different plant structures. Also, species may preferentially select a food item although multiple food items may be present. Without species-specific knowledge regarding foraging behavior, characterizing ecological risk other than in general terms is not possible.
- Acute and chronic risk assessments rely on comparisons of wildlife dietary residues with LC_{50} or NOEC values expressed as concentrations of pesticides in laboratory feed. These comparisons assume that ingestion of food items in the field occurs at rates commensurate with those in the laboratory. Although the screening assessment process adjusts dry-weight estimates of food intake to reflect the increased mass in fresh-weight wildlife food intake estimates, it does not allow for gross energy and assimilative efficiency differences between wildlife food items and laboratory feed. Differences in assimilative efficiency between laboratory and wild diets suggest that current screening assessment methods are not accounting for a potentially important aspect of food requirements.
- There are several other assumptions that can affect non-target species not considered in the risk assessment process. These include possible additive or synergistic effects from applying two or more pesticides or additives in a single application, co-location of pesticides in the environment, cumulative effects from pesticides with the same mode of action, effects of multiple stressors (e.g., combination of pesticide exposure and adverse abiotic and biotic factors), and behavioral changes induced by exposure to a pesticide. These factors may exist at some level contributing to adverse effects to non-target species, but they are usually characterized in the published literature in only a general manner, limiting their value in the risk assessment process.
- It is assumed that aquatic species exclusively and permanently occupy the water body being assessed. Actual habitat requirements of aquatic species are not considered. With the possible exception of scenarios where pesticides are directly applied to water, it is assumed that no habitat use considerations specific for any species would place the organisms in closer proximity to pesticide use sites. This assumption produces a maximum estimate of exposure or risk characterization. It would likely be realistic for many aquatic species that may be found in aquatic habitats within or in close proximity to treated terrestrial habitats. However,

the spatial distribution of wildlife is usually not random because wildlife distributions are often related to habitat requirements of species. Clumped distributions of wildlife may result in an underestimation or overestimation of risk depending upon where the initial pesticide concentration occurs relative to the species or species habitat.

- For species found in the water column, it would be assumed that the greatest bioavailable fraction of the pesticide active ingredient in surface waters is freely dissolved in the water column. Additional chemical exposure from materials associated with suspended solids or food items is not considered because partitioning onto sediments likely is minimal. Adsorption and bioconcentration occur at lower levels for many newer pesticides compared with older, more persistent bioaccumulative compounds. For pesticides with RQs close to the listed species LOC, the potential for additional exposure from these routes may be a limitation of risk assessments, where potential pesticide exposure or risk may be underestimated.
- Mass transport losses of pesticide from a water body (except for losses by volatilization, degradation, and sediment partitioning) would not be considered for ecological risk assessment. The water body would be assumed to capture all pesticide active ingredients entering as runoff, drift, and adsorbed to eroded soil particles. It would also be assumed that pesticide active ingredient is not lost from the water body by overtopping or flow-through, nor is concentration reduced by dilution. In total, these assumptions would lead to a near maximum possible water-borne concentration. However, this assumption would not account for the potential to concentrate pesticide through evaporative loss. This limitation may have the greatest impact on water bodies with high surface-to-volume ratios such as ephemeral wetlands, where evaporative losses are accentuated and applied pesticides have low rates of degradation and volatilization.
- For acute risk assessments, there would be no averaging time for exposure. An instantaneous peak concentration would be assumed, where instantaneous exposure is sufficient in duration to elicit acute effects comparable to those observed over more protracted exposure periods (typically 48 to 96 hours) tested in the laboratory. In the absence of data regarding time-to-toxic event and analyses and latent responses to instantaneous exposure, risk would likely be overestimated.
- For chronic exposure risk assessments, the averaging times considered for exposure are commensurate with the duration of the invertebrate life cycle or fish early life stage tests (e.g., 21-28 days and 56-60 days, respectively). Response profiles (time to effect and latency of effect) to pesticides likely vary widely with mode of action and species and should be evaluated on a case-by-case basis as available data allow. Nevertheless, because the EPA relies on chronic exposure, and toxicity endpoints based on a finding of no observed effect, the potential for any latent toxicity effects or averaging time assumptions to alter the results of an acceptable chronic risk assessment prediction is limited. The extent to which duration of exposure from water-borne concentrations overestimate or underestimate actual exposure depends on several factors. These include the following: localized meteorological conditions, runoff characteristics of the watershed (e.g., soils, topography), the hydrological characteristics of receiving waters, environmental fate of the pesticide active ingredient, and the method of pesticide application. It should also be understood that chronic effects studies are performed using a method that holds water concentration in a steady state. This method is not likely to reflect conditions associated with pesticide runoff. Pesticide concentrations in the field increase and decrease in surface water on a cycle influenced by rainfall, pesticide use patterns, and degradation rates. As a result of the dependency of this assumption on

several undefined variables, risk associated with chronic exposure may in some situations be overestimated or underestimated.

- The EPA is required by the Food Quality Protection Act to assess the cumulative risks of pesticides that share common mechanisms of toxicity, or act the same way within an organism. Currently, the EPA has identified four groups of pesticides that have a common mechanism of toxicity requiring cumulative risk assessments. These four groups are: the organophosphate insecticides, N-methyl carbamate insecticides, triazine herbicides, and chloroacetanilide herbicides.

G.7.3 Pesticide Mixtures and Degradates

Pesticide products are usually a formulation of several components generally categorized as active ingredients and inert or other ingredients. The term active ingredient is defined by the FIFRA as preventing, destroying, repelling, or mitigating the effects of a pest, or a plant regulator, defoliant, desiccant, or nitrogen stabilizer. In accordance with FIFRA, the active ingredient(s) must be identified by name(s) on the pesticide label along with its relative composition expressed in percentage(s) by weight. In contrast, inert ingredient(s) are not intended to affect a target pest. Their role in the pesticide formulation is to act as a solvent (keep the active ingredient is a liquid phase), an emulsifying or suspending agent (keep the active ingredient from separating out of solution), or a carrier (such as clay in which the active ingredient is impregnated on the clay particle in dry formulations). For example, if isopropyl alcohol is used as a solvent in a pesticide formulation, then it would be considered an inert ingredient. FIFRA only requires that inert ingredients identified as hazardous and associated percent composition, and the total percentage of all inert ingredients, must be declared on a product label. Inert ingredients that are not classified as hazardous are not required to be identified.

The EPA (September 1997) issued Pesticide Regulation Notice 97-6, which encouraged manufacturers, formulators, producers, and registrants of pesticide products to voluntarily substitute the term “other ingredients” for “inert ingredients” in the ingredient statement. This change recognized that all components in a pesticide formulation potentially could elicit or contribute to an adverse effect on non-target organisms and, therefore, are not necessarily inert. Whether referred to as “inerts” or “other ingredients,” these constituents within a pesticide product have the potential to affect species or environmental quality. The USEPA categorizes regulated inert ingredients into the following four lists (EPA 2012):

- List 1 – Inert Ingredients of Toxicological Concern
- List 2 – Potentially Toxic Inert Ingredients
- List 3 – Inerts of Unknown Toxicity
- List 4 – Inerts of Minimal Toxicity

Several of the List 4 compounds are naturally occurring earthen materials (e.g., clay materials, simple salts) that would not elicit toxicological response at applied concentrations. However, some of the inerts (particularly the List 3 compounds and unlisted compounds) may have moderate to high potential toxicity to aquatic species based on MSDS or published data.

Comprehensively assessing potential effects to non-target fish, wildlife, plants, and/or their habitats from pesticide use is a complex task. It would be preferable to assess the cumulative effects from exposure to the active ingredient, its degradates, and inert ingredients as well as other active ingredients in the spray mixture. However, it would only be feasible to conduct deterministic risk

assessments for each component in the spray mixture singly. Limited scientific information is available regarding ecological effects (additive or synergistic) from chemical mixtures that typically rely upon broadly encompassing assumptions. For example, the USFS (2005) found that mixtures of pesticides used in forest management likely would not cause additive or synergistic effects to nontarget species based upon a review of scientific literature regarding toxicological effects and interactions of agricultural chemicals (Agency for Toxic Substances and Disease Registry [ATSDR] 2004). Moreover, information on inert ingredients, adjuvants, and degradates is often limited by the availability of and access to reliable toxicological data for these constituents.

Toxicological information regarding "other ingredients" may be available from sources such as the following:

- Toxicology, Occupational Medicine, and Environmental Series (TOMES) (a proprietary toxicological database including EPA's Integrated Risk Information System (IRIS), the Hazardous Substance Data Bank, the Registry of Toxic Effects of Chemical Substances [RTECS])
- EPA's Ecotoxicology (ECOTOX) database, which includes Aquatic Information Retrieval (AQUIRE) (a database containing scientific papers published on the toxic effects of chemicals to aquatic organisms)
- TOXLINE (a literature searching tool)
- MSDSs from pesticide suppliers
- Other sources such as the *Farm Chemicals Handbook*

Because there is a lack of specific inert toxicological data, inert(s) in a pesticide may cause adverse ecological effects. However, inert ingredients typically represent only a small percentage of the pesticide spray mixture, and it would be assumed that negligible effects would be expected to result from inert ingredients.

Although the potential effects of degradates should be considered when selecting a pesticide, it is beyond the scope of this assessment process to consider all possible breakdown chemicals of the various product formulations containing an active ingredient. Degradates may be more or less mobile and more or less hazardous in the environment than their parent pesticides (Battaglin et al. 2003). Differences in environmental behavior (e.g., mobility) and toxicity between parent pesticides and degradates would make assessing potential degradate effects extremely difficult. For example, a less toxic and more mobile, bioaccumulative, or persistent degradate may have potentially greater effects on species and/or degrade environmental quality. The lack of data on the toxicity of degradates for many pesticides represents a source of uncertainty for assessing risk.

An EPA-approved label specifies whether a product can be mixed with one or more pesticides. Without product-specific toxicological data, it would not possible to quantify the potential effects of these mixtures. In addition, a quantitative analysis could only be conducted if reliable scientific information allowed a determination of whether the joint action of a mixture would be additive, synergistic, or antagonistic. Such information would not likely exist unless the mode of action is common among the chemicals and receptors. Moreover, the composition of and exposure to mixtures would be highly site- and/or time-specific and, therefore, it would be nearly impossible to assess potential effects to species and environmental quality.

To minimize or eliminate potential negative effects associated with applying two or more pesticides as a mixture, the use would be conducted in accordance with the labeling requirements. Labels for

two or more pesticides applied as a mixture should be completely reviewed, and products with the least potential for negative effects would be selected for use on the refuge. This is especially relevant when a mixture would be applied in a manner that may already have the potential for an effect(s) associated with an individual pesticide. Use of a tank mix under these conditions would increase the level of uncertainty in terms of risk to species or potential to degrade environmental quality.

Adjuvants generally function to enhance or prolong the activity of pesticide. For terrestrial herbicides, adjuvants aid in the absorption into plant tissue. Adjuvant is a broad term that generally applies to surfactants, selected oils, anti-foaming agents, buffering compounds, drift control agents, compatibility agents, stickers, and spreaders. Adjuvants are not under the same registration requirements as pesticides, and the EPA does not register or approve the labeling of spray adjuvants. Individual pesticide labels identify types of adjuvants approved for use with it. In general, adjuvants compose a relatively small portion of the volume of pesticides applied. Selection of adjuvants with limited toxicity and low volumes would be recommended to reduce the potential for the adjuvant to influence the toxicity of the pesticide.

G.7.4 Determining Effects to Soil and Water Quality

The approval process for pesticide uses would consider potential to degrade water quality on and off refuge lands. A pesticide can only affect water quality through movement away from the treatment site. After application, pesticide mobilization can be characterized by one or more of the following (Kerle et al. 1996):

- Attach (sorb) to soil, vegetation, or other surfaces and remain at or near the treated area;
- Attach to soil and move off-site through erosion from runoff or wind;
- Dissolve in water that can be subjected to runoff or leaching.

As an initial screening tool, selected chemical characteristics and rating criteria for a pesticide can be evaluated to assess potential to enter ground and/or surface waters. These would include the following: persistence, sorption coefficient (K_{oc}), groundwater ubiquity score (GUS), and solubility.

Persistence, which is expressed as half-life ($t_{½}$), represents the length of time required for 50 percent of the deposited pesticide to degrade (completely or partially). Persistence in the soil can be categorized as the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996). Half-life data are usually available for aquatic and terrestrial environments.

Another measure of pesticide persistence is dissipation time (DT_{50}). It represents the time required for 50 percent of the deposited pesticide to degrade and move from a treated site, whereas half-life describes the rate for degradation only. As with half-life, units of dissipation time are usually expressed in days. Field or foliar dissipation times are the preferred data for use to estimate pesticide concentrations in the environment. However, soil half-lives are the most common persistence data cited in published literature. If field or foliar dissipation data are not available, soil half-life data may be used. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Mobility of a pesticide is a function of how strongly it is adsorbed to soil particles and organic matter, its solubility in water, and its persistence in the environment. Pesticides strongly adsorbed to soil particles, relatively insoluble in water, and not environmentally persistent would be less likely to

move across the soil surface into surface waters or to leach through the soil profile and contaminate groundwater. Conversely, pesticides that are not strongly adsorbed to soil particles, are highly water soluble, and are persistent in the environment would have greater potential to move from the application site (off-site movement).

The degree of pesticide adsorption to soil particles and organic matter (Kerle et al. 1996) is expressed as the soil adsorption coefficient. The K_{oc} is measured as micrograms of pesticide per gram of soil (µg/g), which can range from near zero to the thousands. Pesticides with higher K_{oc} values are strongly sorbed to soil and, therefore, would be less subject to movement.

Water solubility describes the amount of pesticide that will dissolve in a known quantity of water. The water solubility of a pesticide is expressed as milligrams of pesticide dissolved in a liter of water (mg/L) or ppm. As pesticide solubility increases, there would be greater potential for off-site movement.

The GUS is a quantitative screening tool to estimate a pesticide's potential to move in the environment. It uses soil persistence and adsorption coefficients in the following formula.

$$GUS = \log_{10}(t½) \times [4 - \log10\ (K_{oc})]$$

The potential pesticide movement rating would be based upon its GUS value. Pesticides with a GUS <0.1 would be considered to have an extremely low potential to move toward groundwater. Values of 1.0 to 2.0 would have low potential, 2.0 to 3.0 would have moderate potential, 3.0 to 4.0 would have high potential, and >4.0 would have a very high potential to move toward groundwater.

GUS, water solubility, half-life, and K_{oc} values are available for selected pesticides from the Oregon State University (OSU) Extension Pesticide Properties Database at http://npic.orst.edu/ppdmove.htm. Many of the values in this database were derived from the Soil Conservation Service/Agricultural Research Service/Cooperative Extension Service (SCS/ARS/CES) Pesticide Properties Database for Environmental Decision Making (Wauchope et al. 1992).

Soil properties influence the fate of pesticides in the environment. The following six properties are mostly likely to affect pesticide degradation and the potential for pesticides to move off-site by leaching (vertical movement through the soil) or runoff (lateral movement across the soil surface).

- Permeability is the rate of water movement vertically through the soil. It is affected by soil texture and structure. Coarse-textured soils (e.g., high sand content) have a larger pore size and are generally more permeable than fine-textured soils (i.e., high clay content). The more permeable soils would have a greater potential for pesticides to move vertically down through the soil profile. Soil permeability rates (inches/hour) are usually available in county soil survey reports.
- Soil texture describes the relative percentage of sand, silt, and clay. In general, greater clay content with smaller pore size would lower the likelihood and rate that water would move through the soil profile. Clay also serves to adsorb (bind) pesticides to soil particles. Soils with high clay content would adsorb more pesticide than soils with relatively low clay content. In contrast, sandy soils with coarser texture and lower water-holding capacity would have a greater potential for water to leach through them.
- Soil structure describes soil aggregation. Soils with a well-developed soil structure have looser, more aggregated structures that would be less likely to be compacted. Both

characteristics would allow for less restricted flow of water through the soil profile, resulting in greater infiltration.

- Organic matter would be the single most important factor affecting pesticide adsorption in soils. Many pesticides are adsorbed to organic matter, which would reduce their rate of downward movement through the soil profile. Also, soils high in organic matter would tend to hold more water, which may make less water available for leaching.
- Soil moisture affects how fast water would move through the soil. If soils are already wet or saturated before rainfall or irrigation, excess moisture would result in runoff rather than infiltrate into the soil profile. Soil moisture also would influence microbial and chemical activity in soil, which effects pesticide degradation.
- Soil pH influences chemical reactions that occur in the soil, which in turn determines whether a pesticide would degrade, the rate of degradation, and, in some instances, which degradation products are produced.

Based upon the aforementioned properties, soils most vulnerable to groundwater contamination would be sandy soils with low organic matter. In contrast, the least vulnerable soils would be well-drained clayey soils with high organic matter. Consequently, pesticides with the lowest potential for movement in conjunction with appropriate BMPs (see below) would be used in an IPM framework to treat pests while minimizing effects to non-target biota and protecting environmental quality.

Along with soil properties, the potential for a pesticide to affect water quality through runoff and leaching would consider site-specific environmental and abiotic conditions including rainfall, water table conditions, and topography (Huddleston 1996).

- Water is necessary to separate pesticides from soil. This can occur in two basic ways. Pesticides that are soluble move easily with runoff water. Pesticide-laden soil particles can be dislodged and transported from the application site in runoff. The concentration of pesticides in the surface runoff would be greatest for the first runoff event following treatment. The rainfall intensity and route of water infiltration into soil, to a large extent, determine pesticide concentrations and losses in surface runoff. The timing of the rainfall after application also would have an effect. Rainfall interacts with pesticides at a shallow soil depth (¼ to ½ inch), which is called the mixing zone (Baker and Miller 1999). The pesticide/water mixture in the mixing zone would tend to leach down into the soil or runoff depending upon how quickly the soil surface becomes saturated and how rapidly water can infiltrate into the soil. Leaching would decrease the amount of pesticide available near the soil surface (mixing zone) to runoff during the initial rainfall event following application and subsequent rainfall events.
- Terrain slope would affect the potential for surface runoff and the intensity of runoff. Steeper slopes would have greater potential for runoff following a rainfall event. In contrast, soils that are relatively flat would have little potential for runoff, except during intense rainfall events. In addition, soils in lower areas would be more susceptible to leaching as a result of receiving excessive water from surrounding higher elevations.
- Depth to groundwater would be an important factor affecting the potential for pesticides to leach into groundwater. If the distance from the soil surface to the top of the water table is shallow, pesticides would have less distance to travel to reach groundwater. Shallower water tables that persist for longer periods would be more likely to experience groundwater contamination. Soil survey reports are available for individual counties. These reports provide data in tabular format regarding the water table depths and the months during which

they persist. In some situations, a hard pan exists above the water table that would prevent pesticide contamination from leaching.

G.7.5 Determining Effects to Air Quality

Pesticides may volatilize from soil and plant surfaces and move from the treated area into the atmosphere. The potential for a pesticide to volatilize is determined by the pesticide's vapor pressure, which would be affected by temperature, sorption, soil moisture, and the pesticide's water solubility. Vapor pressure is often expressed in mm Hg. To make these numbers easier to compare, vapor pressure may be expressed in exponent form ($I \times 10^{-7}$), where I represents a vapor pressure index. In general, pesticides with I<10 would have a low potential to volatilize, whereas pesticides with I>1,000 would have a high potential to volatilize (OSU 1996). Vapor pressure values for pesticides are usually available in the pesticide product MSDS or the USDA Agricultural Research Service (ARS) pesticide database.

G.7.6 Preparing a Chemical Profile

The following instructions would be used by Service personnel to complete chemical profiles for pesticides. Specifically, profiles would be prepared for pesticide active ingredients (e.g., glyphosate, imazapic) that would be contained in one or more trade name products that are registered and labeled with the EPA. All information fields under each category (e.g., toxicological endpoints, environmental fate) would be completed for a chemical profile. If no information is available for a specific field, then "No data is available in references" would be recorded in the profile. Available scientific information would be used to complete chemical profiles. Each entry of scientific information would be shown with applicable references.

Completed chemical profiles would provide a structured decision-making process using quantitative assessment/screening tools with threshold values (where appropriate) that would be used to evaluate potential biological and other environmental effects to refuge resources. For ecological risk assessments presented in these profiles, the "worst-case scenario" would be evaluated to determine whether a pesticide could be approved for use considering the maximum single application rate specified on pesticide labels for habitat management and croplands/facilities maintenance treatments pertaining to refuges. Where the worst-case scenario likely would only result in minor, temporary, and localized effects to listed and non-listed species with appropriate BMPs (see Section G.5), the proposed pesticide's use in a PUP would have a scientific basis for approval under any application rate specified on the label that is at or below rates evaluated in a chemical profile. In some cases, the chemical profile would include a lower application rate than the maximum labeled rate in order to protect refuge resources. As necessary, chemical profiles would be periodically updated with new scientific information or as pesticides with the same active ingredient are proposed for use on the refuge in PUPs.

Throughout this section, threshold values (to prevent or minimize potential biological and environmental effects) would be clearly identified for specific information presented in a completed chemical profile. Comparison with these threshold values provides an explicit scientific basis to approve or disapprove PUPs for habitat management and cropland/facilities maintenance on refuge lands. In general, PUPs would be approved for pesticides with chemical profiles where there would be no exceedances of threshold values. However, BMPs are identified for some screening tools that would minimize/eliminate potential effects (exceedance of the threshold value) as a basis for approving PUPs.

Date: Service personnel would record the date when the chemical profile is completed or updated. Chemical profiles (e.g., currently approved pesticide use patterns) would be periodically reviewed and updated as necessary. The most recent review date would be recorded on a profile to document when it was last updated.

Trade Name(s): Service personnel would accurately and completely record the trade name(s) from the pesticide label, which includes a suffix that describes the formulation (e.g., WP, DG, EC, L, SP, I, II or 64). The suffix often distinguishes a specific product from among several pesticides with the same active ingredient. Service personnel would record a trade name for each pesticide product with the same active ingredient.

Common chemical name(s): Service personnel would record the common name(s) listed on the pesticide label or MSDS for an active ingredient. The common name of a pesticide is listed as the active ingredient on the title page of the product label immediately following the trade name, and the MSDS Section 2: Composition/Information on Ingredients. A chemical profile is completed for each active ingredient.

Pesticide Type: Service personnel would record the type of pesticide for an active ingredient as one of the following: herbicide, desiccant, fungicide, fumigant, growth regulator, insecticide, piscicide, or rodenticide.

EPA Registration Number(s): The EPA Reg. No. appears on the title page of the label and MSDS Section 1: Chemical Product and Company Description. It is not the EPA Establishment Number, which is usually located near it. Service personnel would record the EPA Reg. No. for each trade name product with an active ingredient based upon PUPs.

Pesticide Class: Service personnel would list the general chemical class for the pesticide (active ingredient). For example, malathion is an organophosphate and carbaryl is a carbamate.

CAS (Chemical Abstract Service) Number: This number is often located in the second section (Composition/Information on Ingredients) of the MSDS. The MSDS table listing components usually contains this number immediately prior to or following the percent composition.

Other Ingredients: From the most recent MSDS for the proposed pesticide product(s), Service personnel would include any chemicals in the pesticide formulation that are not listed as active ingredients but are described as toxic or hazardous, or are regulated under the Superfund Amendments and Reauthorization Act (SARA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Toxic Substances Control Act (TSCA), OSHA, State Right-to-Know, or other listed authorities. These are usually found in MSDS sections titled "Hazardous Identifications," "Exposure Control/Personal Protection," and "Regulatory Information." If concentrations of other ingredients are available for any compounds identified as toxic or hazardous, then Service personnel would record this information in the chemical profile by trade name. MSDSs may be obtained from the manufacturer, manufacturer's website or from an online database maintained by Crop Data Management Systems, Inc. (see list below).

G.7.6.1 Toxicological Endpoints

Toxicological endpoint data would be collected for acute and chronic tests with mammals, birds, and fish. Data would be recorded for species available in the scientific literature. If no data are found for

a particular taxonomic group, then "No data available is references" would be recorded as the data entry. Throughout the chemical profile, references (including toxicological endpoint data) would be cited using parentheses (#) following the recorded data.

Mammalian LD_{50}: For test species in the scientific literature, Service personnel would record available data for oral lethal dose (LD_{50}) in mg/kg-bw (body weight) or ppm-bw. The most common test species in scientific literature are the rat and mouse. The lowest LD_{50} value found for a rat would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk to mammals (see Table G-1 in Section G.7.2).

Mammalian LC_{50}: For test species in the scientific literature, Service personnel would record available data for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). The most common test species in scientific literature are the rat and mouse. The lowest LC_{50} value found for a rat would be used as a toxicological endpoint for diet-based RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

Mammalian Reproduction: For test species listed in the scientific literature, Service personnel would record the test results (e.g., Lowest Observed Effect Concentration [LOEC], Lowest Observed Effect Level [LOEL], No Observed Adverse Effect Level [NOAEL], NOAEC) in mg/kg-bw or mg/kg-diet for reproductive test procedure(s) (e.g., generational studies [preferred], fertility, newborn weight). The most common test species available in scientific literature are rats and mice. The lowest NOEC, NOAEC, LOEL, or NOAEL test results found for a rat would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table G-1 in Section G.7.2).

Avian LD_{50}: For test species available in the scientific literature, Service personnel would record values for oral lethal dose (LD_{50}) in mg/kg-bw or ppm-bw. The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LD_{50} value found for an avian species would be used as a toxicological endpoint for dose-based RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

Avian LC_{50}: For test species available in the scientific literature, Service personnel would record values for dietary lethal concentration (LC_{50}) as reported (e.g., mg/kg-diet or ppm-diet). The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest LC_{50} value found for an avian species would be used as a toxicological endpoint for dietary-based RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

Avian Reproduction: For test species available in the scientific literature, Service personnel would record test results (e.g., LOEC, LOEL, NOAEC, NOAEL) in mg/kg-bw or mg/kg-diet consumed for reproductive test procedure(s) (e.g., early life cycle, reproductive). The most common test species available in scientific literature are the bobwhite quail and mallard. The lowest NOEC, NOAEC, LOEL, or NOAEL test results found for an avian species would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table G-1 in Section G.7.2).

Fish LC_{50}: For test freshwater or marine species listed in the scientific literature, Service personnel would record a LC_{50} in ppm or mg/L. The most common test species available in the scientific literature are the bluegill, rainbow trout, and fathead minnow (marine). Test results for many game species may also be available. The lowest LC_{50} value found for a freshwater fish species would be used as a toxicological endpoint for RQ calculations to assess acute risk (see Table G-1 in Section G.7.2).

Fish Early Life Stage/Life Cycle: For test freshwater or marine species available in the scientific literature, Service personnel would record test results (e.g., LOEC, NOAEL, NOAEC, lowest observed adverse effect concentration [LOAEC]) in ppm for test procedure(s) (e.g., early life cycle, life cycle). The most common test species available in the scientific literature are bluegill, rainbow trout, and fathead minnow. Test results for other game species may also be available. The lowest test value found for a fish species (preferably freshwater) would be used as a toxicological endpoint for RQ calculations to assess chronic risk (see Table G-1 in Section G.7.2).

Other: For test invertebrate and nonvascular and vascular plant species available in the scientific literature, Service personnel would record $LC_{50,}$ $LD_{50,}$ LOEC, LOEL, NOAEC, NOAEL, or EC_{50} (environmental concentration) values in ppm or mg/L. The most common test invertebrate species available in scientific literature is the honey bee. Green algae and pondweed are frequently available test species for aquatic non-vascular and vascular plants, respectively.

Ecological Incident Reports: After a site has been treated with pesticide(s), wildlife may be exposed to these chemical(s). When exposure is high relative to the toxicity of the pesticides, wildlife may be killed or visibly harmed (incapacitated). Such events are called ecological incidents. The EPA maintains a database (Ecological Incident Information System) of ecological incidents. This database stores information extracted from incident reports submitted by various Federal and state agencies and non-government organizations. Information included in an incident report is date and location of the incident, type and magnitude of effects observed in various species, use(s) of pesticides known or suspected of contributing to the incident, and results of any chemical residue and cholinesterase activity analyses conducted during the investigation.

Incident reports can play an important role in evaluating the effects of pesticides by supplementing quantitative risk assessments. All incident reports for pesticide(s) with the active ingredient and associated information would be recorded.

G.7.6.2 Environmental Fate

Water Solubility: Service personnel would record values for water solubility (S_w), which describes the amount of pesticide that dissolves in a known quantity of water. S_w is expressed as mg/L (ppm). Pesticide S_w values would be categorized as one of the following: insoluble <0.1 ppm, moderately soluble = 100 to 1,000 ppm, highly soluble >10,000 ppm (U.S. Geological Survey 2000). As pesticide S_w increases, there would be greater potential to degrade water quality through runoff and leaching.

Sw would be used to evaluate potential for bioaccumulation in aquatic species (see Octanol-Water Partition Coefficient (K_{ow}) below).

Soil Mobility: Service personnel would record available values for soil adsorption coefficient (K_{oc} [μg/g]). It provides a measure of a chemical's mobility and leaching potential in soil. K_{oc} values are directly proportional to organic content, clay content, and surface area of the soil. K_{oc} data for a pesticide may be available for a variety of soil types (e.g., clay, loam, sand).

K_{oc} values would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below).

Soil Persistence: Service personnel would record values for soil half-life, which represents the length of time (days) required for 50 percent of the deposited pesticide to degrade (completely or partially) in the soil. Based upon the half-life value, soil persistence would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996).

Threshold for approving PUPs:

If soil half-life ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.

If soil half-life >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the "Specific Best Management Practices (BMPs)" section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil half-life values would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below).

Soil Dissipation: Field dissipation time would be the preferred data for use to estimate pesticide concentrations in the environment because it is based upon field studies, unlike soil half-life, which is derived in a laboratory. However, soil half-life is the most common persistence data available in the published literature. If field dissipation data are not available, soil half-life data would be used in a chemical profile. The average or representative half-life value of most important degradation mechanism would be selected for quantitative analysis for both terrestrial and aquatic environments.

Based upon the DT_{50} value, environmental persistence in the soil also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

Threshold for approving PUPs:

If soil DT_{50} ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.

If soil DT_{50} >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the "Specific Best Management Practices (BMPs)" section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*

- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Along with K_{oc}, soil DT_{50} values (preferred over soil half-life) would be used in evaluating the potential to degrade groundwater by leaching (see Potential to Move to Groundwater below), if available.

Aquatic Persistence: Service personnel would record values for aquatic half-life, which represents the length of time required for 50 percent of the deposited pesticide to degrade (completely or partially) in water. Based upon the aquatic half-life value, aquatic persistence would be categorized as one of the following: nonpersistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days (Kerle et al. 1996).

Threshold for approving PUPs:

If aquatic half-life ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.

If aquatic half-life >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the "Specific Best Management Practices (BMPs)" section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Aquatic Dissipation: Dissipation time (DT_{50}) represents the time required for 50 percent of the deposited pesticide to degrade or move (dissipate), whereas, aquatic half-life describes the rate for degradation only. As with aquatic half-life, units of dissipation time are usually expressed in days. Based upon the DT_{50} value, environmental persistence in aquatic habitats also would be categorized as one of the following: non-persistent <30 days, moderately persistent = 30 to 100 days, and persistent >100 days.

Threshold for approving PUPs:

If aquatic DT_{50} ≤100 days, then a PUP would be approved without additional BMPs to protect water quality.

If aquatic DT_{50} >100 days, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the "Specific Best Management Practices (BMPs)" section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*

- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Potential to Move to Groundwater: GUS = $\log_{10}(\text{soil } t_{½}) \times [4 - \log_{10}(K_{oc})]$. If a DT_{50} value is available, it would be used rather than a $t_{½}$ value to calculate a GUS score. Based upon the GUS value, the potential to move toward groundwater would be recorded as one of the following categories: extremely low potential <1.0, low potential 1.0 to 2.0, moderate potential 2.0 to 3.0, high potential 3.0 to 4.0, and very high potential >4.0.

Threshold for approving PUPs:

If GUS ≤4.0, then a PUP would be approved without additional BMPs to protect water quality.

If GUS >4.0, then a PUP would only be approved with additional BMPs specifically to protect water quality. One or more BMPs such as the following would be included in the "Specific Best Management Practices (BMPs)" section to minimize potential surface runoff and leaching that can degrade water quality:

- *Do not exceed one application per site per year.*
- *Do not use on coarse-textured soils where the groundwater table is <10 feet and average annual precipitation >12 inches.*
- *Do not use on steep slopes if substantial rainfall is expected within 24 hours or ground is saturated.*

Threshold for approving PUPs:

If I ≤1,000, then a PUP would be approved without additional BMPs to minimize drift and protect air quality.

If I >1,000, then a PUP would only be approved with additional BMPs specifically to minimize drift and protect air quality. One or more BMPs such as the following would be included in the "Specific Best Management Practices (BMPs)" section to reduce volatilization and potential to drift and degrade air quality:

- *Do not treat when wind velocities are <2 or >10 mph with existing or potential inversion conditions.*
- *Apply large-diameter droplets possible for spray treatments.*
- *Avoid spraying when air temperatures >85°F.*
- *Use the lowest spray height possible above target canopy.*
- *Where identified on the pesticide label, soil should incorporate pesticide as soon as possible during or after application.*

Octanol-Water Partition Coefficient (K_{ow}): The octanol-water partition coefficient (K_{ow}) is the concentration of a pesticide in octanol and water at equilibrium at a specific temperature. Because octanol is an organic solvent, it is considered a surrogate for natural organic matter. Therefore, K_{ow} would be used to assess potential for a pesticide to bioaccumulate in tissues of aquatic species (e.g., fish). If K_{ow} >1,000 or S_w<1 mg/L and soil $t_{½}$>30 days, then there would be high potential for a pesticide to bioaccumulate in aquatic species such as fish (U.S. Geological Survey 2000).

Threshold for approving PUPs:

If the potential for a pesticide to bioaccumulate is not high in aquatic species, then the PUP would be approved.

If there is a high potential to bioaccumulate in aquatic species (K_{ow}>1,000 or S_w<1 mg/L and soil $t_{½}$>30 days), then the PUP would not be approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Bioaccumulation/Bioconcentration: Bioaccumulation is the physiological process where pesticide concentrations in tissue increase in biota because they are taken and stored at a faster rate than they are metabolized or excreted. The potential for bioaccumulation would be evaluated through bioaccumulation factors (BAFs) or bioconcentration factors (BCFs). Based upon BAF or BCF values, the potential to bioaccumulate would be recorded as one of the following: low = 0 to 300, moderate = 300 to 1,000, or high >1,000 (Calabrese and Baldwin 1993).

Threshold for approving PUPs:

If BAF or BCF ≤1,000, then a PUP would be approved without additional BMPs.

If BAF or BCF >1,000, then a PUP would not be approved, except under unusual circumstances where approval would only be granted by the Washington Office.

Worst-Case Ecological Risk Assessment

Maximum Application Rates (acid equivalent [ae]): Service personnel would record the highest application rate of an active ingredient (ae basis) for habitat management and cropland/facilities maintenance treatments in this data field of a chemical profile. These rates can be found in Table CP.1 under the column heading "Max Product Rate – Single Application (lbs/acre – AI on acid equiv basis)." This table would be prepared for a chemical profile from information specified in labels for trade name products identified in PUPs. If these data are not available in pesticide labels, then write "NS" for "not specified on label" in this table.

EECs: An estimated EEC represents potential exposure to fish and wildlife (birds and mammals) from using a pesticide. EECs would be derived by Service personnel using an EPA screening-level approach (EPA 2004). For each maximum application rate (see previous paragraph), Service personnel would record two EEC values in a chemical profile; these would represent the worst-case terrestrial and aquatic exposures for habitat management and croplands/facilities maintenance treatments. For terrestrial and aquatic EEC calculations, see the description for data entry under Presumption of Unacceptable Risk/Risk Quotients, the next field in a chemical profile.

Presumption of Unacceptable Risk/Risk Quotients: Service personnel would calculate and record acute and chronic RQs for birds, mammals, and fish using the provided tabular formats for habitat management and/or cropland/facilities maintenance treatments. RQs recorded in a chemical profile would represent the worst-case assessment for ecological risk. See Section G.7.2 for a discussion regarding the calculations of RQs.

For aquatic assessments associated with habitat management treatments, RQ calculations would be based upon selected acute and chronic toxicological endpoints for fish, and the EEC would be

derived from Urban and Cook (1986) assuming 100 percent overspray to an entire 1-foot-deep water body using the maximum application rate (ae basis [see above]).

For aquatic assessments associated with cropland/facilities maintenance treatments, RQ calculations would be done by Service personnel based upon selected acute and chronic toxicological endpoints for fish, and an EEC would be derived from the aquatic assessment in AgDRIFT model version 2.01 under Tier I ground-based application with the following input variables: max application rate (ae basis [see above]), low boom (20 inches), fine to medium/coarse droplet size, 20 swaths, EPA-defined wetland, and 25-foot distance (buffer) from treated area to water.

See Section G.7.2.1.2 for more details regarding the calculation of EECs for aquatic habitats for habitat management and cropland/facilities maintenance treatments.

For terrestrial avian and mammalian assessments, RQ calculations would be done by Service personnel based upon dietary exposure, where the "short grass" food item category would represent the worst-case scenario. For terrestrial spray applications associated with habitat management and cropland/facilities maintenance treatments, exposure (EECs and RQs) would be determined using the Kanaga nomogram method through the EPA's T-REX version 1.2.3. T-REX input variables would include the following: max application rate (ae basis [see above]) and pesticide half-life (days) in soil to estimate the initial, maximum pesticide residue concentration on general food items for terrestrial vertebrate species in short (<20 cm tall) grass.

For granular pesticide formulations and pesticide-treated seed with a unique route of exposure for terrestrial avian and mammalian wildlife, see Section G.7.2.1.1.2 for the procedure that would be used to calculate RQs.

All calculated RQs in both tables would be compared with LOCs established by the EPA (see Table G-2 in Section G.7.2). If a calculated RQ exceeds an established LOC value (in brackets inside the table), then there would be a potential for an acute or chronic effect (unacceptable risk) to federally listed (threatened or endangered) species and non-listed species. See Section G.7.2 for detailed descriptions of acute and chronic RQ calculations and comparison to LOCs to assess risk.

Threshold for approving PUPs:

If RQs≤LOCs, then a PUP would be approved without additional BMPs.

If RQs>LOCs, then a PUP would only be approved with additional BMPs specifically to minimize exposure (ecological risk) to bird, mammal, and/or fish species. One or more BMPs such as the following would be included in the "Specific Best Management Practices (BMPs)" section to reduce potential risk to nonlisted or listed species:

- *Lower application rate and/or fewer number of applications so RQs≤LOCs.*
- *For aquatic assessments (fish) associated with cropland/facilities maintenance, increase the buffer distance beyond 25 feet so RQs≤LOCs.*

Justification for Use: Service personnel would describe the reason for using the pesticide based on control of specific pests or groups of pests. In most cases, the pesticide label would provide the appropriate information regarding control of pests to describe in the section.

Specific Best Management Practices (BMPs): Service personnel would record specific BMPs necessary to minimize or eliminate potential effects to non-target species and/or degradation of environmental quality from drift, surface runoff, or leaching. These BMPs would be based upon scientific information documented in previous data fields of a chemical profile. Where necessary and feasible, these specific practices would be included in PUPs as a basis for approval.

If there are no specific BMPs that are appropriate, then Service personnel would describe why the potential effects to refuge resources and/or degradation of environmental quality are outweighed by the overall resource benefit(s) from the proposed pesticide use in the BMP section of the PUP. See Section G.5 of this document for a complete list of BMPs associated with mixing and applying pesticides appropriate for all PUPs with ground-based treatments that would be additive to any necessary, chemical-specific BMPs.

References: Service personnel would record scientific resources used to provide data/information for a chemical profile. They would use the number sequence to uniquely reference data in a chemical profile.

The following online data resources are readily available for toxicological endpoint and environmental fate data for pesticides:

1. California Product/Label Database. Department of Pesticide Regulation, California Environmental Protection Agency. (http://www.cdpr.ca.gov/docs/label/labelque.htm#regprods)

2. ECOTOX database. Office of Pesticide Programs, EPA, Washington, D.C. (http://cfpub.epa.gov/ecotox/)

3. EXTOXNET Pesticide Information Profiles. Cooperative effort of University of California-Davis, Oregon State University, Michigan State University, Cornell University, and University of Idaho through Oregon State University, Corvallis, Oregon. (http://extoxnet.orst.edu/pips/ghindex.html)

4. Food and Agriculture Organization (FAO) specifications and evaluations for plant protection products. Pesticide Management Unit, Plant Protection Services, FAO, United Nations. (http://www.fao.org/WAICENT/FAOINFO/AGRICULT/AGP/AGPP/Pesticid/)

5. Human health and ecological risk assessments. Pesticide Management and Coordination, Forest Health Protection, USFS, USDA. (http://www.fs.fed.us/foresthealth/pesticide/risk.htm)

6. Pesticide Chemical Fact Sheets. Clemson University Pesticide Information Center. (http://entweb.clemson.edu/pesticid/Document/Labels/factshee.htm)

7. Pesticide Fact Sheets. Published by Information Ventures, Inc. for Bureau of Land Management, Bonneville Power Administration, U.S. Department of Energy, and USFS, USDA. (http://infoventures.com/e-hlth/pesticide/pest-fac.html)

8. Pesticide fact sheets. National Pesticide Information Center. (http://npic.orst.edu/npicfact.htm)

9. Pesticide fate database. EPA, Washington, D.C. (http://cfpub.epa.gov/pfate/home.cfm).

10. Pesticide product labels and MSDSs. Crop Data Management Systems, Inc. (http://www.cdms.net/pfa/LUpdateMsg.asp) or multiple websites maintained by agrichemical companies.

11. Registered Pesticide Products (Oregon database). Oregon Department of Agriculture. (http://www.oda.state.or.us/dbs/pest_products/search.lasso)

12. Regulatory notes. Pest Management Regulatory Agency, Health Canada, Ontario, Canada. (http://www.hc-sc.gc.ca/pmra-arla/)

13. Reptile and amphibian toxicology literature. Canadian Wildlife Service, Environment Canada, Ontario, Canada. (http://www.cws-scf.ec.gc.ca/nwrc-cnrf/ratl/index_e.cfm)

14. Specific Chemical Fact Sheet—New Active Ingredients, Biopesticide Fact Sheet and Registration Fact Sheet. EPA, Washington, D.C. (http://www.epa.gov/pestidides/factsheets/chemical_fs.htm)

15. Weed Control Methods Handbook: Tools and Techniques for Use in Natural Areas. The Invasive Species Initiative. The Nature Conservancy. (http://tnsweeds.ucdavis.edu/handbook.html)

16. Wildlife contaminants online. U.S. Geological Survey, Department of Interior, Washington, D.C. (http://www.pwrc.usgs.gov/contaminants-online/)

17. One-liner database. 2000. EPA Office of Pesticide Programs, Washington, D.C.

Chemical Profile

Date:			
Trade Name(s):		**Common Chemical Name(s):**	
Pesticide Type:		**EPA Registration Number:**	
Pesticide Class:		**CAS Number:**	
Other Ingredients:			

Toxicological Endpoints

Mammalian LD_{50}:	
Mammalian LC_{50}:	
Mammalian Reproduction:	
Avian LD_{50}:	
Avian LC_{50}:	
Avian Reproduction:	
Fish LC_{50}:	
Fish ELS/Life Cycle:	
Other:	

Ecological Incident Reports

Environmental Fate

Water solubility (S_w):	
Soil Mobility (K_{oc}):	
Soil Persistence ($t_{½}$):	
Soil Dissipation (DT_{50}):	
Aquatic Persistence ($t_{½}$):	
Aquatic Dissipation (DT_{50}):	
Potential to Move to Groundwater (GUS score):	
Volatilization (mm Hg):	
Octanol-Water Partition Coefficient (K_{ow}):	
Bioaccumulation/Biocentration:	**BAF:`** **BCF:**

Worst Case Ecological Risk Assessment

Max Application Rate (ai lbs/acre – ae basis)	**Habitat Management:** **Croplands/Facilities Maintenance:**
EECs	**Terrestrial (Habitat Management):** **Terrestrial (Croplands/Facilities Maintenance):** **Aquatic (Habitat Management):** **Aquatic (Croplands/Facilities Maintenance):**

Habitat Management Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Non-listed Species**
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]

	Mammals	[1]	[1]
	Fish	[1]	[1]

Cropland/Facilities Maintenance Treatments:

Presumption of Unacceptable Risk		**Risk Quotient (RQ)**	
		Listed (T&E) Species	**Non-listed Species**
Acute	Birds	[0.1]	[0.5]
	Mammals	[0.1]	[0.5]
	Fish	[0.05]	[0.5]
Chronic	Birds	[1]	[1]
	Mammals	[1]	[1]
	Fish	[1]	[1]

Justification for Use:	
Specific Best Management Practices (BMPs):	
References:	

Table CP.1 Pesticide Name

Trade Name[a]	Treatment Type[b]	Max Product Rate – Single Application (lbs/acre or gal/acre)	Max Product Rate - Single Application (lbs/acre - AI on acid equiv basis)	Max Number of Applications Per Season	Max Product Rate Per Season (lbs/acre/season or gal/acre/season)	Minimum Time Between Applications (Days)

[a] From each label for a pesticide identified in PUPs, Service personnel would record application information associated with possible/known uses on Service lands.
[b] Treatment type: H – habitat management or CF – cropland/facilities maintenance. If a pesticide is labeled for both types of treatments (uses), then record separate data for H and CF applications.

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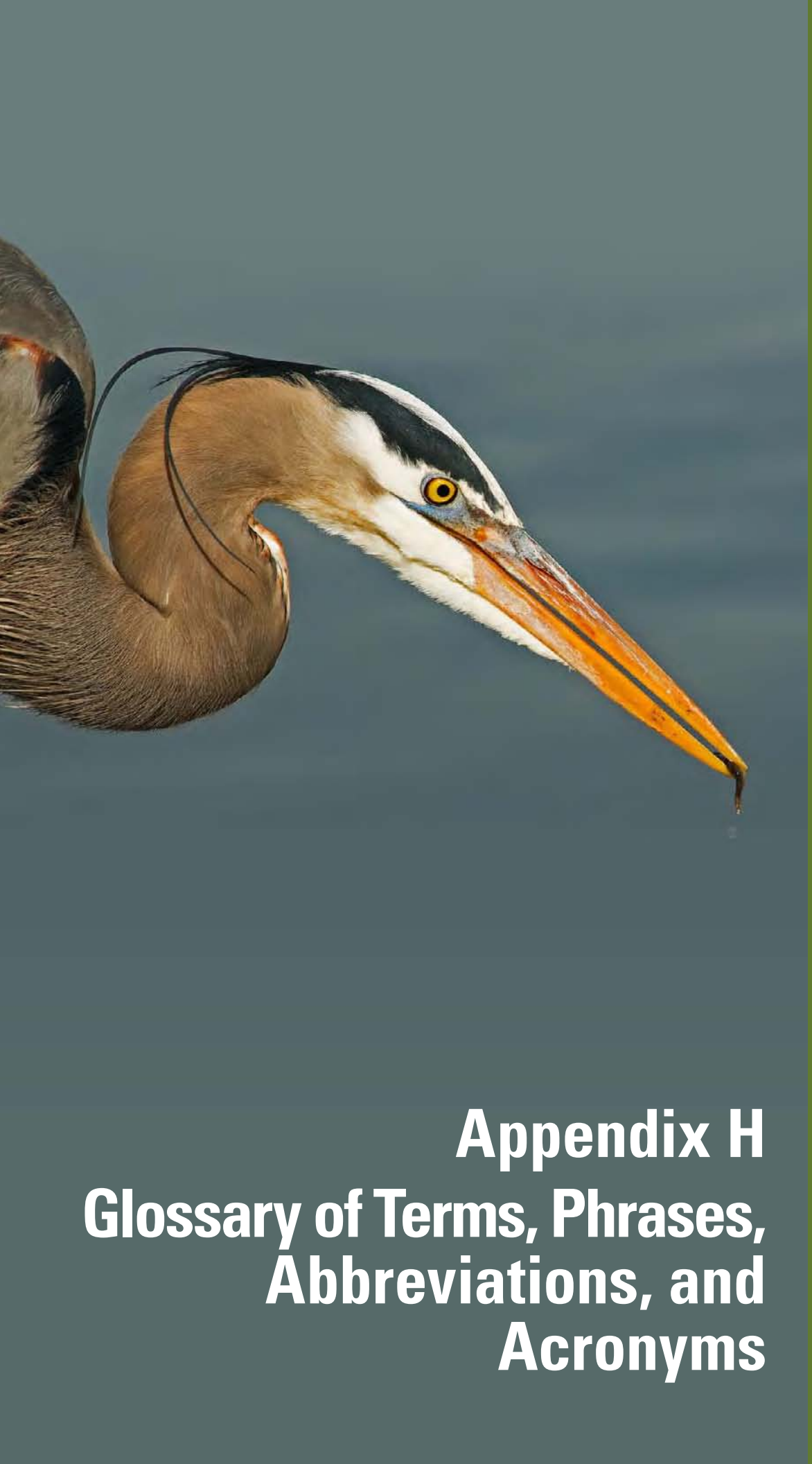

Appendix H
Glossary of Terms, Phrases, Abbreviations, and Acronyms

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Appendix H. Glossary of Terms, Phrases, Abbreviations, and Acronyms

H.1 Acronyms and Abbreviations

AAR	After Action Review
ABC	American Bird Conservancy
ADA	Americans with Disabilities Act
Administration Act	National Wildlife Refuge System Administration Act
AHM	Adaptive harvest management
a.i.	Active ingredient
AMR	Appropriate management response
ARPA	Archaeological Resources Protection Act
ARRA	American Recovery and Reinvestment Act
ARS	Agricultural Research Service
ATSDR	Agency for Toxic Substances and Disease Registry
ATV	All-terrain vehicle
BAF	Bioaccumulation factors
BCC	Birds of Conservation Concern
BCF	Bioconcentration factors
BCR	Bird Conservation Region
BI	Burning Index
BIDEH	Biological Integrity, Diversity, and Environmental Health
BMC	Birds of Management Concern
BMPs	Best management practice(s)
BPA	Bonneville Power Administration
B.t.i.	*Bacillus thuringiensis* var. *israelensis*
CCP	Comprehensive conservation plan
CD	Compatibility determination
CDL	Commercial Driver's License
CEQ	White House Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cfs	Cubic feet per second
CIG	Climate Impacts Group (University of Washington)
CO	Carbon dioxide
COA	Conservation Opportunity Areas
CWS	Clean Water Services
DBH	Diameter at breast height
DEM	Digital elevation model
DEQ	Department of Environmental Quality (Oregon)
DSL	Department of State Lands
DSM	Division of Smoke Management
EA	Environmental assessment
EDRR	Early detection and rapid response
EEC	Estimated environmental concentration
EMDS	Ecosystem Management Decision Support

E.O.	Executive Order
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESR	Emergency Stabilization and Rehabilitation
ESU	Evolutionarily Significant Unit
FAO	Food and Agriculture Organization
FCR	Fire-cracked rock
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
FmHA	Farmers Home Administration
FMP	Fire Management Plan
FMU	Fire Management Unit
GBADC	Game Birds Above Desired Condition
GBBDC	Gamebirds Below Desired Condition
GHGs	Greenhouse gases
GIS	Geographic information system
GLO	General Land Office
GPS	Global positioning system
GUS	Groundwater ubiquity score
HACCP	Hazard Analysis and Critical Control Points
HAP	Hazardous air pollutants
HAR	Height above river
HHS	Health and Human Services
IBA	Important Bird Area
IC	Incident commander
IFQS	Interagency Fire Qualification System
Improvement Act	National Wildlife Refuge System Improvement Act of 1997
IPCC	Intergovernmental Panel on Climate Change
IPM	Integrated pest management
IQCS	Incident Qualification and Certification System
IRPG	Incident Response Pocket Guide
KFF	Ken Foster Farm
LCC	Landscape Conservation Cooperative
LCP	Land Conservation Plan
LEED	Leadership in Energy and Environmental Design
LiDAR	Light Detection and Ranging
LOC	Level of Concern
LOEC	Lowest Observed Effect Concentration
LOEL	Lowest Observed Effect Level
MIST	Minimum impact suppression tactics
MOA	Memorandum of agreement
MOU	Memorandum of understanding
mph	Miles per hour
MSDS	Material Safety Data Sheet
MSL	Mean sea level
MYA	Million years ago
NAAEE	North American Association for Environmental Education
NAGPRA	Native American Graves Repatriation Act
NAS	National Audubon Society
NAWMP	North American Waterfowl Management Plan

NBC	National Business Center
NEPA	National Environmental Policy Act
NFDRS	National Fire Danger Rating System
NGO	Nongovernmental organization
NH_3	Ammonia
NHPA	National Historic Preservation Act
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NOAEC	No Observed Adverse Effect Concentration
NOAEL	No Observed Adverse Effect Level
NOEC	No Observed Effect Concentration
NOx	Nitrogen oxides
NRHP	National Register of Historic Places
NWCG	National Wildfire Coordinating Group
OCCRI	Oregon Climate Change Research Institute
OCS	Oregon Conservation Strategy
ODFW	Oregon Department of Fish and Wildlife
ODOT	Oregon Department of Transportation
OPRD	Oregon Parks and Recreation Department
OSHA	Occupational Safety and Health Administration
Pb	Lead
PCJV	Pacific Coast Joint Venture
PFC	Pacific Flyway Council
PIF	Partners in Flight
PM2.5	Particulate matter less than or equal to 2.5 micrometers
PM10	Particulate matter less than or equal to 10 micrometers
ppb	parts per billion
PPE	Personal protective equipment
ppm	parts per million
PUP	Pesticide Use Proposal
PUPS	Pesticide Use Proposal System
REI	Restricted entry interval
RMIS	Refuge Management Information System
ROCs	Resource(s) of Concern
RONS	Refuge Operating Needs System
RQ	Risk quotient
RV	Recreational vehicle
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
SARA	Superfund Amendments and Reauthorization Act
SCORP	Statewide Comprehensive Outdoor Recreation Plan
SDTF	Spray Drift Task Force
Service	U.S. Fish and Wildlife Service (also USFWS)
SHPO	State Historic Preservation Office
SO_2	Sulfur dioxide
SUP	Special Use Permit
SWCA	SWCA Environmental Consultants
T/E	Threatened and endangered species
TMDL	Total maximum daily load

TRWC	Tualatin River Watershed Council
TSCA	Toxic Substances Control Act
TVFR	Tualatin Valley Fire and Rescue
TVID	Tualatin Valley Irrigation District
TWA	Time-weighted-average
U.S.C.	United States Code
USDA APHIS-PPQ	U.S. Department of Agriculture—Animal Plant Health Inspection Service, Plant Protection and Quarantine
USDOI	U.S. Department Of Interior
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGCRP	United States Global Change Research Program
USGS	U.S. Geological Survey
USHCN	United States Historical Climatology Network
VOC	Volatile organic compounds
WID	Wapato Improvement District
YCPA	Yamhill County Public Health
YMCA	Young Men's Christian Association

H.2 Glossary

Accessible. Without fences or vegetative barriers (tall, dense vegetation) at its margins.

Adaptive management. "The rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities. A process that uses feedback from refuge research and monitoring and evaluation of management actions to support or modify objectives and strategies at all planning levels" (620 FW 1).

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; increases scientific knowledge; and reduces tensions among stakeholders" (522 DM 1).

Alternative. Different sets of objectives and strategies or means of achieving refuge purposes and goals, helping fulfill the National Wildlife Refuge System (Refuge System) mission, and resolving issues (602 FW 1.6). The "no action" alternative is current refuge management, while the "action" alternatives are all other alternatives.

Anadromous fish. Fish that are born in fresh water, migrate to the ocean to grow into adults, and return to fresh water to spawn.

Appropriate use. "A proposed or existing use on a refuge that meets at least one of the following four conditions.

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

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

(3) The use involves the take of fish and wildlife under State regulations.

(4) The use has been found to be appropriate as specified in section 1.11" (603 FW 1).

Approved Acquisition Boundary. National wildlife refuge boundary approved by the U.S. Fish and Wildlife Service director for potential acquisition of lands by the Service.

Approved Refuge Boundary. A national wildlife refuge boundary approved by the national or regional U.S. Fish and Wildlife Service (USFWS) director. Within this boundary, the Service may negotiate with landowners to acquire lands not already owned by the Service.

Archaeology. The scientific study of material evidence remaining from past human life and culture.

Benefiting resources. Those species, species groups, or resources expected to benefit from actions taken for a Resource of Concern.

Big Six. Wildlife-dependent recreational uses under Refuge System Improvement Act. The big sixes uses are hunting, fishing, wildlife observation, photography, and environmental education and interpretation.

Birds of Conservation Concern. A category assembled by the USFWS Division of Migratory Birds identifying the migratory and nonmigratory species (beyond those already designated as federally threatened or endangered) that represent the division's highest conservation priorities.

Biological Diversity (also Biodiversity). The variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur (601 FW 3). The Refuge System's focus is on indigenous species, biotic communities, and ecological processes.

Biological integrity. Biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historical conditions, including the natural biological processes that shape genomes, organisms, and communities (601 FW 3).

Candidate species. Plant or animal species for which USFWS or NOAA Fisheries has on file sufficient information on biological vulnerability and threats to support a proposal to list as endangered or threatened (USFWS Endangered Species Glossary).

Categorical exclusion. A category of actions that do not individually or cumulatively have a significant effect on the human environment and have been found to have no such effect in procedures adopted by a Federal agency pursuant to the National Environmental Policy Act (NEPA) (40 CFR 1508.4).

Climate change. A "… change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties, and that persists for an

extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use" (IPCC 2008).

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" (602 FW 3).

Compatibility Determination. A written determination signed and dated by the refuge manager and regional chief signifying that a proposed or existing use of a national wildlife refuge is a compatible use or is not a compatible use. The director makes this delegation through the Regional Direction (603 FW 2).

Comprehensive Conservation Plan (CCP). A document that describes the desired future conditions of a refuge or planning unit and provides long-range guidance and management direction to achieve the purpose(s) of the refuge; helps fulfill the mission of the Refuge System; maintains and, where appropriate, restores the biological integrity, diversity, and environmental health of each refuge and the Refuge System; helps achieve the goals of the National Wilderness Preservation System, if appropriate; and meets other mandates (USFWS Habitat Management Planning Policy, 602 FW 1.4).

Concern. See Issue.

Connectivity. The arrangement of habitats that allows organisms and ecological processes to move across the landscape; patches of similar habitats are either close together or linked by corridors of appropriate vegetation. The opposite of **fragmentation.**

Conservation Targets (also see **Resources of Concern; Priority Species, Species Groups,** and **Communities).** Term used by land management agencies and conservation organizations to describe the resources (ecological systems, ecological communities, species, species groups, or other natural resources) selected as the focus of conservation actions.

Consumptive use. Recreational activities, such as hunting and fishing, that involve harvest or removal of wildlife or fish, generally to be used as food by humans.

Contaminants or **environmental contaminants.** Chemicals present at levels greater than those naturally occurring in the environment resulting from anthropogenic or natural processes that potentially result in changes to biota at any ecological level (U.S. Geological Survey, Assessing Environmental Contaminant Threats). They are pollutants that degrade other resources upon contact or mixing.

Cooperative agreement. An official agreement between two parties.

Cover. The estimated percent of an area, projected onto a horizontal surface, that is occupied by a particular plant species.

Cultural resources. The physical remains, objects, historic records, and traditional lifeways that connect us to our nation's past (USFWS no date).

Cultural resource inventory. A professionally conducted study designed to locate and evaluate evidence of cultural resources present within a defined geographic area. Inventories may involve

various levels, including background literature search, comprehensive field examination to identify all exposed physical manifestations of cultural resources, or sample inventory to project site distribution and density over a larger area. Evaluation of identified cultural resources to determine eligibility for the National Register of Historic Places follows the criteria found in 36 CFR 60.4 (614 FW 1.7).

DM. U.S. Department of the Interior Manual.

Decadence. Marked by decay or decline, used for plants showing little or no new growth.

Deciduous. Trees and shrubs that shed all of their leaves each year.

Depredation. Causing serious damage to agricultural, horticultural, and fish cultural interests (Adapted from 50 CFR 21.42).

Direct Loss. Loss of food or loss of habitat as nonnative species outcompete natives.

Disturbance. Significant alteration of habitat structure or composition, or of the behavior of wildlife. May be a natural (e.g., fire) or human-caused event (e.g., aircraft overflight).

Ecosystem. A dynamic and interrelating complex of plant and animal communities and their associated nonliving environment.

Ecosystem management. Management of natural resources using systemwide concepts to ensure that all plants and animals in ecosystems are maintained at viable levels in native habitats and basic ecosystem processes are perpetuated indefinitely.

Effect (impact). A direct result of an action that occurs at the same time and place; or an indirect result of an action that occurs later in time or in a different place and is reasonably foreseeable; or the cumulative results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency or person undertakes such other actions (40 CFR 1508.8).

El Niño/La Niña - Southern Oscillation. A quasiperiodic climate pattern that occurs across the tropical Pacific Ocean. The *Southern Oscillation* refers to variations in the temperature of the surface of the tropical eastern Pacific Ocean (warming and cooling known as *El Niño* and *La Niña* respectively) and in air surface pressure in the tropical western Pacific. The two variations are coupled: the warm oceanic phase, El Niño, accompanies high air surface pressure in the western Pacific, while the cold phase, La Niña, accompanies low air surface pressure in the eastern Pacific.

Endemic. In the conservation context, exclusively native to a place. For example, kangaroos are endemic to Australia.

Environmental assessment. A concise public document, prepared in compliance with NEPA, that briefly discusses the purpose and need for an action and alternatives to such action, and provides sufficient evidence and analysis of impacts to determine whether to prepare an environmental impact statement or finding of no significant impact (40 CFR 1508.9).

Environmental harm. Environmental harm by pest species refers to a biologically substantial decrease in environmental quality as indicated by a variety of potential factors, including declines in

native species populations or communities, degraded habitat quality or long-term habitat loss, and/or altered ecological processes.

Endangered Species (Federal). An animal or plant species in danger of extinction throughout all or a significant portion of its range.

Endangered Species (State). A plant or animal species in danger of becoming extinct or extirpated in a state within the near future if factors contributing to its decline continue. Populations of these species are at critically low levels or their habitats have been degraded or depleted to a significant degree.

Environmental education study sites. Outdoor locations where groups of students engage in hands-on activities within an environmental education curriculum.

Environmental health. Composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historical conditions, including the natural abiotic processes that shape the environment (601 FW 3).

Enhance. To improve the condition of an area or habitat, usually for the benefit of certain native species.

Ethnographical. The study and systematic recording of human cultures; also: a descriptive work produced from such research.

Executive Order. A president's or governor's declaration, which has the force of law, usually based on existing statutory powers, and requiring no action by the Congress or state legislature.

Exotic. See **Nonnative species.**

Experimental population. A population (including its offspring) of a listed species designated by rule published in the Federal Register that is wholly separate geographically from other populations of the same species. An experimental population may be subject to less stringent prohibitions than are applied to the remainder of the species to which it belongs.

Focal Species (also Priority Resources of Concern or Focal Conservation Target). A suite of conservation targets that for purposes of planning are sorted and condensed to represent threats to biological integrity, diversity, and environmental health at the refuge level.

Friends of the Refuge. Friends of the Tualatin River National Wildlife Refuge, the official, nonprofit, volunteer organization supporting the refuge.

Geocaching. Known as letter boxing, an outdoor activity in which participants use a global positioning system (GPS) to recover techniques to hide and seek containers.

Goal. Descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose but does not define measurable units (620 FW 1.6).

Habitat. Suite of existing environmental conditions required by an organism for survival and reproduction. It is the place where an organism typically lives.

Habitat Management Plan. A plan that provides refuge managers a decision-making process; guidance for the management of refuge habitat; and long-term vision, continuity, and consistency for habitat management on refuge lands (USFWS Habitat Management Planning Policy 620 FW 1.4).

Habitat restoration. Management emphasis designed to move ecosystems to desired conditions and processes, and/or to healthy ecosystems.

Historical conditions. Composition, structure, and functioning of ecosystems resulting from natural processes that we believe, based on sound professional judgment, were present prior to substantial human related changes to the landscape (601 FW 3).

Hydrology. A graph of waterflows in a river or stream. A hydrograph provides a way of seeing seasonal and yearly changes in the flow or discharge of a waterway.

Important Bird Areas. A site designated by the National Audubon Society that provides essential habitat for one or more species of bird and that is recognized as being important on a global, continental, or state level.

Indicator. A measurable characteristic of a key ecological attribute that strongly correlates with the status of the key ecological attribute; something that serves as a sign or symptom.

Indigenous knowledge. The " … knowledge that an indigenous (local) community accumulates over generations of living in a particular environment. This definition encompasses all forms of knowledge—technologies, know-how skills, practices and beliefs—that enable the community to achieve stable livelihoods in their environment" (United Nations Environment Programme 2012).

Inholding. Refers to lands within an approved refuge boundary that are not owned by the Service. These can be private lands or lands owned by a city, county, state, or other Federal agencies.

Integrated Pest Management. A " … sustainable approach to managing pests by combining biological, cultural, physical, and chemical tools in a way that minimizes economic, health, and environmental risks" (FIFRA, 7 U.S.C. 136 et seq.).

"Examples of tools listed in the IPM definition include, but are not limited to, the following:

(1) Biological tools - predators, parasites, and pathogens;
(2) Cultural tools - crop rotation, alterations in planting dates, and sanitation;
(3) Physical tools - barriers, traps, hand-pulling, hoeing, mowing, and tilling;
(4) Chemical tools - pesticides, such as herbicides, insecticides, or fungicides" (517 DM 1).

Interpretation. A teaching technique that combines factual information with stimulating explanation. Frequently used to help people understand natural and cultural resources.

Invasive species. An " … alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health" (EO 13112).

Inventory. A survey of the plants or animals inhabiting an area.

Inviolate Sanctuary. The original intent of the term "inviolate sanctuary" is found in the Migratory Bird Conservation Act (first passed in 1918 as the Migratory Bird Treaty Act and amended in 1934

and 1938). This Act originally required that all refuges be inviolate sanctuaries and deemed that refuges' primary purposes were as breeding grounds and habitat for migratory birds. Migratory bird hunting was prohibited on migratory waterfowl areas by the Act, but most other human uses were not addressed. The 1938 amendment to the Act gave refuge managers authority to decide if, when, and how bird hunting would be allowed. After World War II, public demand for opening refuges to recreation increased. The 1949 Duck Stamp Act allowed waterfowl hunting on refuges, but restricted the percentage of each refuge open to hunting. Current policy states that portions of a refuge are considered "inviolate sanctuaries" if they were (a) acquired with the approval of the Migratory Bird Conservation Commission for the purpose of an inviolate sanctuary; (b) acquired with MBCC approval or Land and Water Conservation Fund funds to protect a threatened or endangered species; or (c) established by an instrument or document that states the intent to manage the area as an "inviolate sanctuary for migratory birds" or to fulfill the purpose of the Migratory Bird Conservation Act. Policy further allows migratory game bird hunting on no more than 40 percent of the area considered inviolate sanctuary if compatible with a refuge's purposes and mission. Inviolate sanctuary classification imposes no limits on hunting nonmigratory birds, fur bearers, or other game species.

Issue. Any unsettled matter that requires a management decision, for example, an initiative, opportunity, resource management problem, threat to the resources of the unit, conflict in uses, public concern, or the presence of an undesirable resource condition (620 FW 1.6).

Key ecological attributes. Those aspects of the environment, such as ecological processes or patterns of biological structure and composition that are critical to sustain the long-term viability of the target. These key ecological attributes are further divided into measurable indicators.

Keystone species. Species that enrich ecosystem function in a unique and significant manner through their activities, and have an effect that is disproportionate to their numerical abundance. Their removal initiates changes in ecosystem structure and often loss of diversity. These keystone species may be habitat modifiers (e.g., Cottonwoods, beavers), predators (e.g., bobcat, coyote), or herbivores (e.g., elk).

Kalapuya. *It-galapu ywi-yu-ks,* A Chinookan term for the Willamette Valley people, consisting of eight Tribes speaking three different languages, formerly inhabiting the valley of the Willamette River in Oregon.

Land Protection. The acquisition of fee title, easement, or lease of a given land parcel to protect important natural resource values on the land from incompatible land uses.

Listed Species (Federal). Species that have been formally listed under the Endangered Species Act as threatened or endangered. Also includes candidate and proposed species. An endangered species is one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is one that is likely to become endangered in the foreseeable future. Proposed species include taxa for which the Service or National Marine Fisheries Service has published a proposal to list as endangered or threatened in the Federal Register. Candidate species include those taxa for which the Service has sufficient biological information to support a proposal to list as endangered or threatened.

Maintenance. The upkeep of constructed facilities, structures, and capitalized equipment necessary to realize the originally anticipated useful life of a fixed asset. Maintenance includes preventative maintenance; cyclic maintenance; repairs; replacement of parts, components, or items of equipment;

periodic condition assessment; periodic inspections, adjustment, lubrication and cleaning (nonjanitorial) of equipment; painting, resurfacing, rehabilitation; special safety inspections; and other actions to ensure continuing service and to prevent breakdown.

Metro. Regional government for the Portland metropolitan area, including Clackamas, Multnomah, and Washington Counties and associated municipalities. Metro coordinates regionwide land-use planning; provides garbage, recycling, and transportation services; acquires, restores, and manages natural areas; and operates cemeteries, event facilities, and the zoo.

Migration. Seasonal movement of wildlife from one area to another and back.

Migratory birds. Those species of birds listed under 50 CFR 10.13 (as defined by various treaties) (720 FW 1, Policies and Responsibilities of the Migratory Bird Program).

Mixed deciduous/coniferous forest. Forest that has a mixture of Douglas-fir, oak, and maple, with a shrub understory.

Moist soil plants. Plants that are adapted to periodic flooding and drying conditions.

Monitoring. The process of collecting information to track changes of selected parameters over time.

National Environmental Policy Act of 1969 as amended (42 U.S.C. 4321-4375). A Federal law that requires all Federal agencies, including the Service, to examine the environmental impacts of their actions, incorporate environmental information, and use public participation in the planning and implementation of all actions. Federal agencies must integrate NEPA with other planning requirements and prepare appropriate NEPA documents to facilitate better environmental decision making (40 CFR 1500).

National Register of Historic Places. The nation's master inventory of known historic properties administered by the National Park Service. Includes buildings, structures, sites, objects, and districts that possess historic, architectural, engineering, archeological, or cultural significance at the national, state, and local levels (USFWS no date).

National Wildlife Refuge System. Various categories of areas administered by the Secretary of the Interior for the conservation of fish and wildlife, including species threatened with extinction; all lands, waters, and interests therein administered by the Secretary as wildlife refuges; areas for the protection and conservation of fish and wildlife that are threatened with extinction; wildlife ranges; game ranges; wildlife management areas; or waterfowl production areas.

National Wildlife Refuge System Administration Act of 1966, as amended (16 U.S.C. 668dd-668ee). A Federal law that provides guidance on the administration and management of the national wildlife refuge system.

National Wildlife Refuge System Improvement Act of 1997 (Public Law 105-57). A Federal law that amended and updated the National Wildlife Refuge System Administration Act of 1966 (16 U.S.C. 668).

Native. "With respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem" (601 FW 3).

Nonconsumptive recreation. Recreational activities that do not involve harvest, removal, or consumption of fish, wildlife, or other natural resources.

Nonnative species. A species that is present in the planning area but was not known to exist prior to Euro-American settlement of the Americas.

Noxious Weed. A plant species designated by Federal or state law as generally possessing one or more of the following characteristics: aggressive or difficult to manage; parasitic; a carrier or host of serious insect or disease; or nonnative, new, or not common to the United States. According to the Federal Noxious Weed Act (PL 93-639), a noxious weed is one that causes disease or has adverse effects on man or his environment and therefore is detrimental to the agriculture and commerce of the United States and to the public health.

Objective. A concise statement of what we want to achieve, how much we want to achieve, when and where we want to achieve it, and who is responsible for the work. Objectives derive from goals and provide the basis for determining strategies, monitoring refuge accomplishments, and evaluating the success of strategies. Objectives should be attainable, time-specific, and measurable (620 FW 1.6).

Operations. Activities related to the normal performance of the functions for which a facility or item of equipment is intended to be used. Costs such as utilities (electricity, water, sewage) fuel, janitorial services, window cleaning, rodent and pest control, upkeep of grounds, vehicle rentals, waste management, and personnel costs for operating staff are generally included within the scope of operations.

Outreach. The process of providing information to the public on a specific issue through the use of the media, printed materials, and presentations.

Pacific Flyway. One of several major north-south travel corridors for migratory birds. The Pacific Flyway is west of the Rocky Mountains.

Permanent Wetland. Wetlands or portions of refuge that retain water throughout the year. Permanently flooded waters are generally occupied by submergent wetland plants such as pondweeds.

Pest. "(1) any insect, rodent, nematode, fungus, weed, or (2) any other form of terrestrial or aquatic plant or animal life or virus, bacteria, or other micro-organism (except viruses, bacteria, or other micro-organisms on or in living man or other living animals) which the [U.S. Environmental Protection Agency] Administrator declares to be a pest under section 25(c)(1)" (FIFRA, 7 U.S.C. 136 et seq.).

"…living organisms, including invasive plants and introduced or native organisms, that may interfere with achieving our management goals and objectives on or off our lands, or that jeopardize human health or safety" (569 FW 1).

Planning Team. The primary Service staff and others who played a key role in developing and writing the CCP/EA for a refuge. Planning teams are interdisciplinary in membership and function. Teams generally consist of a planning team leader, the refuge manager and staff biologists, a state natural resource agency representative, and other appropriate program specialists (e.g., social

scientists, ecologists, recreation specialists). We also ask other Federal and Tribal natural resource agencies to provide team members, as appropriate. The planning team prepares the CCP and appropriate NEPA documentation (620 FW 1.6).

Plant Community. An assemblage of plant species that is unique in its composition; occurs in particular locations under particular influences; a reflection or integration of the environmental influences on the site such as soils, temperature, elevation, solar radiation, slope, aspect, and rainfall; and denotes a general kind of climax plant community (e.g., Oregon white oak woodland).

Preferred Alternative. This is the alternative determined [by the decision maker] to best achieve the refuge purpose, vision, and goals; to best contribute to the Refuge System mission; to best address the significant issues; and to be consistent with principles of sound fish and wildlife management.

Preplanning. The first phase of the CCP planning process. It includes identifying the planning area and data needs; establishing the planning team and planning schedule; reviewing available information; preparing a public involvement plans and conducting internal scoping.

Priority Public Uses. Defined in Improvement Act as hunting, fishing, wildlife observation and photography, and environmental education and interpretation.

Priority Resources of Concern. See **Resources of Concern** and **Focal Species** definitions.

Public. Individuals, organizations, and groups; officials of Federal, state, and local government agencies; Indian Tribes; and foreign nations. It may include anyone outside the planning team. It includes those who may or may not have indicated an interest in Service issues and those who may be affected by Service decisions.

Public Land Order. Public lands consist of that class of land remaining from the original public domain that was acquired by the United States by treaty, purchase, or cession from a foreign power.

Quality. A national wildlife refuge public use program is considered high quality if it:

A. "Promotes safety of participants, other visitors, and facilities;
B. Promotes compliance with applicable laws and regulations and responsible behavior;
C. Minimizes or eliminates conflict with fish and wildlife population or habitat goals or objectives in an approved plan;
D. Minimizes or eliminates conflicts with other compatible wildlife-dependent recreation;
E. Minimizes conflicts with neighboring landowners;
F. Promotes accessibility and availability to a broad spectrum of the American people;
G. Promotes resource stewardship and conservation;
H. Promotes public understanding and increases public appreciation of America's natural resources and our role in managing and conserving these resources;
I. Provides reliable/reasonable opportunities to experience wildlife;
J. Uses facilities that are accessible to people and blend into the natural setting; and
K. Uses visitor satisfaction to help define and evaluate programs." (General Guidelines for Wildlife-Dependent Recreation, 605 FW 1).

Refuge. Tualatin River National Wildlife Refuge.

Refuge Operating Needs System (RONS). A national database of unfunded refuge operating needs required to meet and/or implement station goals, objectives, management plans, and legal mandates. It is used as a planning, budgeting, and communication tool describing funding and staffing needs of the Refuge System.

Refuge purpose(s). 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. For refuges that encompass congressionally designated wilderness, the purposes of the Wilderness Act are additional purposes of the refuge (620 FW 1.6).

Refuge System. National Wildlife Refuge System.

Resource of Concern (ROC). All plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), Refuge System mission, or international, national, regional, State, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are ROCs on a refuge whose purpose is to protect "migrating waterfowl and shorebirds." Federal or state threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts (Habitat Management Planning Policy, 620 FW1.4).

Restore. To bring back to a former or original condition.

Riparian habitat. Refers to an area of habitat that is transitional from terrestrial to aquatic ecosystems; including streams, lakes, wet areas, and adjacent plant communities and their associated soils that have free water at or near the surface; an area whose components are directly or indirectly attributed to the influence of water; of or relating to a river; specifically applied to ecology, "riparian" describes the land immediately adjoining and directly influenced by streams. For example riparian vegetation includes any and all plant life growing on the land adjoining a stream and directly influenced by the stream.

Riverine. Flowing perennial to intermittent waters bounded by a channel. This habitat encompasses a river or stream, its channel, and the associated aquatic vegetation.

Sanctuary. At the Willamette Valley Complex, the term sanctuary is used colloquially to mean areas that are closed to all public uses during a portion or all of the year. Also see **Inviolate Sanctuary.**

Semipermanent Villages. Lasting or intended to last for a long time but not permanent

Seasonal Wetlands. Areas that are periodically inundated or have soils saturated to the surface at some time during the growing season (but not year-round).

Service. U.S. Fish and Wildlife Service.

Scoping. The phase of notifying the public of the opportunity to participate in the planning process to help identify issues, concerns, and opportunities related to the project early in the planning process.

Significant Effect. Use of the term in NEPA requires consideration of both context and intensity (40 CFR 1508.27). Context means the significance of an action must be analyzed in its current and proposed short- and long-term effects on the whole of a given resource (e.g., affected region). Intensity refers to the severity of the effect.

Species of Concern (Federal). Taxa whose conservation status is of concern to the Service (many were previously known as Category 2 candidates), but for which further information is still needed. Such species receive no legal protection and use of the term does not necessarily imply that a species will eventually be proposed for listing.

Step-down Management Plan. A plan that provides specific guidance on management subjects (e.g., habitat, public use, fire, safety) or groups of related subjects. It describes strategies and implementation schedules for meeting CCP goals and objectives (620 FW 1.6).

Strategy. A specific action, tool, technique, or combination of actions, tools, and techniques used to meet unit objectives (620 FW 1.6).

Thatch. The dense covering of cut grass that remains after mowing. Thatch inhibits growth of new grass and also inhibits goose foraging.

Threatened Species (Federal). An animal or plant species, listed by the Service, as likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Threatened Species (State). A plant or animal species identified by a state wildlife agency as likely to become endangered in a state within the near future if factors contributing to population decline or habitat degradation or loss continue.

TriMet. Local agency that provides public transportation in the Portland area via bus, commuter rail, light rail, and street car.

Upland prairie/oak savanna. Characterized by widely spaced Oregon oak trees with grassland habitats (upland prairie) occurring between them.

Vegetation type (**habitat type**, **forest cover type).** A land classification system based upon the concept of distinct plant associations.

Vision Statement. A concise statement of what the planning unit should be, or what we hope to do, based primarily upon the Refuge System mission and specific refuge purposes, and other mandates. The vision statement for the refuge is tied to the mission of the Refuge System; the purpose(s) of the refuge; the maintenance or restoration of the ecological integrity of each refuge and the Refuge System; and other mandates (620 FW 1.6).

Volatile Organic Compounds (VOCs). Any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, that participates in atmospheric photochemical reactions. (http://www.epa.gov/ttn/naaqs/ozone/ozonetech/def_voc.htm)

Waterfowl. Resident and migratory ducks, geese, and swans.

Water Quality. A term used to describe the chemical, physical, and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Watershed. The land area that drains water to a particular stream, river, or lake. It is a land feature that can be identified by tracing a line along the highest elevations between two areas on a map, often a ridge. Large watersheds, like the Mississippi River Basin contain thousands of smaller watersheds.

Wetlands. Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water at some time during the growing season of each year (660 FW 2; Cowardin et al. 1979).

Wildlife-dependent recreational use. A use of a refuge involving hunting, fishing, wildlife observation and photography, or environmental education and interpretation. These are the six priority public uses of the Refuge System as established in the Administration Act, as amended. Wildlife-dependent recreational uses, other than the six priority public uses, are those that depend on the presence of wildlife. The Service will consider these other uses in the preparation of refuge CCPs; however, the six priority public uses always will take precedence (620 FW 1.6).

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Appendix I. Contributors to the Comprehensive Conservation Plan

I.1 Core Planning Team

Name	Title	Organization
Erin Holmes	Project Leader, Tualatin River National Wildlife Refuge (TRNWR)	U.S. Fish and Wildlife Service (USFWS)
John Gahr	Deputy Refuge Manager, TRNWR	USFWS
Pete Schmidt	Wildlife Biologist, TRNWR	USFWS
Kim Strassburg	Visitor Services Manager, TRNWR	USFWS
Valerie Morgan	Biological Technician, TRNWR	USFWS
Tom Miewald	Geographer, Division of Refuge Information, Region 1	USFWS
Scott McCarthy	Planner, Division of Planning and Visitor Services, Region 1	USFWS
Chris Lapp	Former Deputy Refuge Manager, TRNWR (transferred)	USFWS
Ralph Webber	Former Project Leader, TRNWR (retired)	USFWS

I.2 Extended Planning Team, Reviewers, and Subject Matter Experts

Name	Area of Assistance	Organization
Anderson, Eric	Visitor services	USFWS
Austin, Heather	City planning	City of Sherwood, Oregon
Bales, Brad	Migratory game birds	Oregon Department of Fish and Wildlife (ODFW)
Ball, Gary	Hydrology	USFWS
Barnes, Susan	Nongame wildlife	ODFW
Beall, Jock	Wildlife biology, habitat restoration	USFWS
Buerger, Ted	Wildlife biology, contaminants	USFWS
Carver, Erin	Economic analysis	USFWS
Carver, Kenny	Mosquito control	Washington County, Oregon
Christy, John	Wetlands ecology	Oregon Natural Heritage Information Center

Name	Area of Assistance	Organization
Engler, Joe	Biological goals and objectives	USFWS
Flores, Bob	General review	USFWS
Gonzales-Rogers, Patrick	Tribal coordination	USFWS
Grafe, Dawn	Visitor services	USFWS
Green, Mike	Migratory birds	USFWS
Hagedorn, Greg	Fire management plan	USFWS
Harrison, Ben	General review	USFWS
Hasti, Matt	Visitor services	USFWS
Heimowitz, Paul	Climate change	USFWS
Houghten, Chuck	CCP quality and consistency	USFWS
Humphreys, Brandy	Tribal interests	Confederated Tribes of Grand Ronde
Irvine, Kolleen	Law enforcement	USFWS
Kier-Haggenjos, Kay	Writing, editing	USFWS
Kilbride, Kevin	Biological goals and objectives, integrated pest management	USFWS
Lohr, Sam	Fisheries biology	USFWS
MacCorkle, Staci	Consultant	SWCA Environmental Consultants
Mares, Carmella	Realty	USFWS
Marxen, Mike	Visitor services	USFWS
Mayer, Tim	Climate change	USFWS
McCarthy, Nicole	Writing, editing	USFWS
Moore, Steve	Consultant	Bigfoot Consulting
Moss, Berk	Environmental education	Friends of Tualatin River National Wildlife Refuge
Murphy, Maren	Visitor services	USFWS
Murtagh, Tom	Fisheries biology	ODFW
Nebeker, Mark	Wildlife biology	ODFW
Newell, Avis	Water quality	Oregon Department of Environmental Quality
O'Hara, Kevin	National Environmental Policy Act	USFWS

Name	Area of Assistance	Organization
Parks, Virginia	Cultural resources	USFWS
Patte, David	Climate change—Senior Advisor	USFWS
Pearl, Chris	Wildlife biology	U.S. Geological Survey
Pendergrass, Kathy	Botany	Natural Resources Conservation Service
Porter, Laura	Water quality	Clean Water Services
Raymond, Anan	Cultural resources	USFWS
Rounds, Stuart	Hydrology	U.S. Geological Survey
Rutledge, Joe	Water management (agricultural)	Tualatin Valley Irrigation District
Saul, Susan	Consultant	Cusy Coyllur Communications
Schweizter, John	Maintenance, facilities	USFWS, TRNWR
Seal, Chris	Wildlife biology, habitat restoration	USFWS
Smith, Steve	Wildlife biology, habitat restoration	USFWS
Turner, Jim	Fisheries biology	National Marine Fisheries Service
Valentine, Nick	Cultural resources	USFWS
Vandebergh, Don	Wildlife biology	ODFW
Wall, Lacey	CCP quality and consistency	USFWS
West, Robin	General review	USFWS
Zonick, Curt	Natural resources	Metro

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Date	Legal Document	Direction
December 20, 1991	U.S. Fish and Wildlife Service (USFWS; Service) Urban Refuge Policy	**Policy:** Acquire lands and waters in or adjacent to metropolitan statistical areas to protect fish and wildlife resources and habitats that will provide the public wildlife-oriented recreation, education, and interpretive opportunities. **Purpose:** Primary purpose for establishment of new urban refuges will be to foster environmental awareness and outreach programs to develop an informed and involved citizenry that will support fish and wildlife conservation. General policy and purpose applies to all tracts within the 3,060-acre approved acquisition boundary of the refuge.
February 13, 1992	Tualatin River National Wildlife Refuge (Refuge) Land Protection Plan	**Authority:** Migratory Bird Conservation Act of 1929 (16 U.S. Code [U.S.C.] 715 et. seq.). Established a Migratory Bird Conservation Commission to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund. **Purpose:** "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" **Authority:** Fish and Wildlife Act of 1956, as amended (16 U.S.C. 742a-742j). The Secretary of the Interior is authorized to take such steps as may be required. **Purpose:** "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" **Authority:** Emergency Wetlands Resources Act of 1986 (Public Law 99-645; 100 Stat 3582). Authorized the purchase of wetlands from Land and Water Conservation Fund monies. **Purpose:** "for the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions …" **Authority:** Land and Water Conservation Fund Act of 1965, as amended (16 U.S.C. 460L 4-11). Provides funding through receipts from the sale of surplus Federal land, appropriations from oil and gas receipts from the outer shelf, and other sources for land acquisition under several authorities, including the Fish and Wildlife Act of 1956 and the Emergency Wetlands Resources Act of 1986. General authorities and purposes apply to all tracts within the 3,060-acre approved acquisition boundary of the refuge.
February 13, 1992	Refuge Land Protection Plan and Environmental Assessment (EA)	**Purpose:** Established the Tualatin River National Wildlife Refuge to protect, enhance, and manage upland, wetland, and riparian habitats for a variety of migratory birds and resident fish and wildlife, as well as for the enjoyment of people. Oregon's Natural Heritage Program has referenced Oregon ash and Oregon white oak habitats as well as scrub-shrub wetland as among the rarest that remain in the Tualatin River Valley, and suggests they be considered highest in priority for protection because of their historical status and range of importance for promoting biological diversity.

Date	Legal Document	Direction
		General purpose applies to all tracts within the 3,060-acre approved acquisition boundary of the refuge.
December 31, 1992	Warranty Deed	Tract 31a (12.0 acres) donated by Brenner et al. under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
March 21, 1994	Warranty Deed	Tract 59 (9.7 acres) purchased from Cerenghino et al. under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
March 21, 1994	Warranty Deed	Tract 70 (45.8 acres) purchased from Gerda Cerenghino Estate under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
July 22, 1994	Warranty Deed	Tract 84 (99.03 acres) purchased from Naujock Family Trust under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
July 29, 1994	Warranty Deed	Tract 53 (3.8 acres) purchased from Charles Desmond under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
October 26, 1994	Warranty Deed	Tracts 78, 78a, and 78b (totaling 48.77 acres) purchased from the Claus family (Robert J., Susan., Douglas C., Christine E., and R. James) under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.

Date	Legal Document	Direction
July 6, 1995	Warranty Deed	Tract 40 (47.22 acres) purchased from Edna and David Parr under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. Life use of the property was retained under easement. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
May 6, 1999	Easement	Tract 40 (47.22 acres) purchased from Edna and David Parr under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. Life use of the property was purchased under easement. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
August 7, 1996	Warranty Deed	Tract 16 (140.98 acres) purchased from Daniel Dennis under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA. More specific purposes for management are found within the Refuge Mitigation Plan and Compatibility Determination for Granting of Easement to Washington County Department of Land Use and Transportation. Addressed are compensatory mitigation and compatibility requirements for a right-of-way roadway improvement project granted to Washington County, Department of Land Use and Transportation. Mitigation was performed to offset direct impacts to wetland and upland habitats causing a reduction in floodplain capacity and decline in water quality from stormwater runoff, and indirect impacts causing wildlife disturbance and displacement. Specifically, development conditions were satisfied by the County upon 1) restoring and creating 33 acres of emergent and forested wetland in a managed basin, 2) creating and restoring 12 acres of riparian woodland and emergent wetland swale, 3) restoring 1.5 acres of riparian forest swale to enhance backwater habitat for anadromous fish, and 4) expanding the floodplain adjacent to the managed wetland resulting in no net loss of water-storage capacity. At least 5.1 acres are to be managed in perpetuity as the following habitats: 2.99 acres forested wetland, 0.8 acre emergent wetland, 1.5 acres riparian forest, 1.75 acres floodplain habitat.
September 5, 1996	Warranty Deed	Tract 41 (369.0 acres) purchased from Erhardt Steinborn et ux. under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
September	Easement	Tract 41c (30.5 acres) purchased from Erhardt Steinborn et ux. under

Date	Legal Document	Direction
5, 1996		authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
June 30, 1997	Warranty Deed	Tract 41a (30.5 acres) donated by Erhardt Steinborn et ux. under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …." General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
December 10, 1998	Warranty Deed	Tract 49 (7.99 acres) purchased from Charles Foster under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
February 24, 1999	Warranty Deed	Tracts 56 and 56a (totaling 36.51 acres) purchased from Gary White under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
February 24, 1999	Easement	Tract 56R (0.2 acre) purchased from Gary White under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
August 1, 2000	Warranty Deed	Tract 89 (131.5 acres) purchased from Larry Oleson, Trustee of the Trusts of Alden O. Oleson and Oleta W. Oleson, under authority of the Fish and Wildlife Coordination Act, Section 1 (48 Stat/401 as amended; 16 U.S.C. 661 et seq.) and the Fish and Wildlife Act of 1956, Section 7 (16 U.S.C. 742f [a][4]), which permit acceptance of funds for the acquisition and enhancement of real property. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA. More specific purposes for acquisition and management are found within the memorandum of agreement between USFWS and Bonneville Power Administration (BPA) for Refuge Real Property Acquisition and Enhancement, and the Oleson Tracts I and II Five-Year Restoration and Management Plan.
October 20, 1999	Agreement	The agreement provided a mechanism for BPA to fund and USFWS to implement projects for the mitigation, enhancement, and permanent protection of wildlife habitat to help fulfill BPA's responsibilities under the Northwest Power Act. BPA will receive full credit for Habitat Units, including those from both the acquisition of real property

Date	Legal Document	Direction
		interests and from habitat enhancement activities that are a direct result of BPA funding. A five-year restoration and management plan and a habitat evaluation procedure analysis were both completed as required by BPA. Restoration and enhancement of historically rare seasonal and scrub-shrub wetlands, wet meadow prairie, Oregon ash riparian forest, mixed coniferous/deciduous forests, and oak savanna communities provided an opportunity to compensate for wildlife habitat losses resulting from construction and inundation activities at Dexter and Detroit Dams. The habitat evaluation procedure analysis for the Oleson parcels determined how many habitat units for specific species could be credited to BPA. Species targeted for analysis included mink, yellow warbler, black-capped chickadee, wood duck, beaver, western meadowlark, Wilson's snipe, mallard, red-tailed hawk, American kestrel, ring-necked pheasant, and the black-tailed deer. In general, the success of providing beneficial attributes for these species is dependent upon achieving goals to restore 30 acres of seasonal emergent wetland, 15 acres of riparian forest, 10 acres of scrub-shrub wetland, and 120 acres of oak savanna.
October 20, 1999	Easement	Tract 89R (0.5 acre) purchased from Larry Oleson, Trustee of the Trusts of Alden O. Oleson and Oleta W. Oleson, under authority of the Fish and Wildlife Coordination Act, Section 1 (48 Stat/401 as amended; 16 U.S.C. 661 et seq.) and the Fish and Wildlife Act of 1956, Section 7 (16 U.S.C. 742f [a][4]), which permit acceptance of funds for the acquisition and enhancement of real property. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA. More specific purposes for acquisition and management are found within the memorandum of agreement between USFWS and BPA for Refuge Real Property Acquisition and Enhancement, and the Oleson Tracts I and II Five-Year Restoration and Management Plan.
February 8, 2001	Warranty Deed	Tract 97 (98.25 acres) purchased from Oleson Trusts under authority of the Fish and Wildlife Coordination Act, Section 1 (48 Stat/401 as amended; 16 U.S.C. 661 et seq.) and the Fish and Wildlife Act of 1956, Section 7 (16 U.S.C. 742f [a][4]), which permit acceptance of funds for the acquisition and enhancement of real property. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA. More specific purposes for acquisition and management are found within the memorandum of agreement between USFWS and BPA for Refuge Real Property Acquisition and Enhancement, and the Oleson Tracts I and II Five-Year Restoration and Management Plan.
December 23, 1999	Warranty Deed	Tract 88 (32.01 acres) purchased from Jack Harmon et ux. under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
February 4,	Warranty	Tracts 57b and 57c (totaling 30.92 acres) purchased from Dennis Reese

Date	Legal Document	Direction
2000	Deed	under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
February 4, 2000	Easement	Tracts 57R-1 and 57R-2 (totaling 1.5 acres) purchased from Dennis Reese under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
February 16, 2000	Warranty Deed	Tract 80 (31.82 acres) purchased from Betty Bissell under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
March 13, 2000	Warranty Deed	Tract 27 (20.4 acres) purchased from Ron and Joann Bump under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
August 8, 2001	Agreement	Tract 5M (50.0 acres) (Morand property) owned by Metro and managed by USFWS under authority of the Fish and Wildlife Act of 1956 (16 U.S.C. 742) and the Fish and Wildlife Coordination Act (16 U.S.C. 661-667). General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA. More specific purposes for management are found within the intergovernmental agreement between USFWS and Metro on behalf of the refuge, and in the Restoration Plan for Metro—Morand Property. The intergovernmental agreement establishes a framework for managing a portion of the Morand property located within the refuge boundary to be administered by the Service as part of the National Wildlife Refuge System (Refuge System). As designated land manager, the Service desired to restore and manage habitats for migratory birds and other fish and wildlife. The property is to be managed as open space in accordance with the National Wildlife Refuge Improvement Act of 1997, the Comprehensive Conservation Plan (CCP) developed by the refuge, and the restoration and management plan for the Morand property. The Service is responsible for the designated property on a perpetual basis through agreement renewal, as referenced in the Service's North American Wetlands Conservation Act grant application submitted in July 1997. The plan articulates a partnership with Metro for the purpose of restoring and managing 50 acres of floodplain bottomland on the Morand property. The plan states that Morand project objectives are to

Date	Legal Document	Direction
		restore 13 acres of grassland/savanna, 6 acres of seasonal emergent wetland, and 3.5 acres of mixed deciduous/coniferous forest.
July 9, 2003	Warranty Deed	Tract 25 (15.1 acres) purchased from John and Dawn Westphal under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
July 9, 2003	Easement	Tract 25R (10.0 acres) donated by John and Dawn Westphal under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA.
October 21, 2005	Warranty Deed	Tract 23 (88.3 acres) purchased from Lynn S. and Jane Henriksen under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. The tract is managed under authority of the Fish and Wildlife Coordination Act, Section 1 (48 Stat/401 as amended; 16 U.S.C. 661 et seq.) and the Fish and Wildlife Act of 1956, Section 7 (16 U.S.C. 742f [a][4]), which permit acceptance of funds for the enhancement of real property. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA. More specific purposes for acquisition and management are found within the memorandum of agreement between USFWS and BPA for Refuge Real Property Acquisition and Enhancement, and the Oleson Tracts I and II Five-Year Restoration and Management Plan.
October 21, 2005	Easement	Tracts 23M and 23R (totaling 1.3 acres) purchased from Henriksen under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. The tracts are managed under authority of the Fish and Wildlife Coordination Act, Section 1 (48 Stat/401 as amended; 16 U.S.C. 661 et seq.) and the Fish and Wildlife Act of 1956, Section 7 (16 U.S.C. 742f [a][4]), which permit acceptance of funds for the enhancement of real property. General purpose derived from the Urban Refuge Policy and the Refuge Land Protection Plan and EA. More specific purposes for acquisition and management are found within the memorandum of agreement between USFWS and BPA for Refuge Real Property Acquisition and Enhancement, and the Oleson Tracts I and II Five-Year Restoration and Management Plan.
December 1, 2006	Warranty Deed	Tract 98 (2.28 acres) purchased from Robert M. Burchfield et ux. under authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Urban Refuge Policy and the Refuge

Date	Legal Document	Direction
		Land Protection Plan and EA. More specific purposes for acquisition and management are found within the Project Summary and Decision for the Burchfield Addition. The project land acquisition supported and complemented conservation actions of other partners, specifically those of the BPA, which funded an adjacent restoration project enhancing biological diversity and native landscape habitats for wintering waterfowl, breeding songbirds, migrating shorebirds, marshbirds and other waterbirds, and habitats supporting federally listed and sensitive classified species of fish and wildlife. The addition is a critical link to successfully meeting habitat goals in the most effective manner for restoring 30 acres of seasonal emergent wetland.

Purpose and Acquisition History of Establishment Tualatin River NWR – Wapato Lake Unit

Date	Legal Document	Direction
June 11, 1992	Easement Deed	Tract 610c (32.77 acres) transferred from U.S. Department of Agriculture (USDA) Farmers Home Administration to the Service under authority of the Consolidated Farm and Rural Development Act (7 U.S.C. 1981, 1985, and 2002, Section 331, 335, and 354); Executive Order 11990; and Executive Order 11988, **"**providing for the protection of wetlands" and "providing for the management of floodplains."
August 28, 1992	Warranty Deed	Tracts 610a and 610b (totaling 97.16 acres) transferred from USDA FmHA to the Service under authority of the Food Security Act of 1985 (Public Law 99-198) conveying lands suitable as surplus, of marginal value for agricultural production, and environmentally sensitive or having special management importance for administration as part of the Refuge System.
October 6, 1992	Warranty Deed	Tract 610 (10.98 acres) transferred from USDA FmHA to the Service under authority of the Food Security Act of 1985 (Public Law 99-198) conveying lands suitable as surplus, of marginal value for agricultural production, and environmentally sensitive or having special management importance for administration as part of the Refuge System.
February, 2007	Wapato Lake Addition Land Conservation Plan (LCP) and EA	**Authority:** Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.). Established a Migratory Bird Conservation Commission to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund. **Purpose:** "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General authority and purpose applies to all tracts within the 4,310-acre approved acquisition boundary of the refuge unit.
February, 2007	Wapato Lake Addition LCP	**Purpose:** The purpose of the Wapato Lake Unit is to protect, manage, and restore habitats for migratory birds, fish, and other native fish and

Date	Legal Document	Direction
	and EA	wildlife of the Willamette Valley; maintain and enhance the biological diversity of native plant communities and animals key to watershed health and function; and provide opportunities for people of all ages to enjoy wildlife-dependent recreation and further awareness about the natural world. The Wapato Lake wetland complex supports a variety of regionally and nationally important resources benefitting 1) patches of remnant rare native habitat such as emergent and scrub-shrub wetlands, upland and wet meadow prairies, and Oregon ash riparian hardwood forests; 2) important migratory bird habitat, especially for wintering waterfowl and breeding neotropical songbirds; 3) habitat for anadromous fish such as upper Willamette River winter-run steelhead and spring-run Chinook salmon, coho salmon, Pacific lamprey, and coastal cutthroat trout; and 4) cultural resources of historical importance. The Pacific Coast Joint Venture and Regional Shorebird Management Plans identified and targeted Wapato Lake for acquisition and restoration due to its historical importance to waterfowl of the Willamette Valley and as habitat for shorebirds. Oregon's Natural Heritage Program has referenced Oregon ash and Oregon white oak habitats as well as scrub-shrub wetland as among the rarest that remain in the Tualatin River Valley, and suggests they be considered highest in priority for protection because of their historical status and range of importance for promoting biological diversity. General purpose applies to all tracts within the 4,310-acre approved acquisition boundary of the refuge unit.
	Wapato Lake Migratory Bird Conservation Commission Memo #1	**Purpose:** Purpose of acquisition is to manage lands as a migration and wintering area for waterbirds with special emphasis on tundra swans and on developing a breeding area for neotropical migratory birds. Important goals of the unit are to restore and protect rare native habitats such as wetlands, meadow prairies, and bottomland forests; manage and protect migratory bird habitat, especially for wintering waterfowl and breeding neotropical migratory birds; and provide opportunities for high-quality priority public uses of the Refuge System, including hunting and fishing. The unit supports wetlands, prairies, and a riverine complex of bottomland forest, all considered imperiled wildlife habitats.
June 11, 2008		Unique organic peat soils support a relic shrub wetland community fringed by Oregon ash and dense stands of wapato, an important food source for tundra swan. Imperiled habitats support regionally and nationally important wildlife species including waterfowl, shorebirds, marshbirds, federally listed anadromous fish, raptors, and breeding neotropical migratory birds. Specifically, the Wapato Lake area supports populations of tundra swan, mallard, northern pintail, canvasback, ring-necked duck, lesser scaup, and Canada geese including dusky, cackling, and Aleutian subspecies. Pacific white-fronted geese use the area as well. General purpose applies to all tracts within the 4,310-acre approved acquisition boundary of the refuge unit.

Date	Legal Document	Direction
November 12, 2008	Warranty Deed	Tract 662 (40.0 acres) purchased from McCready Family Trust under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
November 12, 2008	Easement	Tract 662R (0.8 acre) purchased from McCready Family Trust under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
December 1, 2008	Warranty Deed	Tract 664 (15.32 acres) purchased from J.A. Watenpaugh et ux. under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
March 2, 2009	Warranty Deed	Tracts 644, 644a, and 644b (totaling 115.14 acres) purchased from Dennis Reese et ux. under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
May 4, 2009	Warranty Deed	Tracts 656a and 656b (totaling 25.91 acres) purchased from William Crop et al. under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
July 10, 2009	Warranty Deed	Tracts 634b and 634c (totaling 24.04 acres) purchased from Bates Farm Family Limited Partnership under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas

Date	Legal Document	Direction
		recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
July 10, 2009	Warranty Deed	Tracts 660 and 660a (totaling 33.73 acres) purchased from Ronald H. Bates under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
July 10, 2009	Warranty Deed	Tract 716 (47.01 acres) purchased from Ronald Bates et al. under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
September 14, 2009	Warranty Deed	Tracts 653a and 653c (totaling 48.72 acres) purchased from Furukawa Family Trust under authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
September 14, 2009	Warranty Deed	Tract 662 (40 acres) purchased from the McCready Family Trust under the authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
January 25, 2010	Warranty Deed	Tract 646 (3.66 acres) purchased from Gary and Joy Losey under the authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using the Land and Water Conservation Fund. General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird

Date	Legal Document	Direction
		Conservation Commission Memo #1.
February 16, 2010	Warranty Deed	Tract 677 (71.44 acres) purchased from James and Marilyn Beecher under the authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
April 20, 2010	Personal Representatives' Deed	Tracts 658 a-c (142.63 acres) purchased from the Spry Estate under the authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using BPA mitigation funds. General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
May 19, 2010	Warranty Deed	Tract 683 (21 acres) purchased from Sandra Childress under the authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using BPA mitigation funds. General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
May 19, 2010	Warranty Deed	Tracts 659 a-b (28.76 acres) purchased from Richard and Georgann Adamson under the authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using BPA mitigation funds. General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
May 19, 2010	Warranty Deed	Tract 650a (25.66 acres) purchased from Alvin Van Dyke under the authority of the Fish and Wildlife Act of 1956 "for the development, advancement, management, conservation, and protection of fish and wildlife resources …" using BPA mitigation funds. General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.
July 11, 2011	Warranty Deed	Tract 717 (32 acres) purchased from William Crop under the authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.

Date	Legal Document	Direction
January 3, 2012	Warranty Deed	Tract X (27.5 acres) purchased from Henry and Roma Ruth Leuthold under the authority of the Migratory Bird Conservation Act of 1929 (16 U.S.C. 715 et. seq.) to approve areas recommended by the Secretary of the Interior for acquisition with the Migratory Bird Conservation Fund "for use as an inviolate sanctuary, or for any other management purpose, for migratory birds …" General purpose derived from the Wapato Lake Addition LCP and EA. Specific purpose derived from the Wapato Lake Migratory Bird Conservation Commission Memo #1.

Document continues on the following page.

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Appendix K. Public Involvement

Public involvement was sought throughout the development of the Tualatin River National Wildlife Refuge comprehensive conservation plan (CCP), starting in November 2010. Public involvement strategies included communication with federally elected officials (or their aides), Tribal governments, key agencies, local refuge users, and the general public.

Three planning updates were mailed to a mailing list that included over 800 recipients representing Federal, local, and state agencies; congressional representatives; state and local elected officials; Tribal representatives; nongovernment organizations; businesses; learning institutions; media; private landowners; and individual citizens. The refuge also maintained a website where CCP information could be found and where the public could provide comments during the scoping phase.

Two public meetings and one agency meeting were held inviting discussion and soliciting feedback. Below is a brief summary of the events, meetings, and outreach tools that were used in our public involvement efforts.

Federal Register Notice

- November 3, 2010. Federal Register published the Notice of Intent to Prepare a Comprehensive Conservation Plan and Environmental Assessment; and the Request for Comments.

Coordination with Congressional Representatives and/or Their Aides

- November 1, 2010. Letter sent to Oregon's two U.S. Senators and five U.S. Representatives. Letter described the start of the CCP process; invited coordination during initial public scoping; and provided public meeting dates and times.

- November 30, 2010. John Valley, aide to U.S. Senator Jeff Merkley, attended public open house.

Coordination with Tribes

- November 1, 2010. Letter to Tribal Chairwoman, Confederated Tribes of Grand Ronde. Letter described the start of the CCP process, invited coordination during initial public scoping through attendance at public meetings, and/or supplemental meetings directly with the Tribe.

- March 16, 2011. Letter to Tribal Chairwoman, Confederated Tribes of Grand Ronde. Letter invited Tribe to a face-to-face meeting with refuge staff to discuss tribal input to the CCP.

- April 13, 2011. Letter to Tribal Chairwoman, Confederated Tribes of Grand Ronde. Letter invited Tribe to a face-to-face meeting with refuge staff to discuss tribal input to the CCP.

Coordination with State, Regional, and Local Agencies

- November 1, 2010. Letter to state, regional, and local agency stakeholders, including Oregon Department of Fish and Wildlife representatives. Letter described the start of the CCP process; invited coordination during initial public scoping; invited participation in an agency scoping meeting; and provided public meeting dates and times.

- November 16, 2010. Meeting with agency representatives. Refuge hosted a round-table discussion to solicit input and feedback on identified issues, opportunities, and concerns.

Planning Updates

- November 2010. *Planning Update Number 1* described planning process, preliminary issues to be considered, and announcement of public meetings.

- April 2011. *Planning Update Number 2* summarized public scoping results, presented draft refuge vision statement, and presented draft refuge goals.

- October 2011. *Planning Update Number 3* summarized preliminary alternatives.

Public Open Houses/Scoping Sessions

- November 30, 2010 (evening). Public open house for CCP scoping. Sherwood, Oregon.

- December 2, 2010 (evening). Public open house for CCP scoping. Forest Grove, Oregon.

Meetings with Local Community Organizations on CCP Issues

- March 21, 2011. Presentation about the CCP process to the Friends of Tualatin River National Wildlife Refuge.

Outreach and Media

- October 8, 2010. Press release sent to media. Announcement of upcoming public meetings published in several regional and community newspapers and newsletters, including *The Oregonian*.

- October 2010 to present. Website (http://www.fws.gov/tualatinriver/refugeplanning.htm) featuring CCP information, public involvement opportunities, reports, and progress.

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Appendix L. Hydrological Modeling

L.1 Introduction/Overview

To identify habitat alternatives, the Tualatin River National Wildlife Refuge developed a habitat modeling exercise to determine what habitats would likely develop if the refuge relied solely on natural (flows as they currently exist) flows from the Tualatin River. The essential question that we attempt to answer in this analysis can be framed as: *Given our current ecological understanding and best available data, how much support do we have that current habitat patch* ***x*** *will develop into future habitat type* ***y*** *if the Tualatin River National Wildlife Refuge managed the refuge using the current natural flows of the Tualatin River*?"

The refuge was interested in modeling four floodplain habitat types for the refuge: emergent wetland, wet prairie, bottomland riparian forest, and scrub-shrub wetland.

L.2 Methods

L.2.1 Overview of Methods

The methods for this modeling exercise incorporate Light Detection and Ranging (LiDAR) topographic data, hydrological data from the Farmington Gaging Station, a hydrological model to understand the potential future conditions on the refuge under different alternatives, and a decision support modeling framework to use the best existing knowledge on soils and current and historical vegetation to predict future habitat types (Figure L-1).

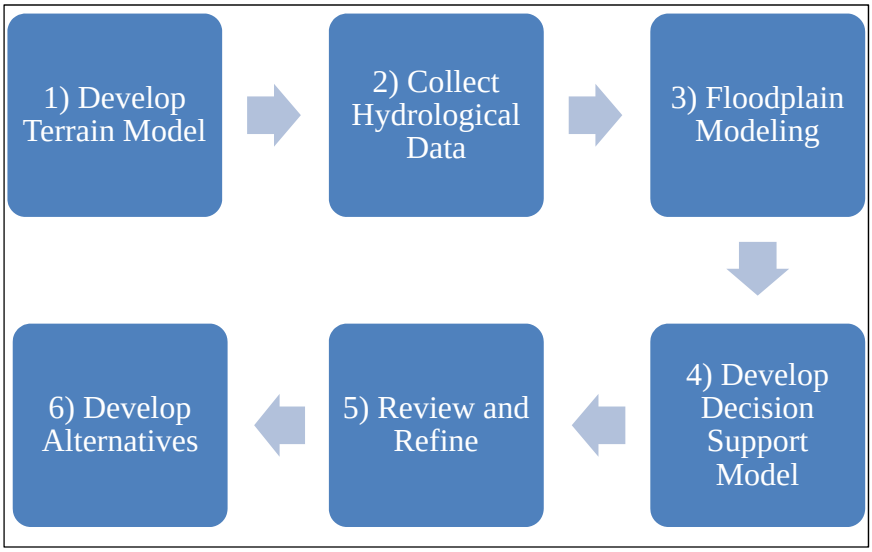


Figure L-1. Steps taken in the modeling process.

L.2.1.1 Develop a Terrain Model

LiDAR topographic data were acquired over the entire refuge as part of the Portland Metro LiDAR acquisition of 2005-2007. A digital elevation model (DEM) was produced that provides a terrain model of these data.

The LiDAR data were acquired during the fall of 2005. Thus, several of the wetland ponds were full of water during the acquisition. This made terrain modeling across the wetland ponds impossible. A mixture of ground-based surveys and engineering as-built data provided a data source to "fill-in" the flat areas caused by water. These data were collected and "burnt-in" to the LiDAR-based DEM.

L.2.1.2 Collect Hydrological Data

Daily data were gathered over a 20-year period from the Farmington Gaging Station located about 8 miles upstream of the nearest refuge unit. From this, we developed hydrographs (Figure L-2) that depict the frequency that river levels on the Tualatin reached for particular heights.

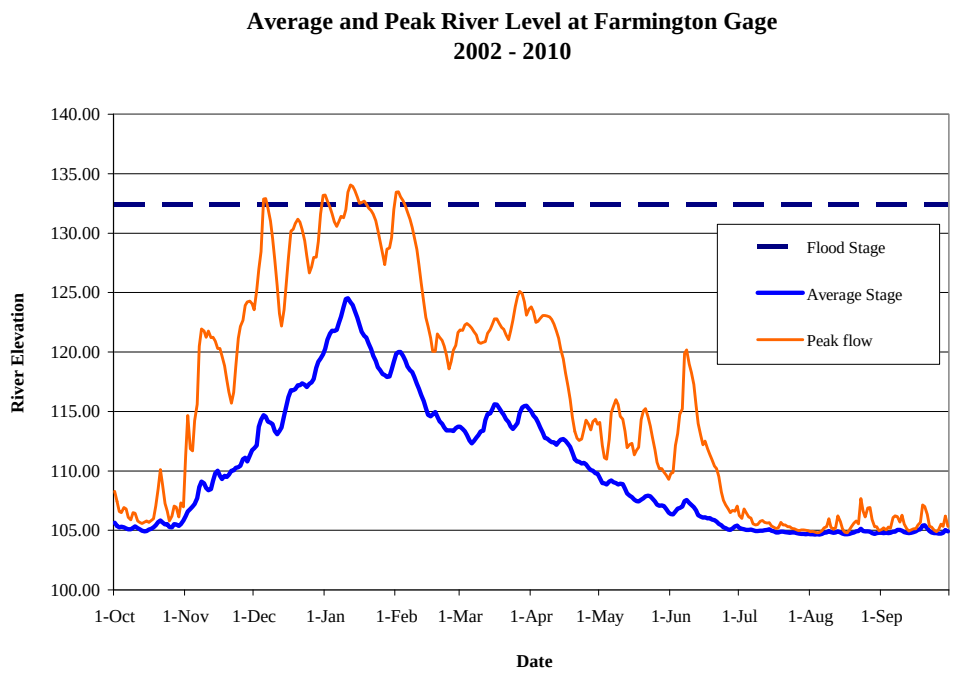


Figure L-2. Average and peak river level at Farmington Gage.

L.2.1.3 Floodplain Modeling

Hydrological modeling was conducted using a set of ArcGIS tools for floodplain and riparian areas, the Riparian Topography Toolbox (Dilts et al. 2009). This method works primarily by developing height above river (HAR) layers. The HAR outputs can be used to calculate ecologically important variables such as inundation area with some knowledge of the terrain, high-resolution LiDAR data, and information on the stream gage.

The first step was to develop a HAR layer. For this, we needed the LiDAR DEM and a binary stream/not-stream data layer. A kernel size of 3,500 meters was used to determine the height of the surrounding landscape above the river. Larger kernel sizes mean that larger stretches of river are being averaged. HAR is estimated by subtracting the elevation from the weighted average of the river elevation. The elevation was simply subtracted from the river elevations to come up with HAR. Then, flood scenarios were developed for different river elevations at an increment of 0.5 foot, starting at 118 feet (see Figures L-3 to L-5), which is normal river winter flow.

The Riparian Topography Toolbox has an algorithm that takes the flows of the river at a given height and develops a flow model based upon least cost path estimates. For the water to flow realistically across the landscape, we had to refine the LiDAR DEM. This included doing typical "hydro-enforcement," or removing structures that impede the flow of water on the LiDAR data such as levees and culverts.

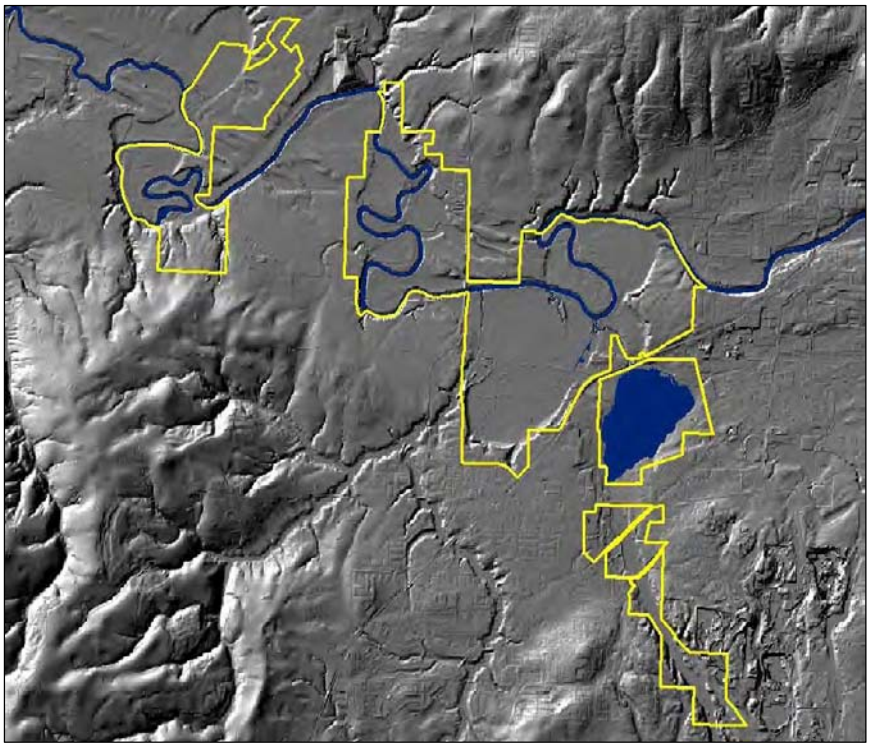


Figure L-3. Floodplain model at 118 feet.

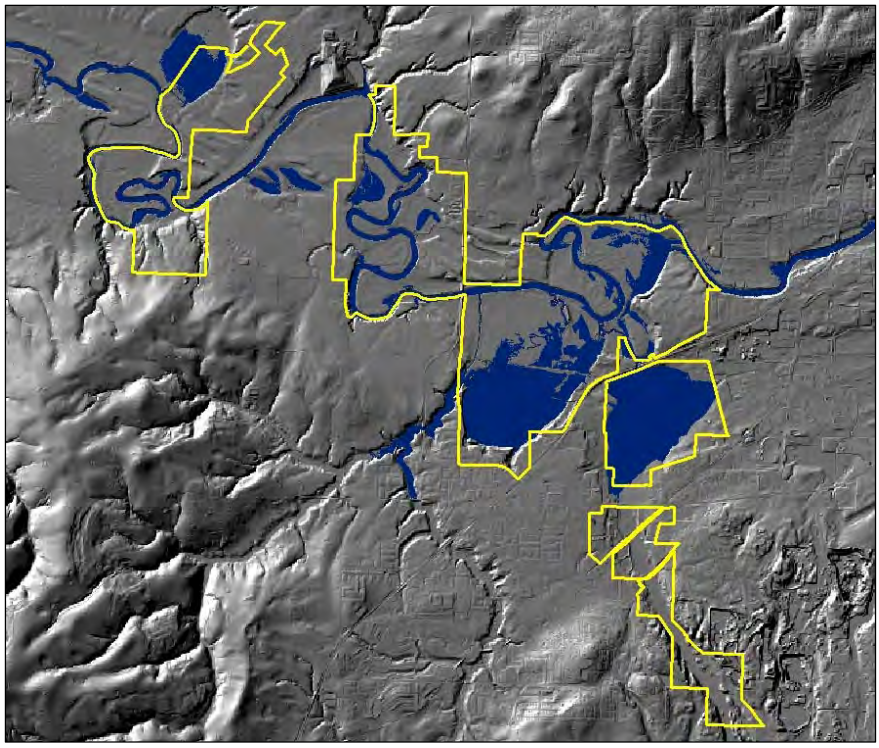


Figure L-4. Floodplain model at 128 feet.

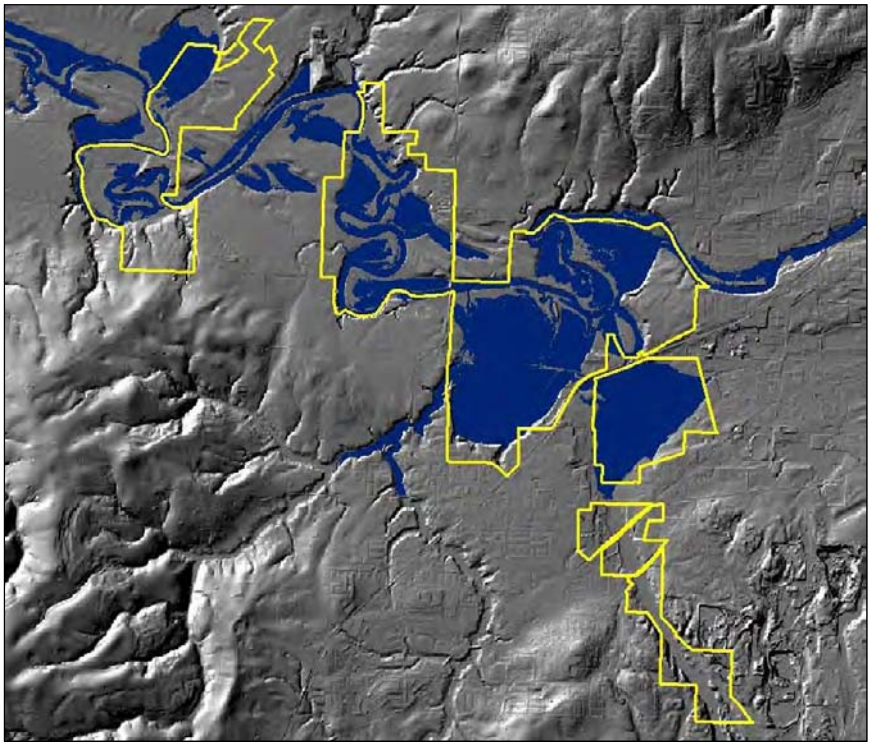


Figure L-5. Floodplain model at 132 feet.

L.2.1.4 Decision Support Modeling

The process outlined above provides modeling for the planners to know how frequently a patch of vegetation is flooded by the flows of the Tualatin River. The next step involved incorporating these data with other information including soils and vegetation.

Ecosystem Management Decision Support (EMDS) provides a flexible tool for managers to assess various scenarios with a quantifiable amount of certainty that an outcome will occur. From a geographic information system (GIS) perspective, it provides many advantages to traditional overlay analyses. In concept, EMDS provides functionality that is similar to combining different layers into an index. However, it uses formal logic operators, combined with methods and concepts from fuzzy logic and knowledge-based decision support (Reynolds et al. 2000). Using EMDS, a "knowledge base" is developed that articulates formal logic specifications of how attributes relate to a proposition. For example, one of our propositions is that "scrub-shrub wetlands will develop over time." The attributes in our knowledge base to support this proposition are flooding frequency, soils, and current and historical vegetation. EMDS allows the user to specify the "good" and "poor" qualities of these attributes to support the proposition. For example, we know that areas that are not flooded are "poor" for supporting scrub-shrub wetland. Instead of merely a binary "good" and "poor," EMDS allows fuzzy gradations between good and poor, which is more realistic in the real world.

The decision support model was developed with the refuge biologist. The initial exercise involved the refuge biologist providing suitability scores for soils, historical vegetation, current vegetation, and flooding frequency. These scores were translated to the EMDS system. A score of +1 indicates "Full Support" for the proposition, and a score of −1 indicates "No Support" for the proposition, with varying levels of support in between.

For example, if the refuge biologist determined that a high frequency of flooding was highly suitable in terms of supporting scrub-shrub wetlands, then that characteristic would get a +1. If the biologist determined that a certain soil type would never support scrub-shrub wetlands, then that characteristic would receive a score of −1. Or, if the current vegetation type is an indicator that scrub-shrub wetlands are not likely, but would be possible if other characteristics were favorable, then an intermediate score of .25 or .50 would have been given to that attribute.

As noted, four attributes were used in the decision support model. Below is a list of the attributes, their rationale, and source data.

- **Flood Frequency**
  - *Rationale*: Predicted flood frequency is a primary influence on potential wetland types.
  - *Data source:* Described in the water modeling section.
- **Soils**
  - *Rationale*: Soil types are a good indicator of potential vegetation types. For example, Labish Mucky Clays are very likely to support scrub-shrub wetlands.
  - *Data source:* U.S. Department of Agriculture (USDA) Soils Survey data (SSURGO), Washington County.

- **Current Vegetation**
  - *Rationale*: Current vegetation type provides some support for what could develop. It also provides support for where habitat will not develop. For example, developed areas will remain developed in the future.
  - *Data source:* Vegetation map developed by the refuge in 2007.

- **Historical Vegetation**
  - *Rationale*: Historical vegetation provides another piece of evidence to support the habitat propositions. For example, if an area was historically oak savanna, it would provide low support for an emergent wetland proposition.
  - *Data source:* Oregon Natural Heritage Program

Each patch of vegetation was given a score that is a summary of the four different attributes.

L.2.1.5 Review and Refine the Model

The results are spatial depictions of the amount of support for the different habitat types of interest. This could be interpreted as a suitability model. It is similar in concept, but what is being quantified is the amount of support for a given proposition. Higher scores from −1 to 1 indicate higher support. Figures L-6 to L-9 provide spatial depictions of all the different habitat types that were assessed.

L.2.1.6 Development of Alternatives

Refuge staff spent a day going over the modeling results. This provided the science-based data that facilitated the decision-making process.

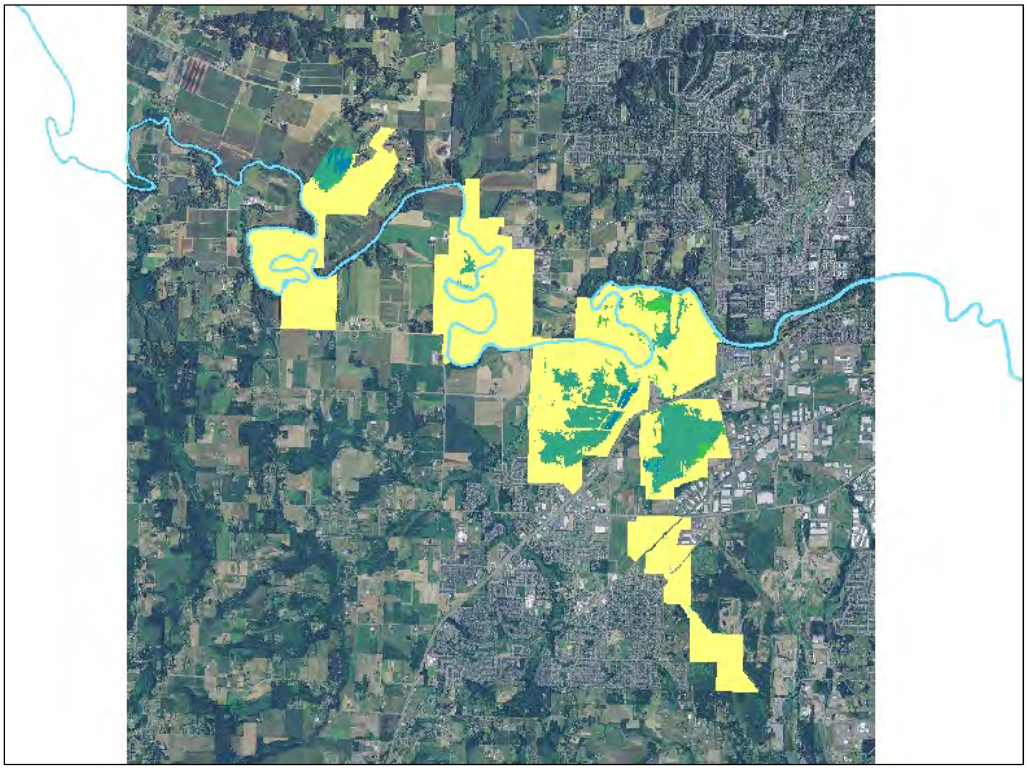


Figure L-6. Decision support for emergent wetland.

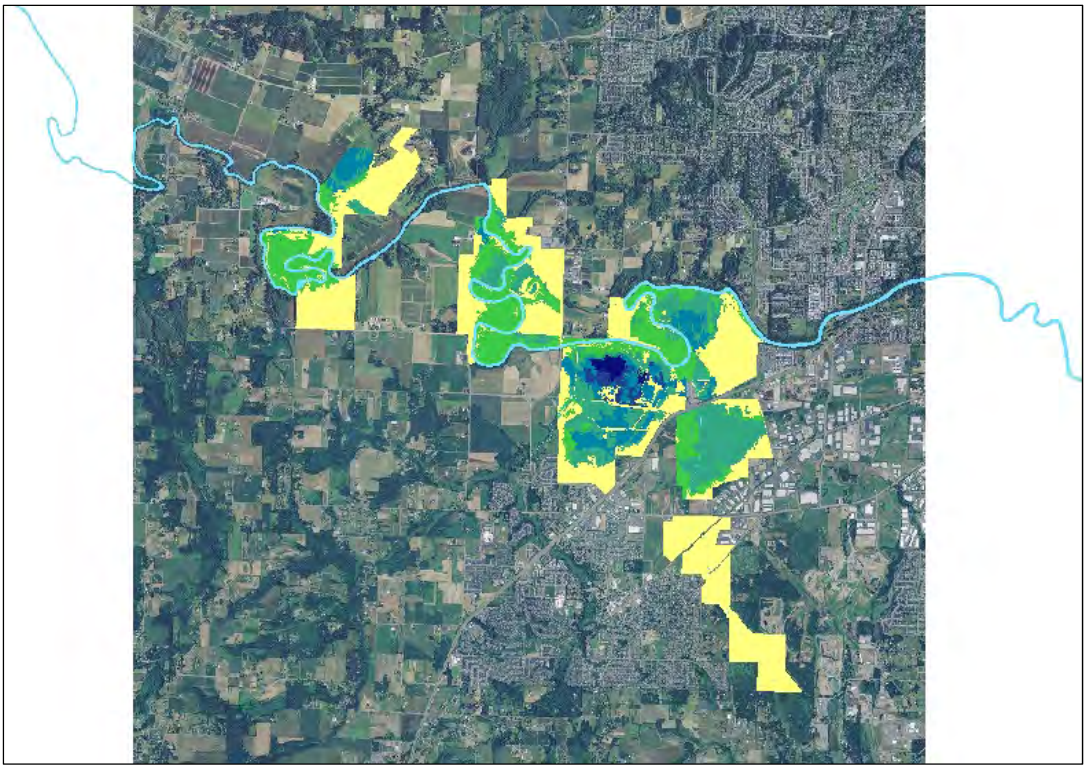


Figure L-7. Decision support for wet prairie

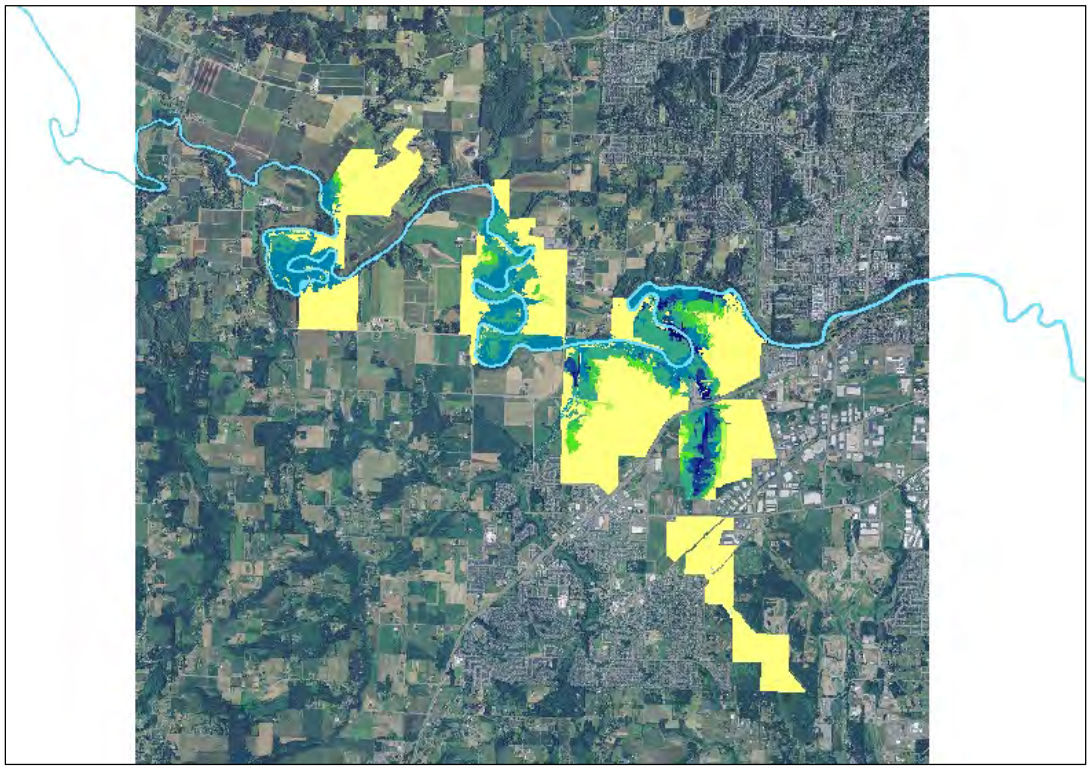


Figure L-8. Decision support for bottomland riparian forest.

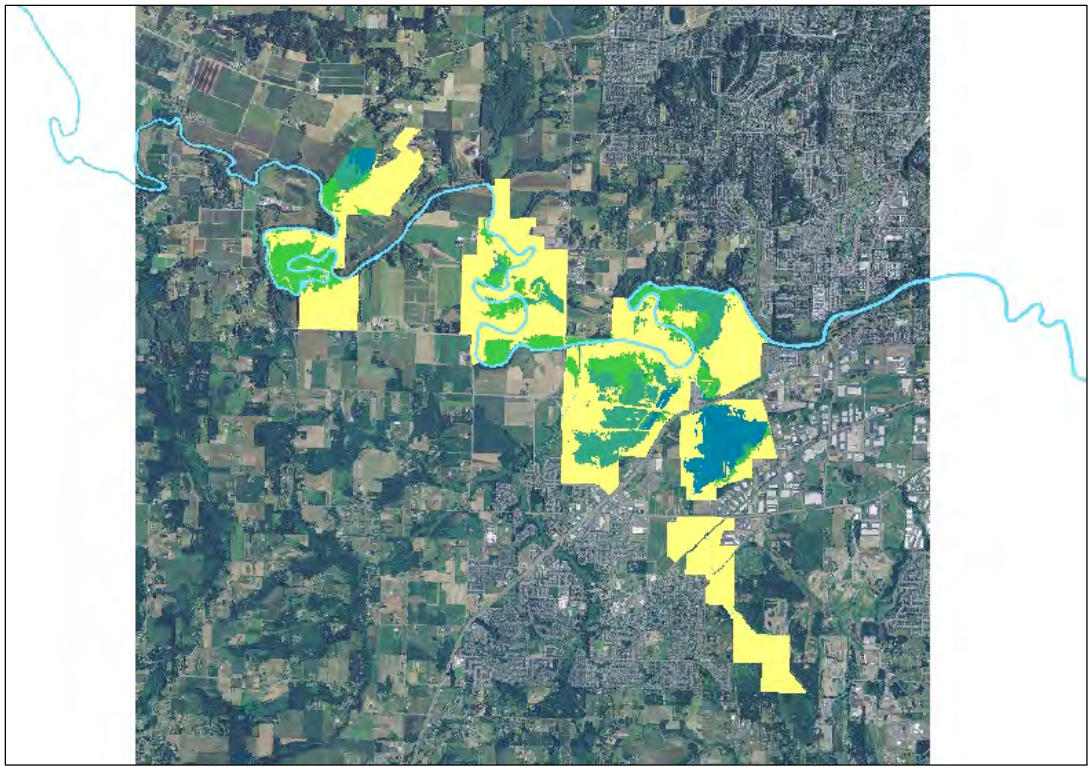
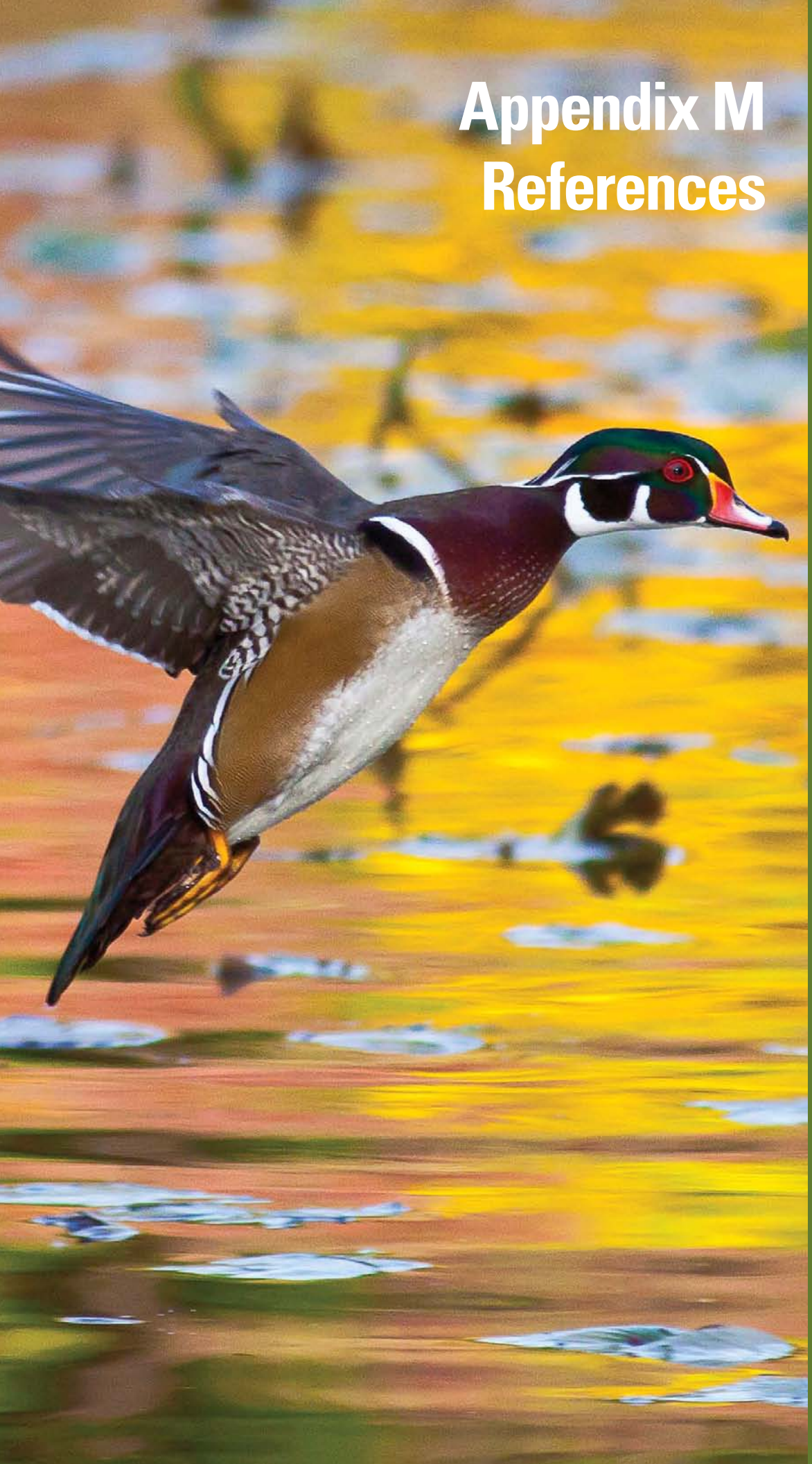


Figure L-9. Decision support for scrub-shrub wetland.

L.3 Conclusion

It is important to note that the modeling exercise didn't make the decision, but rather provided support for the final alternative decisions. Models and data played an important role in the alternative development dialogue.

Appendix M
References



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List of Refuge Species

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Appendix N. List of Refuge Species

This is a list of species that have been documented currently on the refuge. More species are expected to be added to this list upon conducting additional surveys.

Birds

Common Name	Scientific Name
Grebes (family Podicipedidae)	
Eared Grebe	*Podiceps nigricollis*
Horned Grebe	*Podiceps auritus*
Pied-billed Grebe	*Podilymbus podiceps*
Red-necked Grebe	*Podiceps grisegena*
Western Grebe	*Aechmophorus occidentalis*
Cormorants (family Phalacrocoracidae)	
Double-crested Cormorant	*Phalacrocorax auritus*
Bitterns, Herons, and Egrets (family Ardeidae)	
American Bittern	*Botaurus lentiginosus*
Great Blue Heron	*Ardea herodias*
Great Egret	*Ardea alba*
Green Heron	*Butorides virescens*
Snowy Egret	*Egretta thula*
Ibises and Spoonbills (family Threskiornithidae)	
White-faced Ibis	*Plegadis chihi*
New World Vultures (family Cathartidae)	
Turkey Vulture	*Cathartes aura*
Swans, Geese, and Ducks (family Anatidae)	
Aleutian Canada Goose	*Branta canadensis leucopareia*
American Wigeon	*Anas americana*
Black Brant	*Branta bernicla nigricans*
Blue-winged Teal	*Anas discors*
Bufflehead	*Bucephala albeola*
Cackling Canada Goose	*Branta canadensis minima*
Canvasback	*Aythya valisineria*
Cinnamon Teal	*Anas cyanoptera*

Common Name	Scientific Name
Common Goldeneye	*Bucephala clangula*
Common Merganser	*Mergus merganser*
Dusky Canada Goose	*Branta canadensis occidentalis*
Emperor Goose	*Chen canagica*
Eurasian Wigeon	*Anas penelope*
Gadwall	*Anas strepera*
Greater White-fronted Goose	*Anser albifrons*
Green-winged Teal	*Anas crecca*
Hooded Merganser	*Lophodytes cucullatus*
Lesser Canada Goose	*Branta canadensis parvipes*
Lesser Scaup	*Aythya affinis*
Mallard	*Anas platyrhynchos*
Northern Pintail	*Anas acuta*
Northern Shoveler	*Anas clypeata*
Redhead	*Aythya americana*
Ring-necked Duck	*Aythya collaris*
Ross’s Goose	*Chen rossii*
Ruddy Duck	*Oxyura jamaicensis*
Snow Goose	*Chen caerulescens*
Tavener's Canada Goose	*Branta canadensis taverneri*
Tule White-fronted Goose	*Anser albifrons gambeli*
Tundra Swan	*Cygnus columbianus*
Western Canada Goose	*Branta canadensis moffitti*
Wood Duck	*Aix sponsa*
Osprey (family Pandionidae)	
Osprey	*Pandion haliaetus*
Kites, Hawks, and Eagles (family Accipitridae)	
Bald Eagle†	*Haliaeetus leucocephalus*
Northern Harrier	*Circus cyaneus*
Sharp-shinned Hawk	*Accipiter striatus*
Cooper’s Hawk	*Accipiter cooperii*
Red-shouldered Hawk	*Buteo lineatus*

Common Name	Scientific Name
Red-tailed Hawk	*Buteo jamaicensis*
Rough-legged Hawk	*Buteo lagopus*
Falcons and Caracaras (family Falconidae)	
American Kestrel	*Falco sparverius*
Merlin	*Falco columbarius*
Peregrine Falcon	*Falco peregrinus*
Gallinaceous Birds (order Galliformes- families Odontophoridae, Phasianidae)	
California Quail	*Callipepla californica*
Northern Bobwhite	*Colinus virginianus*
Ring-necked Pheasant	*Phasianus colchicus*
Rails (family Rallidae)	
American Coot	*Fulica americana*
Sora	*Porzana carolina*
Virginia Rail	*Rallus limicola*
Cranes (family Gruidae)	
Sandhill Crane	*Grus canadensis*
Plovers (family Gruidae)	
Black-bellied Plover	*Pluvialis squatarola*
Killdeer	*Charadrius vociferus*
Semipalmated Plover	*Charadrius semipalmatus*
Stilts and Avocets (family Recurvirostridae)	
Black-necked Stilt	*Himantopus mexicanus*
Sandpipers and Phalaropes (family Scolopacidae)	
Dunlin	*Calidris alpina*
Greater Yellowlegs	*Tringa melanoleuca*
Least Sandpiper	*Calidris minutilla*
Lesser Yellowlegs	*Tringa flavipes*
Long-billed Curlew	*Numenius americanus*
Long-billed Dowitcher	*Limnodromus scolopaceus*
Marbled Godwit	*Limosa fedoa*
Pectoral Sandpiper	*Calidris melanotos*
Red Phalarope	*Phalaropus fulicarius*

Common Name	Scientific Name
Red-necked Phalarope	*Phalaropus lobatus*
Sharp-tailed Sandpiper	*Calidris acuminata*
Short-billed Dowitcher	*Limnodromus griseus*
Solitary Sandpiper	*Tringa solitaria*
Spotted Sandpiper	*Actitis macularius*
Stilt Sandpiper	*Calidris himantopus*
Western Sandpiper	*Calidris mauri*
Wilson’s Phalarope	*Phalaropus tricolor*
Wilson’s Snipe	*Gallinago delicata*
Skuas, Jaegers, Gulls, and Terns (family Laridae)	
Black Tern	*Chlidonias niger*
Bonaparte’s Gull	*Chroicocephalus philadelphia*
California Gull	*Larus californicus*
Caspian Tern	*Hydroprogne caspia*
Forster's Tern	*Sterna forsteri*
Mew Gull	*Larus canus*
Stilts and Avocets (family Columbidae)	
Band-tailed Pigeon†	*Patagioenas fasciata*
Mourning Dove	*Zenaida macroura*
Rock Pigeon	*Columba livia*
Barn Owls (family Tytonidae)	
Barn Owl	*Tyto alba*
Typical Owls (family Strigidae)	
Barred Owl	*Strix varia*
Great Horned Owl	*Bubo virginianus*
Northern Pygmy-owl	*Glaucidium gnoma*
Short-eared Owl	*Asio flammeus*
Western Screech Owl	*Megascops kennicottii*
Swifts (family Apodidae)	
Vaux’s Swift	*Chaetura vauxi*
Hummingbirds (family Trochilidae)	
Anna's Hummingbird	*Calypte anna*

Common Name	Scientific Name
Rufous Hummingbird	*Selasphorus rufus*
Kingfishers (family Alcedinidae)	
Belted Kingfisher	*Megaceryle alcyon*
Woodpeckers (family Picidae)	
Downy Woodpecker	*Picoides pubescens*
Hairy Woodpecker	*Picoides villosus*
Northern Flicker	*Colaptes auratus*
Pileated Woodpecker	*Dryocopus pileatus*
Red-breasted Sapsucker	*Sphyrapicus ruber*
Tyrant Flycatchers (family Tyrannidae)	
Eastern Kingbird	*Tyrannus tyrannus*
Hammond's Flycatcher	*Empidonax hammondii*
Olive-sided Flycatcher†	*Contopus cooperi*
Pacific-slope Flycatcher	*Empidonax difficilis*
Say's Phoebe	*Sayornis saya*
Western Kingbird	*Tyrannus verticalis*
Western Wood-pewee	*Contopus sordidulus*
Willow Flycatcher†	*Empidonax traillii*
Shrikes (family Laniidae)	
Northern Shrike	*Lanius excubitor*
Vireos (family Vireonidae)	
Cassin's Vireo	*Vireo cassinii*
Hutton's Vireo	*Vireo huttoni*
Warbling Vireo	*Vireo gilvus*
Crows, Jays, and Magpies (family Corvidae)	
American Crow	*Corvus brachyrhynchos*
Common Raven	*Corvus corax*
Steller's Jay	*Cyanocitta stelleri*
Western Scrub-jay	*Aphelocoma californica*
Swallows (family Hirundinidae)	
Bank Swallow	*Riparia riparia*
Barn Swallow	*Hirundo rustica*

Common Name	Scientific Name
Cliff Swallow	*Petrochelidon pyrrhonota*
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*
Purple Martin†	*Progne subis*
Tree Swallow	*Tachycineta bicolor*
Violet-green Swallow	*Tachycineta thalassina*
Titmice and Chickadees (family Paridae)	
Black-capped Chickadee	*Poecile atricapillus*
Chestnut-backed Chickadee	*Poecile rufescens*
Bushtits (family Aegithalidae)	
Bushtit	*Psaltriparus minimus*
Nuthatches (family Sittidae)	
Red-breasted Nuthatch	*Sitta canadensis*
White-breasted Nuthatch	*Sitta carolinensis*
Creepers (family Certhiidae)	
Brown Creeper	*Certhia americana*
Wrens (family Troglodytidae)	
Bewick's Wren	*Thryomanes bewickii*
House Wren	*Troglodytes aedon*
Marsh Wren	*Cistothorus palustris*
Pacific Wren	*Troglodytes pacificus*
Kinglets (family Regulidae)	
Golden-crowned Kinglet	*Regulus satrapa*
Ruby-crowned Kinglet	*Regulus calendula*
Thrushes (family Turdidae)	
American Robin	*Turdus migratorius*
Swainson's Thrush	*Catharus ustulatus*
Varied Thrush	*Ixoreus naevius*
Western Bluebird	*Sialia mexicana*
Starlings (family Sturnidae)	
European Starling*	*Sturnus vulgaris*
Wagtails and Pipits (family Motacillidae)	
American Pipit	*Anthus rubescens*

Common Name	Scientific Name
Waxwings (family Bombycillidae)	
Cedar Waxwing	*Bombycilla cedrorum*
Wood Warblers (family Parulidae)	
Black-throated Gray Warbler	*Setophaga nigrescens*
Common Yellowthroat	*Geothlypis trichas*
MacGillivray's Warbler	*Geothlypis tolmiei*
Orange-crowned Warbler	*Oreothlypis celata*
Townsend's Warbler	*Setophaga townsendi*
Wilson's Warbler	*Cardellina pusilla*
Yellow Warbler	*Setophaga petechia*
Yellow-breasted Chat†	*Icteria virens*
Yellow-rumped Warbler	*Setophaga coronata*
Tanagers (family Cardinalidae)	
Western Tanager	*Piranga ludoviciana*
Sparrows and Towhees (family Emberizidae)	
Chipping Sparrow	*Spizella passerina*
Dark-eyed Junco	*Junco hyemalis*
Fox Sparrow	*Passerella iliaca*
Golden-crowned Sparrow	*Zonotrichia atricapilla*
Lincoln's Sparrow	*Melospiza lincolnii*
Savannah Sparrow	*Passerculus sandwichensis*
Song Sparrow	*Melospiza melodia*
Spotted Towhee	*Pipilo maculatus*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-throated Sparrow	*Zonotrichia albicollis*
Cardinals, Grosbeaks, and Allies (family Cardinalidae)	
Black-headed Grosbeak	*Pheucticus melanocephalus*
Lazuli Bunting	*Passerina amoena*
Blackbirds and Orioles (family Icteridae)	
Brewer's Blackbird	*Euphagus cyanocephalus*
Brown-headed Cowbird	*Molothrus ater*
Bullock's Oriole	*Icterus bullockii*

Common Name	Scientific Name
Red-winged Blackbird	*Agelaius phoeniceus*
Western Meadowlark	*Sturnella neglecta*
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*
Finches (family Fringillidae)	
American Goldfinch	*Spinus tristis*
Evening Grosbeak	*Coccothraustes vespertinus*
House Finch	*Carpodacus mexicanus*
Lesser Goldfinch	*Spinus psaltria*
Pine Siskin	*Spinus pinus*
Purple Finch	*Carpodacus purpureus*
Red Crossbill	*Loxia curvirostra*
Old World Sparrows (family Passeridae)	
House Sparrow*	*Passer domesticus*

*=Introduced Species

†= Species of Concern

Mammals

Common Name	Scientific Name
Beaver	*Castor canadensis*
Black-tailed Deer	*Odocoileus hemionus*
Brush Rabbit	*Sylvilagus bachmani*
California Ground Squirrel	*Spermophilus beecheyi*
Coyote	*Canis latrans*
Creeping Vole	*Microtus oregoni*
Deer Mouse	*Peromyscus maniculatus*
Douglas Squirrel	*Tamiasciurus douglasii*
Eastern Fox Squirrel*	*Sciurus niger*
Feral Cat*	*Felis catus*
Mink	*Mustela vison*
Mouse-eared Bat	*Myotis spp.*
Muskrat	*Ondatra zibethicus*
Northern Flying Squirrel	*Glaucomys sabrinus*

Common Name	Scientific Name
Nutria*	*Myocastor coypus*
Pacific Jumping Mouse	*Zapus trinotatus*
Raccoon	*Procyon lotor*
River Otter	*Lontra canadensis*
Roosevelt Elk	*Cervus elaphus*
Short-tailed Weasel	*Mustela erminea*
Shrew-mole	*Neurotrichus gibbsii*
Striped Skunk	*Mephitis mephitis*
Townsend's Chipmunk	*Tamias townsendii*
Trowbridge's Shrew	*Sorex trowbridgii*
Vagrant Shrew	*Sorex vagrans*
Virginia Opossum*	*Didelphis virginiana*
Western Gray Squirrel	*Sciurus griseus*
Western Pocket Gopher	*Thomomys mazama*

*=Introduced Species

Reptiles and Amphibians

Common Name	Scientific Name
Alligator lizard	*Elgaria sp.*
Bullfrog*	*Rana catesbeiana*
Chorus Frog	*Pseudacris regilla*
Ensatina	*Ensatina eschscholtzii*
Long-toed Salamander	*Ambystoma macrodactylum macrodactylum*
Northern Red-legged Frog†	*Rana aurora aurora*
Northwestern Salamander	*Ambystoma gracile*
Red-eared Slider*	*Trachemys scripta elegans*
Red-spotted Garter Snake	*Thamnophis sirtalis concinnus*
Rough-skinned Newt	*Taricha granulosa*
Rubber Boa	*Charina bottae*
Western Painted Turtle	*Chrysemys picta belli*
Western Pond Turtle	*Clemmys marmorata marmorata*
Western Terrestrial Garter Snake	*Thamnophis elegans*

*=Introduced Species
†= Species of Concern

Fish

Common Name	Scientific Name
Bluegill*	*Lepomis macrochirus*
Catfish*	*Ictalurus sp.*
Coastal Cutthroat Trout†	*Oncorhynchus clarki ssp*
Common Carp*	*Cyprinus carpio*
Mosquito fish*	*Gambusia affinis*
Pacific Lamprey†	*Lampetra tridentata*
Redside Shiner	*Richardsonius balteatus*
Sculpin	*Cottus sp.*
Smallmouth Bass*	*Micropterus dolomieu*
Steelhead/Rainbow Trout	*Oncorhynchus mykiss*
Threespine Stickleback	*Gasterosteus aculeatus*
Warmouth*	*Chaenobryttus gulosus*
Western Brook Lamprey	*Lampetra richardsoni*
White Crappie*	*Pomoxis annularis*

*=Introduced Species
†= Species of Concern

Invertebrates

Dragonflies and Damselflies (order Odonata)

Common Name	Species Name
Blue Dasher	*Pachydiplax longipennis*
California Darner	*Aeshna californica*
Cardinal Meadowhawk	*Sympetrum illotum*
Common Green Darner	*Anax junius*
Common Whitetail	*Plathemis lydia*
Eight-spotted Skimmer	*Libellula forensis*
Pacific Forktail	*Ischnura cervula*
Spot-winged Glider	*Pantala hymenaea*

Dragonflies and Damselflies (order Odonata)

Common Name	Species Name
Striped Meadowhawk	*Sympetrum pallipes*
Tule Bluet	*Enallagma carunculatum*
Twelve-spotted Skimmer	*Libellula pulchella*
Variegated Meadowhawk	*Sympetrum corruptum*
Western Forktail	*Ischnura perparva*
Western Pondhawk	*Erythemis collocata*

Freshwater Mussels (family Margaritiferidae)

Common Name	Species Name
Western Pearlshell Mussel	*Margaritifera falcata*

Aquatic Invertebrates (identified to order)

Common Name	Order
Backswimmer	Hemiptera
Caddisfly	Trichoptera
Copepods	Copepoda
Cranefly	Diptera
Crawling Water Beetle	Coleoptera
Crayfish	Decapoda
Dobsonfly	Neuroptera
Fairy Shrimp	Anostraca
Fingernail Clam	Veneroida
Giant Waterbug	Hemiptera
Mayfly	Ephemeroptera
Mosquito	Diptera
Orb Snail	Basommatophora
Phantom Midge	Diptera
Predaceous Diving Beetle	Coleoptera
Scud	Amphipoda
Sowbug	Isopoda

Aquatic Invertebrates (identified to order)

Common Name	Order
Water Boatman	Hemiptera
Water Scavenger Beetle	Coleoptera
Water Scorpion	Hemiptera
Water Strider	Hemiptera
Whirligig Beetle	Coleoptera

Plants

Herbaceous (forbs)

Common Name	Scientific Name
Velvetleaf*	*Abutilon theophrasti*
Yarrow	*Achillea millefolium*
Vanilla Leaf	*Achlys triphylla*
Pathfinder	*Adenocaulon bicolor*
Maidenhair Fern	*Adiantum pedatum*
Lanceleaf Water Plantain*	*Alisma lanceolatum*
Water Plantain	*Alisma plantago-aquatica*
Field Garlic*	*Allium vineale*
Powell's Amaranth*	*Amaranthus powellii*
Ragweed*	*Ambrosia artemisiifolia*
Scarlet Pimpernel*	*Anagallis arvensis*
Pearly Everlasting	*Anaphalis margaritacea*
Three-leaved Anemone	*Anemone deltoidea*
Corn Chamomile*	*Anthemis arvensis*
Stinking Chamomile	*Anthemis cotula*
Bur Chervil*	*Anthriscus caucalis*
Spreading Dogbane	*Apocynum androsaemifolium*
Red Columbine	*Aquilegia formosa*
Mouseear Cress*	*Arabadopsis thaliana*
Hairy Rockcress	*Arabis hirsuta*
Greater Burdock*	*Arctium lappa*

Herbaceous (forbs)

Common Name	Scientific Name
Wild Ginger	*Asarum caudatum*
Lady Fern	*Athyrium filix-femina*
Fat Hen	*Atriplex patula*
Mexican Mosquitofern	*Azolla mexicana*
American Winter Cress	*Barbarea orthoceras*
English Daisy*	*Bellis perennis*
Nodding Beggarticks	*Bidens cernua*
Three-lobed Beggarticks	*Bidens tripartita*
Deer Fern	*Blechnum spicant*
Black Mustard*	*Brassica nigra*
Crown Brodiaea	*Brodiaea coronaria*
Clustered Moss	*Bryum pseudotriquetrum*
Pond Water-starwort	*Callitriche stagnalis*
Morning-glory*	*Calystegia microcarpus*
Small Camas	*Camassia quamash*
Shepherd's Purse*	*Capsella bursa-pastoris*
Nuttall's Bitter-cress	*Cardamine nuttallii*
Western Bitter-cress	*Cardamine occidentalis*
Few-seeded Bitter-cress	*Cardamine oligosperma*
Italian Thistle*	*Carduus pycnocephalus*
Slender-beaked Sedge	*Carex athrostachya*
Dense Sedge	*Carex densa*
Greensheath Sedge	*Carex feta*
Henderson's Sedge	*Carex hendersonii*
Tapefruit Shortscale Sedge	*Carex leptopoda*
Slough Sedge	*Carex obnupta*
Chamisso Sedge	*Carex pachystachya*
Sawbeak Sedge	*Carex stipata*
One-sided Sedge	*Carex unilateralis*
Awlfruit Sedge	*Carex stipata*
Spotted Knapweed*	*Centaurea stoebe*

Herbaceous (forbs)

Common Name	Scientific Name
Doubtful Chickweed*	*Cerastium dubium*
Big Chickweed*	*Cerastium fontanum*
Sticky Chickweed*	*Cerastium viscosum*
Coon's Tail	*Ceratophyllum demersum*
Spotted Sandmat*	*Chamaesyce maculata*
Fireweed	*Chamerion angustifolium*
Lambsquarters*	*Chenopodium album*
Chicory*	*Cichorium intybus*
Enchanter's Nightshade	*Circaea alpina*
Canada Thistle*	*Cirsium arvense*
Edible Thistle	*Cirsium edule*
Bull Thistle*	*Cirsium vulgare*
Farewell-to-spring	*Clarkia amoena*
Winecup Clarkia	*Clarkia purpurea*
Miner's-lettuce	*Claytonia perfoliata*
Candy Flower	*Claytonia sibirica*
Western Clematis	*Clematis ligusticifolia*
Yerba Buena	*Clinopodium douglasii*
Poison-hemlock*	*Conium maculatum*
Field Bindweed*	*Convolvulus arvensis*
Candian Horseweed*	*Conyza canadensis*
Nursery Cotoneaster*	*Cotoneaster buxifolius*
Five-angled Dodder	*Cuscuta pentagona*
Strawcolored Flatsedge	*Cyperus erythrohizos*
Queen Anne's Lace*	*Daucus carota*
Tansy Mustard	*Descurainia pinnata*
Deptford Pink*	*Dianthus armeria*
Northern Saitas	*Dichelostemma congestum*
Pacific Bleeding Heart	*Dicentra formosa*
Fuller's Teasel*	*Dipsacus fullonum*
Showy Downingia	*Downingia elegans*

Herbaceous (forbs)

Common Name	Scientific Name
Willamette Downingia	*Downingia yina*
Whitlow Grass	*Draba verna*
False Dog Fennel	*Dyssodia papposa*
Needle Spikerush	*Eleocharis acicularis*
Ovate Spikerush	*Eleocharis ovata*
Common Spikerush	*Eleocharis palustris*
Small Spikerush	*Eleocharis parvula*
Fewflower Spikerush	*Eleocharis quinqueflora*
Autumn Willowherb	*Epilobium brachycarpum*
Chaparral Willowherb	*Epilobium minutum*
Tall Willowherb	*Epilobium palustre*
Swamp Willowherb	*Epilobium densiflorum*
Marsh Horsetail	*Equisetum palustre*
Giant Horsetail	*Equisetum telmateia*
Philadelphia Daisy*	*Erigeron philadelphicus*
Fleabane Daisy	*Erigeron strigosus*
Oregon Sunshine	*Eriophyllum lanatum*
Redstem Stork's Bill*	*Erodium cicutarium*
Oregon Coyote Thistle	*Eryngium petiolatum*
Wormseed Wallflower*	*Erysimum cheiranthoides*
Giant White Fawnlily	*Erythronium oregonum ssp oregonum*
California Poppy	*Eschschoizia californica*
Petty Spurge*	*Euphorbia peplus*
Roughleaf Aster	*Eurybia radulina*
Japanese Knotweed*	*Polygonum cuspidatum*
Woodland Strawberry	*Fragaria vesca*
Coastal Strawberry	*Fragaria chiloensis*
Virginia Strawberry	*Fragaria virginiana*
Checker Lily	*Fritillaria affinis*
Cleavers Bedstraw	*Galium aparine*
Northern Bedstraw	*Galium boreale*

Herbaceous (forbs)

Common Name	Scientific Name
Oregon Bedstraw	*Galium oreganum*
Threepetal Bedstraw	*Galium trifidum ssp.columbianum*
Cut-leaved Geranium*	*Geranium dissectum*
Shiny Leaf Geranium*	*Geranium lucidum*
Dovefoot Geranium*	*Geranium molle*
Herb-Robert*	*Geranium robertianum*
Largeleaf Avens	*Geum macrophyllum*
Bluehead Gilia	*Gilia capitata*
Western Marsh Cudweed*	*Gnaphalium palustre*
Marsh Cudweed*	*Gnaphalium uliginosum*
Bractless Hedgehyssop	*Gratiola ebracteata*
English Ivy*	*Hedera helix*
Tawny Daylily*	*Hemerocallis fulva*
Cowparsnip	*Heracleum maximum*
Coral Bells	*Heuchera glabra*
Pacific Waterleaf	*Hydrophyllum tenuipes*
St. Johnswort*	*Hypericum perforatum*
Hairy Cat's Ear*	*Hypochaeris radicata*
Orange Balsam*	*Impatiens capensis*
Douglas Iris	*Iris douglasiana*
Oregon Iris	*Iris tenax*
Tapertip Rush	*Juncus acuminatus*
Toad Rush	*Juncus bufonius*
Common Rush	*Juncus effusus*
Spreading Rush	*Juncus patens*
Poverty Rush	*Juncus tenuis*
Pointed Rush	*Juncus oxymeris*
Prickly Lettuce*	*Lactuca serriola*
Spotted Henbit*	*Lamium maculatum*
Purple Deadnettle*	*Lamium purpureum*
Nipplewort	*Lapsana communis*

Herbaceous (forbs)

Common Name	Scientific Name
Purple Peavine	*Lathyrus nevadensis*
Sweetpea*	*Lathyrus odoratus*
Leafy Pea	*Lathyrus polyphyllus*
Pacific Pea	*Lathyrus vestitus*
Duckweed*	*Lemna minor*
Fall Dandelion*	*Leontodon autumnalis*
Hairy Hawkbit*	*Leontodon taraxacoides*
Field Pepperweed*	*Lepidium campestre*
Oxeye Daisy*	*Leucanthemum vulgare*
Celeryleaf Licorice-root	*Ligusticum apiifolium*
Columbia Lily	*Lilium columbianum*
False-pimpernel	*Lindernia dubia*
Barestem Biscuitroot	*Lomatium nudicaule*
Orange Honeysuckle	*Lonicera ciliosa*
Hairy Honeysuckle	*Lonicera hispidula*
Twinberry Honeysuckle	*Lonicera involucrata*
Bird’s-foot Lotus*	*Lotus corniculatus*
Small-flowered Lotus	*Lotus micranthus*
Spanish-Clover	*Lotus purshianus*
Sicklekeel Lupine	*Lupinus albicaulis*
Miniature Lupine	*Lupinus bicolor*
Bigleaf Lupine	*Lupinus polyphyllus*
Skunk Cabbage	*Lysichiton americanus*
Spatulaleaf Loosestrife*	*Lythrum portula*
Purple Loosestrife*	*Lythrum salicaria*
Elegant Tarweed	*Madia elegans*
Small Tarweed	*Madia exigua*
Slender Tarweed	*Madia gracilis*
Coast Tarweed	*Madia sativa*
Feathery False Lily of the valley	*Maianthemum racemosum*
Starry False Lily of the Valley	*Maianthemum stellatum*

Herbaceous (forbs)

Common Name	Scientific Name
Common Mallow*	*Malva neglecta*
Disc Mayweed*	*Matricaria discoidea*
Black Medick*	*Medicago lupulina*
Common Balm*	*Melissa officinalis*
Sweetclover*	*Melilotus alba*
Wild Mint*	*Mentha arvensis*
Pennyroyal*	*Mentha pulegium*
Stinky Mint	*Mentha villosa*
Seep Monkeyflower	*Mimulus guttatus*
Linearleaf Snapdragon	*Misopates orontium*
Largeleaf Sandwort	*Moehringia macrophylla*
Indianpipe	*Monotropa uniflora*
Blinking Chickweed	*Montia fontana*
Narrowleaf Minerslettuce	*Montia linearis*
Changing Forget-me-not*	*Myosotis discolor*
Bay Forget-me-not	*Myosotis laxa*
Spring Forget-me-not	*Myosotis verna*
Tiny Mousetail	*Myosurus minimus*
Western Watermilfoil	*Myriophyllum hippuroides*
Daffodil	*Narcissus pseudonarcissus*
Skunkbush	*Navarretia squarrosa*
Smallflower Nemophila	*Nemophila parviflora*
Water Parsley	*Oenanthe sarmentosa*
Sweetcicely	*Osmorhiza berteroi*
Redwood-Sorrel	*Oxalis oregana*
Suksdorf Woodsorrel	*Oxalis suksdorfii*
Yellow Glandweed*	*Parentucellia viscosa*
Rydberg’s Penstemon	*Penstemon rydbergii*
Gardner’s Yampah	*Perideridia gairdneri*
Fragrant Popcornflower	*Plagiobothyrus figuratus*
Scouler’s Popcornflower	*Plagiobothyrus scouleri*

Herbaceous (forbs)

Common Name	Scientific Name
Narrowleaf Plantain*	*Plantago lanceolata*
Common Plantain*	*Plantago major*
Shortspur Seabrush	*Plectritis congesta*
Water Knotweed	*Polygonum amphibium*
Prostrate Knotweed*	*Polygonum arviculare*
Japanese Knotweed*	*Polygonum cuspidatum*
Curlytop Knotweed*	*Polygonum lapathifolium*
Spotted Ladysthumb*	*Polygonum persicaria*
Licorice Fern	*Polypodium glycyrrhiza*
Sword Fern	*Polystichum munitum*
Little Hogweed*	*Portulaca oleracea*
Leafy Pondweed	*Potamogeton foliosus*
English Cinquefoil*	*Potentilla anglica*
Slender Cinquefoil	*Potentilla gracilis*
Drops-of-gold	*Prosartes hookeri*
Common Selfheal*	*Prunella vulgaris*
Bracken Fern	*Pteridium aquilinum*
Tall Buttercup	*Ranunculus acris*
Lesser celandine*	*Ranunculus ficaria*
Lesser Buttercup	*Ranunculus flammula*
Western Buttercup	*Ranunculus occidentalis*
Redbacked Buttercup	*Ranunculus orthorhynchus*
Smallflower Buttercup*	*Ranunculus parviflorus*
Creeping Buttercup	*Ranunculus repens*
Celery-leaved Buttercup	*Ranunculus sceleratus*
Little Buttercup	*Ranunculus uncinatus*
Cultivated Radish*	*Raphanus sativus*
Bluntleaf Yellowcress	*Rorippa curvipes*
Curvepod Yellowcress	*Rorippa curvisiliqua*
Bog Yellowcress	*Rorippa palustris*
Sheep Sorrel*	*Rumex acetosella*

Herbaceous (forbs)

Common Name	Scientific Name
Curled Dock*	*Rumex crispus*
Toothed Dock*	*Rumex dentatus*
Mountain Sorrel	*Rumex pauciflorus*
Willow-leaved Dock	*Rumex salicifolius*
Redveined Dock*	*Rumex sanguineus*
Wigeon Grass	*Ruppia maritime*
Wapato	*Sagittaria latifolia*
Pacific Blacksnakeroot	*Sanicula crassicaulis*
Flaxleaf Plainsmustard*	*Schoenocrambe linifolia*
Softstem Bulrush	*Schoenoplectus tabernaemontani*
Small-flowered bulrush	*Scirpus microcarpus*
Blue Skullcap	*Scutellaria lateriflora*
Oregon Stonecrop	*Sedum oreganum*
Tansy Ragwort*	*Senecio jacobaea*
Old-man-in-the-Spring*	*Senecio vulgaris*
Meadow Checker-mallow	*Sidalcea campestris*
Nelson's Checker-mallow†	*Sidalcea nelsoniana*
Dwarf Checkerbloom	*Sidalcea malviflora*
Sleepy Silene*	*Silene antirrhina*
Wild Mustard*	*Sinapis arvensis*
Hedgemustard*	*Sisymbrium officinale*
American Black Nightshade	*Solanum americanum*
Climbing Nightshade*	*Solanum dulcamara*
Buffalobur*	*Solanum rostratum*
Field Sowthistle*	*Sonchus arvensis*
Spiny Sowthistle*	*Sonchus asper*
Common Sowthistle*	*Sonchus oleraceus*
Simple-stemmed Bur-reed	*Sparganium emersum*
Hooded Lady's Tresses	*Spiranthes romanzoffiana*
Common Duckmeat	*Spirodela polyrrhiza*
Coastal Hedgenettle*	*Stachys chamissonis*

Herbaceous (forbs)

Common Name	Scientific Name
Mexican Hedgenettle	*Stachys mexicana*
Curled Starwort	*Stellaria crispa*
Chickweed*	*Stellaria stellaria*
Hall's Aster	*Symphyotrichum hallii*
Douglas Aster	*Symphyotrichum subspicatum*
Common Tansy*	*Tanacetum vulgare*
Common Dandelion*	*Taraxacum officinale*
Bigflower Tellima	*Tellima grandiflora*
Fendler's Meadow-rue	*Thalictrum fendleri*
Claspleaf Pennycress*	*Thlaspi perfoliatum*
Youth-on-age	*Tolmiea menziesii*
Pacific Poison Oak	*Toxicodendron diversilobum*
Goatsbeard*	*Tragopogon sp.*
Starflower	*Trientalis borealis*
Rabbitfoot Clover*	*Trifolium arvense*
Strawberry Clover*	*Trifolium fragiferum*
Alsike Clover*	*Trifolium hybridum*
Crimson Clover*	*Trifolium incarnatum*
White Clover*	*Trifolium repens*
Subterranean Clover*	*Trifolium subterraneum*
Arrowleaf Clover*	*Trifolium vesiculosum*
Pacific Trillium	*Trillium ovatum*
Smallflower Wakerobin	*Trillium parviflorum*
White Brodiaea	*Triteleia hyacinthina*
Broadleaf False Carrot*	*Turgenia latifolia*
Common Cattail	*Typha latifolia*
Stinging nettle	*Urtica dioica ssp. gracillis*
White Insideout Flower	*Vancouveria hexandra*
California False Hellebore	*Veratrum californicum*
Moth Mullein*	*Verbascum blattaria*
Common Mullein*	*Verbascum thapsus*

Herbaceous (forbs)

Common Name	Scientific Name
American Speedwell	*Veronica americana*
Water Speedwell	*Veronica anagallis-aquatica*
Corn Speedwell*	*Veronica arvensis*
Threadstalk Speedwell*	*Veronica filiformis*
Neckweed	*Veronica peregrina*
Skullcap Speedwell	*Veronica scutellata*
Thymeleaf Speedwell	*Veronica serpyllifolia*
American Vetch*	*Vicia americana*
Bird Vetch*	*Vicia cracca*
Tiny Vetch*	*Vicia hirsuta*
Garden Vetch*	*Vicia sativa*
Slender Vetch	*Vicia tetrasperma*
Hookedspur Violet	*Viola adunca*
Stream Violet	*Viola glabella*
Common Whipplea	*Whipplea modesta*
Canada Cocklebur*	*Xanthium strumarium*
False Carrot*	*Yabea microcarpa*

*=Introduced Species

†= Species of Concern

Grasses

Common Name	Scientific Name
Spike Bentgrass	*Agrostis exarata ssp monolepsis*
Spike Bentgrass	*Agrostis exarata ssp exarata*
Silver Hairgrass*	*Aira caryophyllea*
Water Foxtail*	*Alopecurus geniculatus*
Meadow Foxtail*	*Alopecurus pratensis*
Pacific Foxtail	*Alopecurus saccatus*
Sweet Grass	*Anthoxanthum odoratum*
Wild Oat*	*Avena fatua*
Slough Grass*	*Beckmannia syzgichne*

Grasses

Common Name	Scientific Name
Soft Brome*	*Bromus hordeaceus*
Ripgut Brome*	*Bromus rigidus*
Alaska Brome	*Bromus sitchensis*
California Brome	*Bromus carinatus*
Bermudagrass*	*Cynodon dactylon*
Orchardgrass*	*Dactylis glomerata*
California oatgrass	*Danthonia californica*
Tufted Hairgrass	*Deschampsia caespitosa*
Annual Hairgrass	*Deschampsia danthonoides*
Slender Hairgrass	*Deschampsia elongata*
Purple Foxglove*	*Digitalis purpurea*
Hairy Crabgrass*	*Digitaria sanguinalis*
Barnyard Grass*	*Echinochloa crusgallii*
Blue Wildrye	*Elymus glaucus*
Tall Fescue*	*Festuca arundinacea*
Idaho Fescue	*Festuca idahoensis*
Meadow Fescue*	*Festuca pratensis*
Red Fescue	*Festuca rubra*
Common Velvetgrass	*Holcus lanatus*
Oceanspray	*Holodiscus discolor*
Meadow Barley	*Hordeum brachyantherum*
Foxtail Barley*	*Hordeum jubatum*
Prairie Junegrass	*Koeleria macrantha*
Rice Cutgrass*	*Leersia oryzoides*
Italian Ryegrass*	*Lolium multiflorum*
Perennial Ryegrass*	*Lolium perenne*
Witchgrass	*Panicum capillare*
Knotgrass	*Paspalum disitichum*
Reed Canarygrass*	*Phalaris arundinacea*
Timothy	*Phleum pratense*
Idaho Blue-eyed Grass	*Sisyrinchium idahoense*

Grasses

Common Name	Scientific Name
Golden Blue-eyed Grass	*Sisyrinchium californicum*
Brome Fescue	*Vulpia bromoides*

*=Introduced Species

Shrubs

Common Name	Scientific Name
Vine Maple	*Acer circinatum*
Saskatoon Serviceberry	*Amelanchier alnifolia*
Canadian Serviceberry*	*Amelanchier canadensis*
Kinnikinnick	*Arctostaphylos uva-ursi*
Redstem Ceanothus	*Ceanothus sanguineous*
Snowbrush	*Ceanothus velutinus*
European Centaury	*Centaurium erthraea*
Red-osier Dogwood	*Cornus sericea*
Beaked Hazlenut	*Corylus cornuta var. californica*
Black Hawthorn	*Crataegus douglasii*
Red Hawthorn*	*Crataegus monogyna*
Scotch Broom*	*Cytisus scoparius*
Western Wahoo	*Euonymus occidentalis*
Salal	*Gaultheria shallon*
English Holly	*Ilex aquifolium*
Hollyleaved Barberry	*Mahonia aquifolium*
Cascade Barberry	*Mahonia nervosa*
Indian Plum	*Oemleria cerasiformis*
Mock-Orange	*Philadelphus lewisii*
Pacific Ninebark	*Physocarpus capitatus*
Cascara	*Rhamnus purshiana*
Sticky Gooseberry	*Ribes lacustre*
Red-flowering Currant	*Ribes sanguineum*
Baldhip Rose	*Rosa gymnocarpa*
Nootka Rose	*Rosa nutkana*

Shrubs

Common Name	Scientific Name
Dwarf Rose	*Rosa pisocarpa*
Himalayan Blackberry*	*Rubus armeniacus*
Evergreen Blackberry*	*Rubus lacianatus*
Whitebark Raspberry	*Rubus leucodermis*
Thimbleberry	*Rubus parviflorus*
Salmonberry	*Rubus spectabilis*
Trailing Blackberry	*Rubus ursinus*
Narrowleaf Willow	*Salix fluviatilis*
Geyer Willow	*Salix geyeriana*
Dune Willow	*Salix hookeriana*
Pacific Willow	*Salix lucida*
Scouler's Willow	*Salix scouleriana*
Northwest Sandbar Willow	*Salix sessilifolia*
Sitka Willow	*Salix sitchensis*
Black Elderberry	*Sambucus nigra*
Red Elderberry	*Sambucus racemosa*
Climbing Nightshade	*Solanum dulcamara*
Buffalobur Nightshade	*Solanum rostratum*
Douglas Spiraea	*Spiraea douglasii var. douglasii*
White Snowberry	*Symphoricarpos albus*
Creeping Snowberry	*Symphoricarpos hesperius*
Red Huckleberry	*Vaccinium parvifolium*
Common Viburnum	*Viburnum ellipticum*

*=Introduced Species

Trees

Common Name	Scientific Name
Grand Fir	*Abies grandis*
Bigleaf Maple	*Acer macrophyllum*
Red Alder	*Alnus rubra*
Pacific Madrone	*Arbutus menziesii*

Trees

Common Name	Scientific Name
European White Birch*	*Betula pendula*
Incense Cedar*	*Calocedrus decurans*
Pacific Dogwood	*Cornus nuttallii*
Oregon Ash	*Fraxinus latifolia*
Black Walnut*	*Juglans nigra*
Pacific Crab Apple	*Malus fusca*
Engelmann Spruce*	*Picea engelmannii*
White Spruce*	*Picea glauca*
Ponderosa Pine	*Pinus ponderosa*
Longleaf Pine*	*Pinus australis*
Black Cottonwood	*Populus balsamifera trichocarpa*
Quaking Aspen	*Populus tremuloides*
Bitter Cherry	*Prunus emarginata*
Cultivated Cherry*	*Prunus mahaleb*
Douglas-fir	*Pseudotsuga menziesii*
Common Pear*	*Pyrus communis*
Garry Oak	*Quercus garryana*
Weeping Willow*	*Salix sepulcralis*
Pacific Yew	*Taxus brevifolia*
Western Red Cedar	*Thuja plicata*
Western Hemlock	*Tsuga heterophylla*
California Laurel	*Umbellularia californica*

*=Introduced Species

Appendix O
Fire Management Plan

USFWS

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WILDLAND FIRE MANAGEMENT PLAN

TUALATIN RIVER NATIONAL WILDLIFE REFUGE

2012

Prepared By:

_____ _____

Greg Hagedorn, Zone Fire Management Officer Date

Submitted By:

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Erin Holmes, Project Leader Date

Tualatin River National Wildlife Refuge

Review:

_____ _____

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Pacific Region, U.S. Fish and Wildlife Service

Concurrence:

_____ _____

Bob Flores, Refuge Supervisor Date

Pacific Region, National Wildlife Refuge System

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Robin West, Regional Chief, Date

Pacific Region, National Wildlife Refuge System

Approved:

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Robyn Thorson, Regional Director Date

Pacific Region, U.S. Fish and Wildlife Service

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1. INTRODUCTION

1.1. PURPOSE OF THE FIRE MANAGEMENT PLAN

This Fire Management Plan (FMP) is written to meet the U.S. Department of the Interior (USDOI) and U.S. Fish and Wildlife Service (USFWS; the Service) requirement that every area with burnable vegetation have an approved FMP (620 DM 1.4). It also enables the Tualatin River National Wildlife Refuge (the refuge) to meet the Service requirement that refuges review and/or revise the FMP at a minimum of 5-year intervals or when significant land use changes are proposed (621 FW 2).

The goal of wildland fire management is to plan and implement actions that help accomplish the mission of the National Wildlife Refuge System (Refuge System). That mission is to administer a national network of lands and waters for the conservation, management, and, where appropriate, restoration of fish, wildlife, and plant resources and their habitats within the United States for the benefit of present and future generations of Americans (095 FW 3.2).

The approval of this FMP enables the refuge to consider a full range of appropriate suppression strategies and to conduct prescribed fires; without this FMP, prescribed fires cannot be conducted and only wildfire suppression strategies may be implemented.

This plan outlines both wildland fire suppression and prescribed fire activities on the refuge within the context of an approved comprehensive conservation plan (CCP). The CCP planning process began in 2010 and is scheduled to be completed by December 2012. The FMP defines a program to manage wildland fires and to ensure that wildland fire management goals and components are coordinated and in compliance with all required direction.

Figure 1: Tualatin River National Wildlife Refuge

1.2. General Description of the Area in the Fire Management Plan

Tualatin River National Wildlife Refuge, which includes both the Sherwood Units and the Wapato Lake Unit, is located within the Tualatin River Basin in the northern portion of the Willamette Valley, in Washington and Yamhill Counties, Oregon. The refuge preserves a wetland ecosystem and provides a Wildlife Center in the shadow of Oregon's largest metropolitan area, Portland. The overall management focus cited for the Sherwood Units in the Land Protection Plan (1992) is to "protect, enhance, and manage upland, wetland, and riparian habitats for a variety of migratory birds and resident fish and wildlife, as well as for the enjoyment of people." The Wapato Lake Unit serves a similar purpose as the Sherwood Units and supports many of the same types of habitats. The approved acquisition boundary of the refuge totals approximately 7,370 acres. The refuge may purchase any lands within the boundary from willing sellers (Figures 3 and 4).

Figure 2: Regional Vicinity Map of Tualatin River National Wildlife Refuge

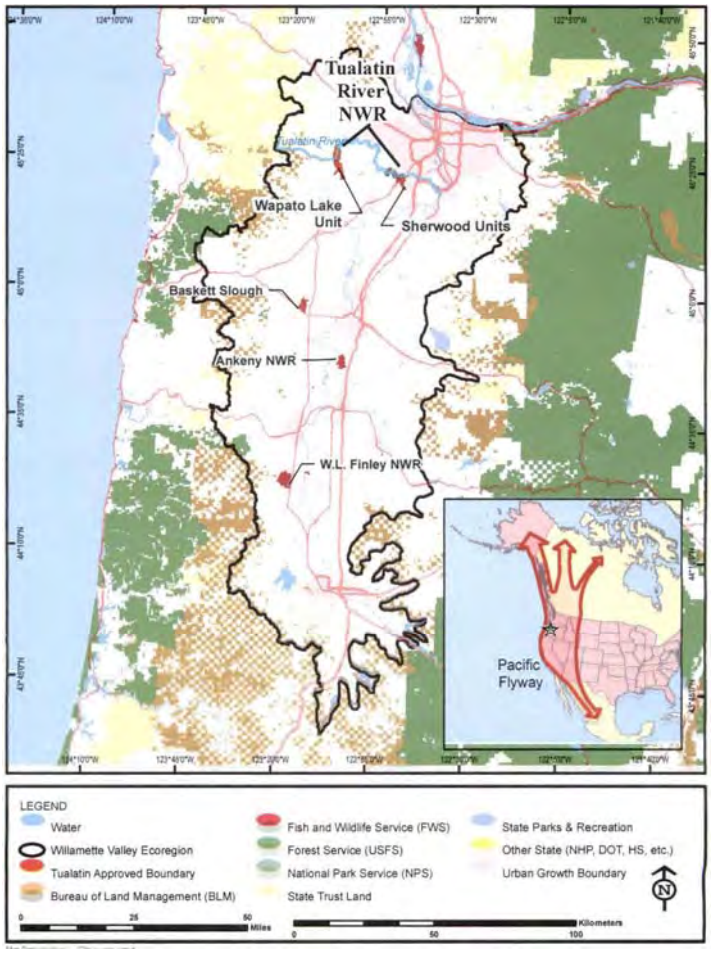
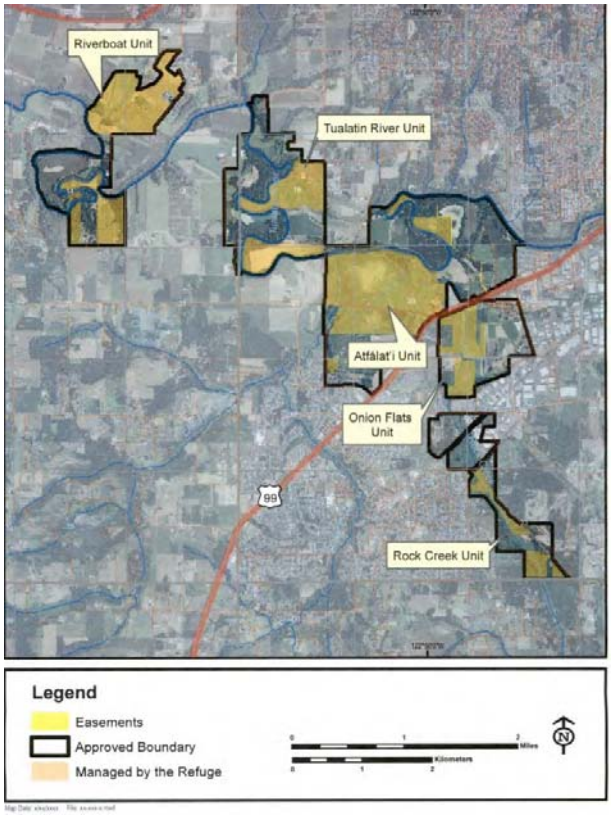


Figure 3: Sherwood Units Land Status on Tualatin River National Wildlife Refuge

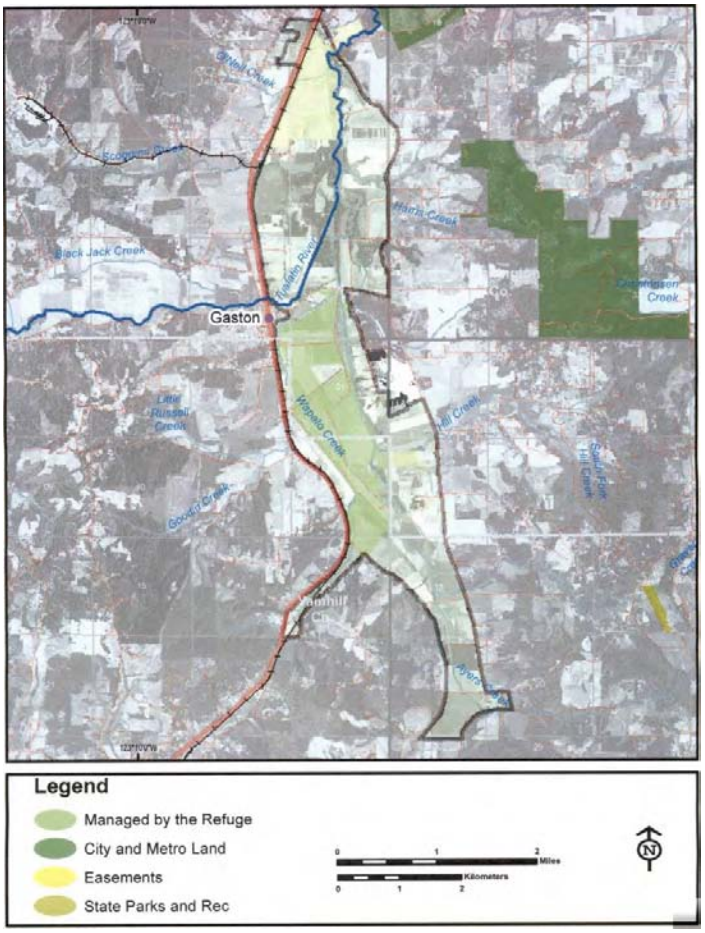


Current acreage owned or managed by the refuge is distributed among six management units (Table 1). The Tualatin River Valley consists of low foothills, terraces, alluvial fans, and floodplains. The refuge's landscape is predominately flat bottomland bordered by uplands with elevations ranging from 105 to 300 feet above sea level. Habitats consist of rivers and streams; herbaceous and scrub-shrub wetlands; riparian forests; wet prairie; oak savanna, and mixed coniferous/deciduous forested uplands.

Table 1: Management Units on Tualatin River National Wildlife Refuge

Management Unit	Acres
Riverboat	355
Tualatin River	229
Atfálat'i	561
Onion Flats	129
Rock Creek	75
Wapato Lake	816
Total	2,165

Figure 4: Land Status of Wapato Lake Unit on Tualatin River National Wildlife Refuge



1.3. Significant Values to Protect

1.3.1. Cultural Resources

Three pre-European sites have been recorded on the refuge. They are not listed but may be eligible for listing on the National Register of Historic Places (NRHP). Two post-European sites have not been evaluated, but may also qualify for listing on the NRHP. Ground disturbance will be avoided if possible during suppression activities on all archeological sites. The regional archeologist will be notified of any suppression actions taken on refuge lands.

1.3.2. Fish and Wildlife

The diverse habitat types found on the refuge host a variety of fish and wildlife. Over 165 species of birds have been recorded on the refuge. Mammals, reptiles, amphibians, and fish have not been inventoried on the refuge, but a diverse number of species breed, migrate, or forage on refuge properties. Large concentrations of waterfowl including Canada geese, northern pintails, and green-winged teal occur during late fall and winter. In spring and summer, numerous species of neotropical migrant songbirds migrate through or nest on the refuge. Two federally listed

threatened species, the bald eagle and upper Willamette steelhead, are potentially present year-round on the refuge, although no known bald eagle nesting territories occur or have been located on the refuge. In addition, peregrine falcons are present during fall through early spring. Western pond turtles and red-legged frogs use many of the refuge wetlands.

1.3.3. Structures and Facilities

There are numerous refuge facilities that serve both the visitor services and biological programs and range from boundary fencing, barns, outbuildings, and numerous water control structures to residences and public use facilities, such as the Wildlife Center and environmental education shelter. In addition, there are structures that serve as offices for other Service programs, such as the Office of Law Enforcement and Cultural Resources.

There is a mixture of properties adjacent to the refuge. Many of the properties adjacent to the Sherwood Units have a rural agricultural nature as well as highly urbanized components. Many of the rural lots have single-family homes with other structures such as barns. The urban areas include closely spaced single- and multi-family residences and commercial businesses of various types. Adjacent and in the vicinity of refuge boundaries are large subdivisions within the urban growth boundary Properties adjacent to the Wapato Lake Unit are mostly rural in nature with some single-family homes.

2. Policy, Land Management Planning, and Partnerships

2.1. Implementation of Fire Policy

2.1.1. Federal Interagency Wildland Fire Policy

This FMP implements these guiding principles of Federal wildland fire policy:

- Firefighter and public safety is the first priority in every fire management activity.
- The role of wildland fire as an essential ecological process and natural change agent has been incorporated into the planning process. Federal agency land and resource management plans set the objectives for the use and desired future condition of the various public lands.
- FMPs, programs, and activities support land and resource management plans and their implementation.
- Sound risk management is a foundation for all fire management activities. Risks and uncertainties relating to fire management activities must be understood, analyzed, communicated, and managed as they relate to the cost of either doing or not doing an activity.
- Fire management programs and activities are economically viable, based upon values to be protected, costs, and land and resource management objectives.
- FMPs and activities are based upon the best available science.
- FMPs and activities 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.

2.1.2. National Fire Plan

This FMP emphasizes the following primary goals of the 10-year Comprehensive Strategy and the Cohesive Strategy for Protecting People and Sustaining Natural Resources:

- Improving fire prevention and suppression
- Reducing hazardous fuels
- Restoring fire-adapted ecosystems
- Promoting community assistance

2.1.3. U.S. Department of Interior Fire Policy

This FMP incorporates and adheres to USDOI policy stated in 620 DM 1, by giving full consideration to use of wildland fire as a natural process and tool during the land management planning process and by providing for the following guidelines.

Wildland fires, whether on or adjacent to lands administered by the USDOI, that threaten life, improvements, or are determined to be a threat to natural and cultural resources or improvements under the USDOI's jurisdiction will be considered emergencies and their suppression given priority over other USDOI programs.

Bureaus shall cooperate in the development of interagency preparedness plans to ensure timely recognition of approaching critical wildland fire situations; to establish processes for analyzing situations and establishing priorities; and for implementing appropriate management responses to these situations.

Bureaus will enforce rules and regulations concerning the unauthorized ignition of wildland fires, and aggressively pursue violations.

2.1.4. U.S. Fish and Wildlife Service Fire Policy

This FMP addresses a full range of potential wildland fires and considers a full spectrum of tactical options (from monitoring to intensive management actions) for appropriate management response (AMR) to meet Fire Management Unit (FMU) objectives. It fully applies procedures and guidelines in the Service Fire Management Handbook and the National Interagency Fire Center's Interagency Standards for Fire and Fire Aviation Operations and affirms these key elements of Service fire policy:

- Firefighter and public safety is the first priority of the wildland fire management program and all associated activities.
- Only trained and qualified leaders and agency administrators will be responsible for, and conduct, wildland fire management duties and operations.

- Trained and certified employees will participate in the wildland fire management program as the situation requires, and noncertified employees will provide needed support as necessary.
- Fire management planning, preparedness, wildfire and prescribed fire operations, other hazardous fuel operations, monitoring, and research will be conducted on an interagency basis with involvement by all partners to the extent practicable.
- The responsible agency administrator must have coordinated, reviewed, and approved this FMP to ensure consistency with approved land management plans, values to be protected, and natural and cultural resource management plans, and to ensure that it addresses public health issues related to smoke and air quality.
- Fire, as an ecological process, will be integrated into resource management plans and activities on a landscape scale, across agency boundaries, based upon the best available science.
- Wildland fire will be used to meet identified resource management objectives and benefits when appropriate.
- Prescribed fire and other treatment types will be employed whenever they are the appropriate tool to reduce hazardous fuels and the associated risk of wildfire to human life, property, and cultural and natural resources and to manage our lands for habitats as mandated by statute, treaty, and other authorities.
- Appropriate management response will consider firefighter and public safety, cost effectiveness, values to protect, and natural and cultural resource objectives.
- Staff members will work with local cooperators and the public to prevent unauthorized ignition of wildfires on our lands.

2.2. Land/Resource Management Planning

2.2.1. Land Resource Management Documents

The refuge is in the process of developing a CCP. The CCP will create a roadmap to guide refuge management over the next 15 years and beyond. An environmental assessment (EA) will be developed with the CCP to analyze the effects of the proposed plan and alternatives.

2.2.2. Compliance with Regulatory Acts

Compliance with regulatory acts (i.e., National Environmental Policy Act [NEPA]) associated with fire management activities will be documented in the CCP and associated EA.

2.3. Fire Management Partnerships

2.3.1. Internal Partnerships

The refuge does not have a dedicated fire position on the refuge. Fire management activities are coordinated by the zone fire management officer (FMO) stationed at the W.L. Finley National Wildlife Refuge. The Zone FMO is responsible for updating suppression agreements, providing fire management guidance in the event of a wildfire, and assisting with implementing prescribed fire projects identified by the refuge. The Zone FMO is also responsible for maintaining training records and ensuring that current policy and procedures are followed.

2.3.2. External Partnerships

A memorandum of understanding with Tualatin Valley Fire and Rescue (TVFR) is in the process of being developed to cover suppression response in the Sherwood FMU (Appendix E of FMP). A similar agreement is also being developed with the Gaston Rural Fire Department to cover fire suppression on the Wapato Lake Unit (Appendix F of the FMP).

3. Fire Management Units Characteristics

The intent of this portion of the FMP is to articulate and describe the general fire management situation within the local area and describe the specific fire management goals and objectives for the refuge. In addition, this portion of the FMP will describe the particular FMUs defined within the refuge. These FMUs attempt to categorize lands on the refuge based on fire suppression response and are not limited to vegetation type or fuel model.

3.1. Area-wide Considerations

3.1.1. Fire Management Organization

The refuge has no dedicated fire personnel. It relies on local fire departments for fire suppression and the Zone FMO to keep agreements for suppression up to date. The Zone FMO also provides program oversight for the development of annual dispatch plans and prescribed fire projects.

3.1.2. The History of Prescribed Fire at the Refuge

The earliest historical records indicate that Native Americans started fires that burned extensive areas of the Willamette Valley annually. What role fire played prehistorically is not known. In general, fire is considered beneficial to the native grassland areas and oak savanna uplands. Fire is considered essential in the prairie areas to maintain the grassland condition and suppress encroaching woody vegetation. Previous versions of the FMP for Tualatin River National Wildlife Refuge only allowed for pile burning, and prescribed fire broadcast burning was not addressed. With the approval of this document, prescribed fire broadcast burning will be considered as a management tool available to managers. Each prescribed fire project will have an approved prescribed fire plan outlining procedures, notifications, and permits required for implantation of prescribed fire.

3.1.3. Management Goals, Objectives, and Constraints in the CCP

3.1.3.1. Goals for Tualatin River National Wildlife Refuge

The following goals were derived from the refuge CCP that is currently being developed with expected completion in December 2012.

1. Maintain, enhance, and restore bottomland riparian habitat to a historical range of variability representative of the Willamette Valley ecosystem in order to support breeding and migratory landbirds and other native species.
2. Maintain, enhance, and restore mixed coniferous/deciduous upland habitat to a historical range of variability representative of the Willamette Valley ecosystem in order to support breeding and migratory landbirds and other native species.
3. Maintain, enhance and restore oak savanna habitat to a historical range of variability

representative of the Willamette Valley ecosystem in order to support breeding and migratory landbirds and other native species.

4. Maintain, enhance, and restore native Willamette Valley wet prairie habitat, with an emphasis on management for rare and listed plant species.
5. Maintain, enhance, and restore a diversity of wetlands to support landbirds, waterbirds, and shorebirds with special emphasis on wintering waterfowl.
6. Maintain, enhance, and, where feasible, restore streams and off-water backwater slough habitats to benefit salmonids and other native aquatic species.
7. Cultivate and maintain croplands as an interim measure to control nonnative invasive species.
8. Collect scientific information (surveys, scientific assessments, and research) necessary to support adaptive management decisions that are associated with Goals 1 through 9 of the CCP.
9. Protect and manage the refuge's unique cultural resources for their cultural, scientific, and educational values, while consulting with appropriate Native American groups and preservation organizations and complying with historic preservation legislation.
10. Provide visitors, local residents, volunteers, and partners with opportunities to understand and appreciate fish and wildlife conservation as well as the purpose, ecology, and management of the refuge and the Refuge System.
11. Provide students and teachers from the greater Portland area with compatible and high-quality opportunities to participate in environmental education.
12. Provide refuge visitors with diverse, compatible, and high-quality opportunities to participate in wildlife-dependent recreation and interpretation.

3.1.3.2. SPECIFIC RESOURCE MANAGEMENT GOALS RELATED TO FIRE MANAGEMENT

.

Objective 2.1 Enhance and maintain mixed coniferous/deciduous upland forest
Strategies Applied to Achieve Objective
• Use common forest health practices including prescribed fire and mechanical removals to create variable age structure.
Objective 2.2 Restore mixed coniferous/deciduous upland forest
Strategies Applied to Achieve Objective
• Use prescribed fire as appropriate to control invasive species and reduce thatch.
Objective 3.1 Enhance and maintain oak savanna habitat
Strategies Applied to Achieve Objective
• Use prescribed fire during fall with burn interval of 3 to 5 years.
Objective 3.2 Restore oak savanna habitat
Strategies Applied to Achieve Objective
• Use prescribed fire during spring to control nonnative species prior to initial planting. • Use prescribed fire during fall with burn intervals of 3 to 5 years to reduce thatch and control invasive species.

Objective 4.1 Enhance and maintain native wet prairie
Strategies Applied to Achieve Objective
• Use prescribed fire at burn intervals of 3 to 5 years.
Objective 4.2 Restore native wet prairie
Strategies Applied to Achieve Objective
• Use prescribed fire during spring to control nonnative species prior to initial planting. • Use prescribed fire at burn intervals of 3 to 5 years.
Objective 5.1 Enhance and maintain herbaceous wetland
Strategies Applied to Achieve Objective
• Use prescribed fire to reduce extent of emergent stands and/or remove encroaching woody species (e.g., willow).
Objective 5.2 Restore native herbaceous wetland
Strategies Applied to Achieve Objective
• Use prescribed fire during spring to control nonnative species prior to initial planting.
Objective 5.3 Enhance and maintain scrub-shrub wetland
Strategies Applied to Achieve Objective
• Use prescribed fire to increase diversity in older stands.
Objective 8.2 Research
Strategies Applied to Achieve Objective
• Conduct study to evaluate timing of prescribed fire to best promote native herbaceous cover and control invasive plants.
Objective 5.2 Restore native herbaceous wetland
Strategies Applied to Achieve Objective
• Use prescribed fire during spring to help remove nonnative species prior to initial planting.
Objective 5.3 Enhance and maintain scrub-shrub wetland
Strategies Applied to Achieve Objective
• Use prescribed fire to increase diversity in older stands.

3.1.3.3. Objectives for Fire Management at the Refuge

The objectives for fire management at the refuge are:

- Promote a program to ensure firefighter and public safety, reduce occurrence of human-caused fires, and ensure appropriate suppression response capability to meet expected wildland fire complexity.
- Utilize prescribed fire and mechanical treatments to reduce hazardous fuels and enhance and maintain wildlife habitat.

3.1.3.4. Specific Fire Management Objectives

- Promote a safety-oriented fire management program.
- Protect life, property, and resources from wildland fires at costs commensurate with

resource values at risk.

- Use appropriate suppression tactics and strategies that minimize long-term impacts of suppression actions.

- Use prescribed fire to reduce hazardous fuels and enhance and maintain native habitats.

3.2. Fire Management Units

3.2.1. Fire Management Units—Specific Descriptions

FMUs are areas on a refuge that have common wildland fire management objectives and strategies, are manageable as units from a wildland fire standpoint, and are based on natural or human-made fuel breaks. An FMU may coincide with a prescribed fire burn block or treatment area or unit, but this is not always the case. Current acreage owned and managed by the refuge is distributed among six management units within the Sherwood and Wapato Lake Units. Five management units are located within the Sherwood Units and one on the Wapato Lake Unit. Due to the similarity in fire response within the management units, the refuge is categorized into two FMUs. Other factors, including the geographic separation within the urban setting, allow for the simple organization of the refuge into two FMUs.

The two FMUs at Tualatin River National Wildlife Refuge are:

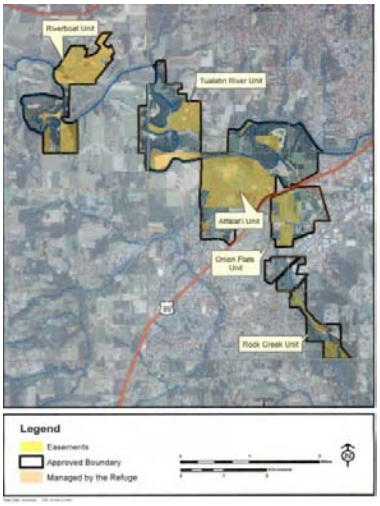
FMU 1: Sherwood;
Riverboat Unit (355 acres)
Tualatin River Unit (229 acres)
Atfálat'i Unit (561 acres)
Onion Flats Unit (129 acres)
Rock Creek Unit (75 acres)

FMU 2: Wapato Lake (816 acres)

3.2.2. FMU 1—Sherwood

The Sherwood FMU is 1,349 acres and includes the Riverboat, Tualatin River, Atfálat'i, Onion Flats, and Rock Creek Units (Figure 5). These management units are defined in the CCP, and would elicit a similar response in the event of a wildfire. FMU 1 is predominately flat bottomland bordered by uplands. It has oak savanna habitat, mixed coniferous/deciduous forested uplands, riparian forests, scrub-shrub wetlands, and wet prairies. In the event of a fire within this FMU, suppression actions would include using existing natural and human-made fire breaks to catch the fire at the smallest possible size. The lands surrounding the Sherwood FMU are primarily a mix of urban and agricultural lands. The City of Sherwood abuts the southern and western edge of the Sherwood FMU. The City of Tualatin is to the east, and King City is to the northeast.

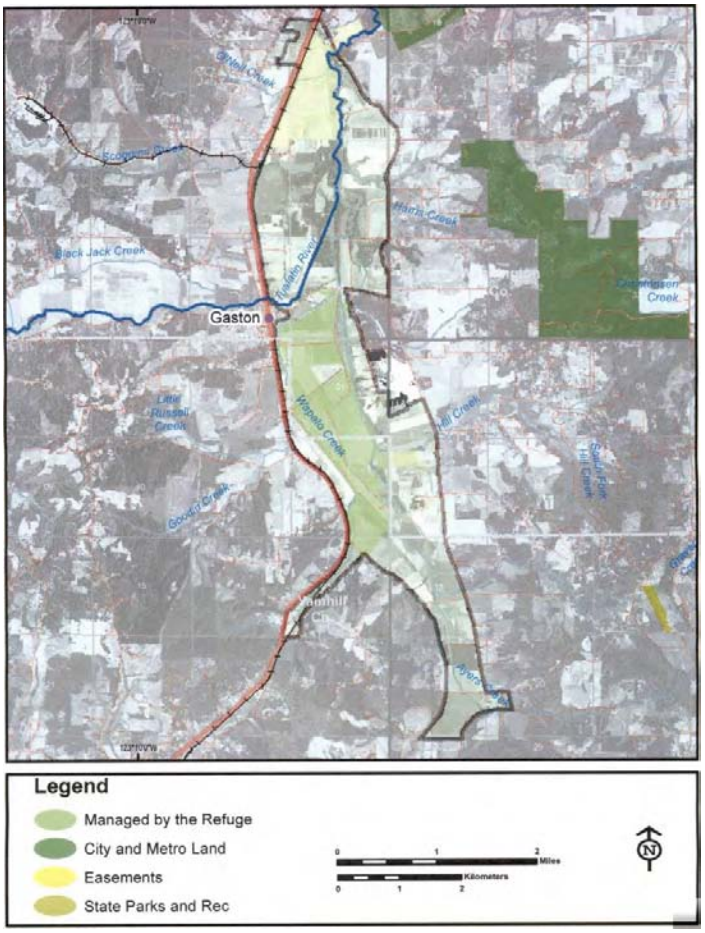
Figure 5: FMU 1 (Sherwood)



3.2.3. FMU 2—WAPATO LAKE

The Wapato Lake FMU is approximately 816 acres (Figure 6). The Wapato Lake Unit was established in 2007. This unit serves a similar purpose as the Sherwood Units and supports many of the same types of habitats. Current ownership is primarily of a historical lake bed where a series of dikes and levees were built in the 1930s to support irrigation of onion farming practices. The City of Gaston is adjacent to the western boundary of the Wapato Lake FMU and Forest Grove sits to the north.

Figure 6: FMU 2 (Wapato Lake)



4. WILDLAND FIRE OPERATIONAL GUIDANCE

The procedures used to implement the FMP for the refuge are covered in this section. Information pertaining to this management is either directly provided or references are cited. Interagency standards for fire and fire aviation operations have been developed, and are documented and available for reference in the Interagency Standards for Fire and Fire Aviation Operations (National Interagency Fire Center's National Fire Equipment System [NFES] No. 2724).

Structural fire suppression is the responsibility of local governments. USFWS may assist with exterior structural protection activities under formal Fire Protection Agreements that specify mutual responsibilities, including funding (Redbook 01-3).

All wildfires will be supervised by a qualified incident commander (IC), through a delegation of authority (0 of FMP) from the project leader. The IC is responsible for the following:

- Assessing the fire situation and making a report to dispatch as soon as possible.
- Using guidance in this FMP and/or a delegation of authority to determine and implement an appropriate management response.
- Determining organization, resource needs, strategy, and tactics.
- Preparing brief incoming and assigned resources on the organization, strategy and tactics, weather and fire behavior, LCES, seasonal and historical ERCs, and radio frequencies.
- Advising dispatch of resources needed for the appropriate management response.
- Managing the incident until relieved or until the fire is suppressed.

The FMP and a delegation of authority can provide a general strategy to an IC, who has the discretion to select and implement appropriate tactics within the limits described for the FMU, including when and where to use minimum impact suppression tactics (MIST), unless otherwise specified.

All resources, including mutual aid resources, will report to the IC, in person or by radio and receive an assignment prior to tactical deployment.

The refuge is dedicated to providing for the safety of each visitor and all residents and property adjacent to the refuge's boundary. Residents adjacent to the refuge will be notified with as much advance warning possible of any wildfire that poses the threat of burning outside refuge boundaries. A contact list can be found in Appendix A of this FMP.

4.1. Preparedness

Preparedness is the work accomplished prior to fire occurrence to ensure that the appropriate response, as directed by the FMP, can be carried out. Preparedness activities include budget planning, equipment acquisition, equipment maintenance, dispatch planning, equipment inventory, personnel qualifications, and training. The preparedness objective is to have a well-trained and equipped fire management organization to manage all fire situations within the refuge. Preparedness efforts are to be accomplished outside the normal fire season dates. The general fire season recognized by the Oregon Department of Forestry runs from June 10 through October 15.

Wildland fire training, experience, and position qualifications information will be maintained through the Service's Incident Qualification and Certification System (IQCS) database. The information will be updated annually.

The minimum qualification will be Firefighter Type 2 (FFT2), which requires the annual firefighter refresher. Specific training and certification requirements can be found in the Redbook Chapter 13.

Fire lines consisting of vegetation-cleared area will be constructed around the perimeter of the refuge annually. Work on these lines will begin after July 16. Fire lines will consist of combination mow and disc lines, and will be cleared to make them accessible to Type 6 engines.

There are two apparatus available at Baskett Slough National Wildlife Refuge (35 miles to the south of Tualatin River National Wildlife Refuge) for suppression and prescribed fire. Equipment is primarily designed and maintained for use in support of prescribed fire activities on-refuge. They are:

- Type 6 engine (E-76 fire-ready)
- Type 4 engine (unmaintained)

E-76 is a Type 6 engine and will be maintained fire-ready during the specified fire season. The Type 4 engine requires an operator with a Commercial Driver's License (CDL) and will be maintained for fire suppression and used if qualified personnel are available to operate it. Personal protective equipment (PPE) will be assigned to qualified personnel. Assigned PPE will be inspected annually as part of the annual fire refresher.

Additional equipment and supplies are available through cooperators and the interagency cache system and would be ordered through the Coastal Valley IACC.

4.2. Detection

Most wildland fires at Tualatin River National Wildlife Refuge are caused by human-related activities. Many times the person who started the fire will call refuge headquarters for help or the local fire department if the refuge office is closed after hours. Fires are typically reported through 911 emergency services, and the refuge is contacted along with the TVFR.

4.3. Communications

Cellular phones are the primary means of communication on the refuge. All immediate emergency notifications and contacts can be found in Appendix A of the FMP. During emergency fire operations, local radio frequencies will be used. Frequencies that will be used are found in Table 2.

Table 2: Radio Frequencies

Channel Name	Assignment	Tx:	Rx:
ODF Red Net	Command	151.3400	151.3400
ODF White Net	Air to Ground	151.3100	151.3100
NIFC Tac 1	Tactical	168.0500	168.0500
NIFC Tac 2	Tactical	168.2000	168.2000
NIFC Tac3	Tactical	168.6000	168.6000

4.4. Dispatch, Initial Response, and Initial Attack

Upon report of wildfire, qualified refuge personnel will respond initially and provide the dispatch center with a fire update. These procedures and criteria for status reports are outlined in the dispatch plan (Appendix D of FMP). Qualified and available refuge staff should respond to assist with tasks such as securing the point of origin, fire suppression, protecting visitors at risk, and implementing necessary closures. In most cases, initial attack (IA) resources will respond from

TVFR. The refuge will use the Incident Command System (ICS) as a guide for suppression organization and actions.

4.5. Extended Attack and Large Fire Management

If the fire exceeds the capabilities of IA resources and transitions into extended attack, additional resources and logistics will be handled through TVFR. The required incident analysis, delegations of authority, and briefing regarding incoming resources will be initiated by the Zone FMO. Specific incident management procedures for transition into extended attack can be found in the Redbook Chapter 11.

4.6. Aviation Operations

All fire-related aviation operations will follow applicable guidelines of the USDOI National Business Center Aviation Management Directorate. Aviation requests and operations will be coordinated with regional office staff.

Aircraft may be used in all phases of fire management operations. All aircraft must be approved by the National Business Center (NBC) or the U.S. Forest Service (USFS). An OAS Aviation Policy Department Manual will be provided by OAS.

Helicopters may be used for reconnaissance, bucket drops, and transportation of personnel and equipment. Natural helispots and parking lots are readily available in most cases. Clearing for new helispots should be avoided where possible. Improved helispots will be rehabilitated following a fire.

As in all fire management activities, safety is the primary consideration. Qualified aviation personnel will be assigned to all flight operations.

4.7. Reviews and Investigations

Reviews and investigations are used by wildland fire and aviation managers to assess and improve the effectiveness and safety of organizational operations. Brief descriptions of various reviews and associated procedures and requirements, including those for serious wildland fire accidents, entrapments, and trespass are listed in the Redbook Chapter 18.

4.8. Reports

The Zone FMO will complete and file an individual fire report (DI-1202) for the following types of fires within 10 days of a fire being declared out:

- All wildfires on Service lands.
- Wildfires threatening Service lands on which Service personnel take action.
- All escaped prescribed fires. When a fire exceeds prescription, it must be declared a wildfire and a separate new report filed to report acres burned by the wildfire from the time of declaration to the time of being declared out.
- All false alarms responded to by field office staff.

DI-1202s are required regardless of who takes action, whether it is a Service engine, cooperator, or contractor. When we take IA off our lands, the agency with jurisdiction over where the fire occurs will file a report and we will file a limited report to document our response and to support potential billing to non-Federal entities for trespass fires.

4.9. Hazardous Fuels Management

4.9.1. Prescribed Fire Program for Hazardous Fuels and Habitat Restoration

The annual prescribed fire and fuels treatment schedule should be prepared in February/March and included as an important aspect in the annual work plan. Prescribed fire plans (i.e., burn plans) should be completed and submitted prior to the burn season.

4.9.1.1. Program Overview

All prescribed fires must comply with NEPA requirements. An EA for management actions associated with prescribed fire was completed as part of the CCP development process. The CCP recognizes prescribed fire as a necessary tool for habitat management and restoration. All prescribed fire activities must also adhere to Service requirements, which can be found in the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide in Chapter 17 of the USFWS Fire Management Handbook and the Redbook.

The fire management program consults with the refuge wildlife biologist to formulate a prescribed fire program for the annual work plan that:

- Identifies the annual target acreage scheduled for treatment.
- Designates the burn units to be treated.
- Determines prescribed burn unit complexities.
- Identifies the preferred treatment interval (this can vary by fuel type).
- Recommends the approved method of treatment (fire, fire/mechanical/chemical, etc.).
- Recommends an effective treatment sequence (rotation).
- Identifies the type of monitoring and frequency.

4.9.1.2. Prescribed Burn Program Objectives

Prescribed fire is a useful tool for restoring and maintaining natural conditions and processes. The goals of prescribed fire are to:

- Restore and maintain native wetland prairies and oak savanna using fire to set back and reduce woody vegetation, such as Douglas-fir.
- Enrich soil nutrients that benefit vegetation.
- Provide benefits to specific rare plant species, such as Nelson's checker-mallow (*Sidalcea nelsoniana*).
- Provide opportunities for research of fire-dependent species and plant communities.
- Remove unwanted accumulations of residual vegetation in association with wetland restoration.
- Realize beneficial effects upon native prairie plant species.

Upland grasslands are burned to maintain an open oak savanna habitat by inhibiting the encroachment of shrubs and woody vegetation, and to invigorate native plant species. Wetland habitats on the refuge may be burned to remove dense stands of reed canarygrass, which dominate the shallow moist soil areas. Some areas may be treated with herbicide post-burn, as reed canarygrass sprouts quickly following fire. The increase in sunlight and exposed soil will allow native species to germinate, thereby promoting and supporting a healthy wetland ecosystem.

The Willamette Valley native prairies evolved under a regime of fire. There are no known ecological equivalents to the use of fire, although mowing can be used to mimic some of the effects. Mowing is used as a restoration tool as it provides a disturbance. Timing of mowing allows nonnative species to be targeted prior to the development of seed heads. Mowing is used as an alternative treatment type to burning if burn windows are not available during a given field season.

4.9.1.3. EFFECT OF NATIONAL AND REGIONAL PREPAREDNESS LEVELS

Prescribed fires may be ignited during National Preparedness Levels 4 or 5 as specified in the National Interagency Mobilization Guide.

The program relies on interagency cooperators from the USFS, the Bureau of Land Management (BLM), and the Bureau of Indian Affairs (BIA) to accomplish prescribed fire projects. Elevated preparedness levels are indicative of an active fire season, and resource availability may be limited due to local resources being committed to ongoing incidents.

4.9.1.4. PROJECT PLANNING

Prescribed fire will be used to reduce hazard fuel accumulations, restore fire-dependent ecological communities, improve conditions for federally listed threatened and endangered species, improve wildlife habitat, and contribute to research. All prescribed fire activity will comply with applicable Federal, state, and local air quality laws and regulations.

Prescribed fire plans for the units to be treated will be prepared and approved prior to treatment. Prescribed fire plans should be prepared well enough in advance to allow for as much time as possible for review prior to the start of a burn season or burn execution phase.

A smoke management section is required and must contain adequate information to meet Oregon State requirements. No permits are required.

All burn plans are prepared by a qualified burn boss, reviewed by a technical reviewer and the Zone FMO, and then approved by the project leader.

Which qualified burn boss will be assigned burn boss duties is determined near the time of the burn by the Zone FMO or designated member of the Zone FMO’s staff. The approved burn plan must be reviewed and signed by the designated burn boss before implementation. Procedures for

prescribed fire implementation are covered within the Interagency Prescribed Fire Planning and Implementation Procedures Reference Guide.

4.9.1.5. PROJECT IMPLEMENTATION

Site-specific treatment objectives are developed to guide project operations. Prescribed fire objectives describe what a treatment must accomplish in order to meet a resource management objective. Each prescribed burn plan contains objectives for the project that are quantifiable and measurable.

The Zone FMO shall assign the burn boss appropriate to the complexity level of the planned burn. The burn boss will follow all the guidelines and procedures that are contained in the prescribed fire plan.

Cooperators, contractors, and administratively determined emergency hires may be used to implement prescribed fires. All individuals working on Federal agency prescribed fires must meet the Fire Management Handbook and Wildland Fire Qualification Guide (published by the National Wildfire Coordinating Group [NWCG], PMS 310-1) standards unless local agreements specify otherwise. The complexity of each prescribed burn determines the organization needed to safely achieve the objectives specified in the burn plan. Further information on qualifications is found in Chapter 17 of the 2008 Interagency Standards for Fire and Fire Aviation Operations. The Zone FMO will be responsible for ensuring that refuge personnel maintain the qualifications necessary to implement prescribed fire programs.

A prescribed fire must be declared a wildfire by those identified in the burn plan when those person(s) determine that the contingency actions have failed or are likely to fail and cannot be mitigated by the end of the next burning period. An escaped prescribed fire must be declared a wildfire when the fire has spread outside the project boundary, or is likely to do so, and cannot be contained by the end of the next burning period. A prescribed fire can be converted to a wildfire for reasons other than an escape. An appropriate management response will be made to such incidents. A formal analysis using a required wildfire decision support tool will be undertaken when needed. The refuge manager and project leader will be notified of an escaped prescribed fire.

The public will be informed of prescribed fires through news releases, interpretive messages, and educational programs. Individual prescribed fires should not be conducted without informing agencies and members of the public likely to be impacted.

4.9.1.6. SMOKE MANAGEMENT

All grass burning in the Willamette Valley is strictly regulated by the Oregon Department of Environmental Quality (DEQ) through the Oregon Department of Agriculture, Division of Smoke Management (DSM), to comply with smoke dispersal requirements in the Willamette Valley. DSM decides, on a daily basis, whether burning will be allowed and how many acres may be burned. No prescribed burns are conducted without DSM approval. Approval is obtained by contacting DSM on the morning of a proposed burn. In addition to smoke management by DSM, the refuge lands are also constrained by fire danger ratings for the area. If the fire danger

rating is extreme, then no prescribed burning will be allowed even when weather conditions are favorable for smoke dispersion.

4.9.1.7. After Action Reviews and Escaped Fire Reviews

The burn boss will ensure an informal After Action Review (AAR) is conducted for each operational period on a prescribed fire, as described in the Incident Response Pocket Guide (IRPG).

All prescribed fires declared a wildfire will have an investigative review initiated by the refuge manager or project leader. The level and scope of the review will be determined by policy and procedures of the Redbook and the USFWS Fire Management Handbook.

4.9.1.8. Reports

Burn plans will specify information to be included in a project file. The burn boss will ensure this information is provided to the refuge manager and/or Zone FMO as specified. This includes documenting conditions and fire behavior during the prescribed fire to assess how well actual fire characteristics fit those predicted, documenting any unanticipated difficulties encountered during implementation, and assessing how well the fire accomplished the intended objectives.

The burn boss will complete an Individual Fire Report (DI-1202) with the Zone FMO, who will file an Individual Fire Report (DI-1202) electronically within 10 days of the fire being declared out.

4.9.2. Non-fire Hazard Fuels Treatment Program

Many activities associated with normal habitat maintenance are similar to pre-suppression fire activities. Mowing is a regular tool used to treat invasive species of grasses and shrubs and to mimic a fire disturbance. These activities may not be funded through the fire program but directly benefit the fire program as well as the habitat. Mowing is used in pretreatment of prescribed fire units to lower flame lengths near the control lines. These areas may not be classified as hazardous fuels but their treatment would aid in suppression if a fire were to occur on the refuge.

4.9.3. Process to Identify Hazard Fuels Treatments

Due to the difficulty of access to areas within the refuge, most hazardous fuels treatments are identified to aid in creating defensible space and engine access. An annual site visit is conducted with the project leader, refuge biologist, and the Zone FMO to identify areas that would benefit ecologically as well as aid in suppression in the event of a wildfire.

4.10. Emergency Stabilization and Burned Area Rehabilitation

Immediate post-wildfire actions are needed to minimize the threat to life and health and prevent unacceptable degradation to natural and cultural resources (see Interagency Burned Area Emergency Response Guidebook). Required repair of damage resulting for wildland fire activities will be completed before crews and resources are released from assignment to the incident.

Rehabilitation and restoration efforts will be undertaken to protect and sustain ecosystems, public health, and safety, and to help communities protect infrastructure. Natural recovery is the preferred emergency stabilization or burned area rehabilitation (BAR) treatment.

The goal of the Emergency Stabilization and Rehabilitation (ESR) Plan is to promote public safety, stabilize and prevent further degradation of natural and cultural resources, and rehabilitate the stability, productivity, diversity, and ecological integrity of refuge lands after a wildland fire as described in approved refuge management plans. The ESR Plan is tiered to the refuge CCP, FMP, and operations or step-down plans. Development of ESR Plan objectives is guided by resource management objectives, general management practices, and constraints identified in an approved CCP, habitat management plan, and/or supporting step-down plans.

If burned area ESR is required to reduce the effects of a wildland fire, then the refuge should request appropriate funding through the ESR fund. The Service representative at the National Interagency Fire Center administers the ESR fund. A rehabilitation and restoration survey, plan, and request must be prepared and submitted according to agency guidelines. Smaller incidents may only need simple plans prepared by refuge staff. Larger incidents with extensive rehabilitation efforts should employ an ESR team. An ESR team is composed of personnel who specialize in key disciplines of resource management and are experts in ESR Plan preparation. A formal request for an ESR team should be made in consultation with the Incident Management Team as soon as it appears that damage may be significant. Instructions for ESR team mobilization can be found in the NWCG mobilization guide. Delays in making a request may hinder funding approval and magnify the damage. Once an ESR team is employed, the project leader or their representative should provide guidance to the ESR team leader with expectations. The project leader, biologist, and Zone FMO will review all ESR plans. The final plan will be submitted to the Regional Office for review prior to submission to the Washington Office. Direction on ESR guidelines can be found in the Service Fire Management Handbook.

4.11. PREVENTION, MITIGATION AND EDUCATION

4.11.1. PREVENTION/MITIGATION

The objective of fire prevention activities is to prevent human-caused wildfires. The inadvertent or intentional ignition of wildland fuels by humans is illegal. All human-caused wildfires will be investigated at the earliest possible time. The investigation may range from a documented determination of cause by the IA crew to criminal investigation by a qualified arson investigator.

Educating the public on the value of fire as a natural process is important to increasing public understanding and support for the fire management program. The refuge will use the most appropriate and effective means to explain the overall future of the fire and smoke management programs. This may include supplemental handouts, signage, personal contacts, auto tour routes, or media releases. When deemed necessary, interpretive presentations will address the fire management program and explain the role of fire in the environment.

The public information program would include the following options.

1. The concepts of the prescribed burn program will be incorporated, as appropriate, in publications, brochures, and handouts.
2. During periods when prescribed burns are ignited, handouts will be prepared and distributed to all visitors entering areas of fire activity.
3. The fire management program may be incorporated into visitor contacts. Particular attention will be given when fires are conspicuous from roads or visitor use areas.
4. News releases will be distributed to the media as appropriate.
5. The public information outlets of neighboring and cooperating agencies and the Regional Office will be provided with all fire management information.
6. The fire management program will be discussed in informal talks with all employees, volunteers, residents, and neighbors.

5. Monitoring and Evaluation

The intent of this section is to document the processes for determining whether the FMP is being implemented as planned and fire-related goals and objectives are being achieved. Information obtained from monitoring is used to update the FMP and land management plans.

5.1. Fire Management Plan Monitoring

5.1.1. Annual Fire Management Plan Review

This FMP will be reviewed annually and updated as needed, upon local agency administrator approval. Revisions of FMPs with regional review and concurrence are required every 5 years and following completion of a new (or significantly revised) CCP or habitat management plan.

5.2. Hazard Fuels Treatment Monitoring

Any prescribed fire treatment will be monitored according the 2010 Pacific Region Hazardous Fuels Monitoring Framework. At a minimum, a perimeter will be collected of the treatment area and archived in the regional database.

5.3. Fire Critiques

Fire reviews will be documented and filed with the final fire report. The Zone FMO will retain a copy for the refuge files.

5.4. Fire Management Terminology

Terms in the FMP are defined by the NWCG, at http://www.nwcg.gov/pms/pubs/glossary.

Appendix A. *Directory (update annually)*

Name	Position	Office Phone	Extension	Cell Phone	Home
Erin Holmes	Project Leader	(503) 625-5944	221	(503) 816-1227	(971) 400-4405
John Gahr	Deputy Project Leader	(503) 625-5944	223	(503) 816-1666	(971) 239-9122
Greg Hagedorn	Zone Fire Management Officer	(541) 757-7236	205	(541) 740-5613	(503) 913-2883
Kolleen Irvine	Law Enforcement Officer	(503) 625-5944	230	(971) 832-1730	N/A
Sarah Gray	Administrative Assistant	(503) 625-5944	226	N/A	N/A
Kim Strassburg	Visitor Services Manager	(503) 625-5944	228	(503) 539-5194	N/A
Pete Schmidt	Refuge Biologist	(503) 625-5944	231	(503) 816-2007	N/A
John Schweitzer	Equipment Operator	(503) 625-5944	N/A	(503) 329-8384	N/A
Wildlife Center	N/A	(503) 625-5945	N/A	N/A	N/A

Appendix B. *Fire Management—Roles and Responsibilities*

Agency Administrator/Project Leader

- Is responsible for implementation of all fire management activities within the refuge, and will ensure compliance with USDOI, Service, and refuge policies.
- Selects the appropriate management responses to wildland fire.
- Coordinates refuge programs to ensure personnel and equipment are made available and utilized for fire management activities including fire suppression, prescribed burning, and fire effects monitoring.
- Ensures that the fire management program has access to refuge and resources when needed.
- Ensures that staff consider the fire management program during refuge-related planning and implementation.

Refuge Biologist

- Identifies prescribed burn units and biological objectives to the Zone FMO, notifies Zone FMO of prescribed fire project constraints, and ensures that refuge resources are available to accomplish prescribed fire and fire suppression objectives.
- Acts as the primary refuge resource management specialist during fire management planning and operations.
- Drafts wildland fire rehabilitation plans for project leader.
- Coordinates through project leader to provide biological input for the fire program to the Zone FMO.
- Assists in design and implementation of fire effects monitoring for the Zone FMO.
- Participates, as requested, and is appropriately trained in prescribed burning and wildland fire suppression.

Fire Management Officer

- Maintains oversight and review role for fire management activities on refuge lands.
- Responsible for all fire-related planning and implementation.
- Responsible for implementation of this FMP. This responsibility includes coordination and supervision of all prevention, pre-suppression, detection, wildland fire, prescribed fire, suppression, monitoring, and post-fire activities involving refuge lands.
- Prepares burn plans.
- Integrates biological refuge objectives into all fire management planning and implementation.
- Solicits program input from the project leader.
- Supervises prescribed fire planning.
- Responsible for planning, coordinating, and directing preparedness activities including fire training, physical fitness testing, and Interagency Fire Qualification System (IFQS) data entry, fire cache and equipment inventory accountability, maintenance, and operation, and cooperation with cooperative agencies.
- Responsible for setting up rural fire assistance agreements and grants.

- Responsible for setting up and overseeing WUI and hazardous fuels treatment contracts.
- Responsible for preparation of fire reports following the suppression of wildland fires and for operations undertaken while conducting prescribed fires.
- Prepares an annual report detailing fire occurrences and prescribed fire activities undertaken in each calendar year. This report serves as a post-year fire management activities review, as well as provides documentation for development of a comprehensive fire history record for the refuge.
- Submits budget requests and monitors FIREBASE funds.
- Nominates personnel to receive fire-related training, as appropriate.
- Responsible for interagency coordination.
- Ensures fire management policies are observed.
- When available, may serve as prescribed fire burn boss and propose prescribed fire projects.
- Prepares refuge fire prevention plan, and coordinates fire prevention with other employees.
- Assists in updates of this FMP, maintains fire records, reviews fire reports (DI-1202) for accuracy, and enters fire reports into FMIS.
- Maintains engines and fire-related equipment in state of readiness.

Fire Management/Suppression Personnel

- Consists of all refuge personnel, whether permanent or seasonal, who meet the minimum standards set by the NWCG for firefighters.
- Are fully equipped with proper PPE, have taken and passed the minimum classroom training, and meet physical fitness standards required.
- Undertake fire management duties as assigned by the qualified IC on each suppression action or by the prescribed fire burn boss on each prescribed fire project.
- Responsible for their PPE and physical conditioning, qualifying annually with the work capacity test.

Incident Commander

ICs (of any level) use strategies and tactics as directed by the project leader and WFDSS where applicable to implement selected objectives on a particular incident. A specific Delegation of Authority (0 of FMP) will be provided to each IC prior to their assuming responsibility for an incident. Major duties of the IC are given in the NWCG Fireline Handbook.

Initial Attack Teams

IA teams consist of experienced, fully qualified firefighters. Teams will be prepared and equipped with hand and power tools as needed and will be dispatched self-sufficient to function up to 24 hours without additional support.

Employees participating in any wildland fire activities on Service or cooperator lands will meet fitness requirements established in PMS 310-1, except where Service-specific fitness requirements apply.

Resource Advisor
Resource advisors (RAs) are technical specialists appointed by the agency administrator; they report to the IC or designee and provide guidance for natural and cultural resource protection from suppression operations. The RA provides input to the IC in the development of fire suppression strategies and tactics to minimize or mitigate the expected impacts of fire and fire suppression actions upon natural and cultural resources. The RA also provides input required for the development of rehabilitation plans. RA responsibilities include providing analysis, information, and advice to fire managers for areas of concern, including:

- Critical watersheds, riparian areas, fisheries, and water sources
- Threatened or endangered species
- Prehistoric and historic archaeological sites and cultural landscapes
- Fuelbreaks—locations and specifications
- Urban interface impact—structures and improvements
- Hazardous materials

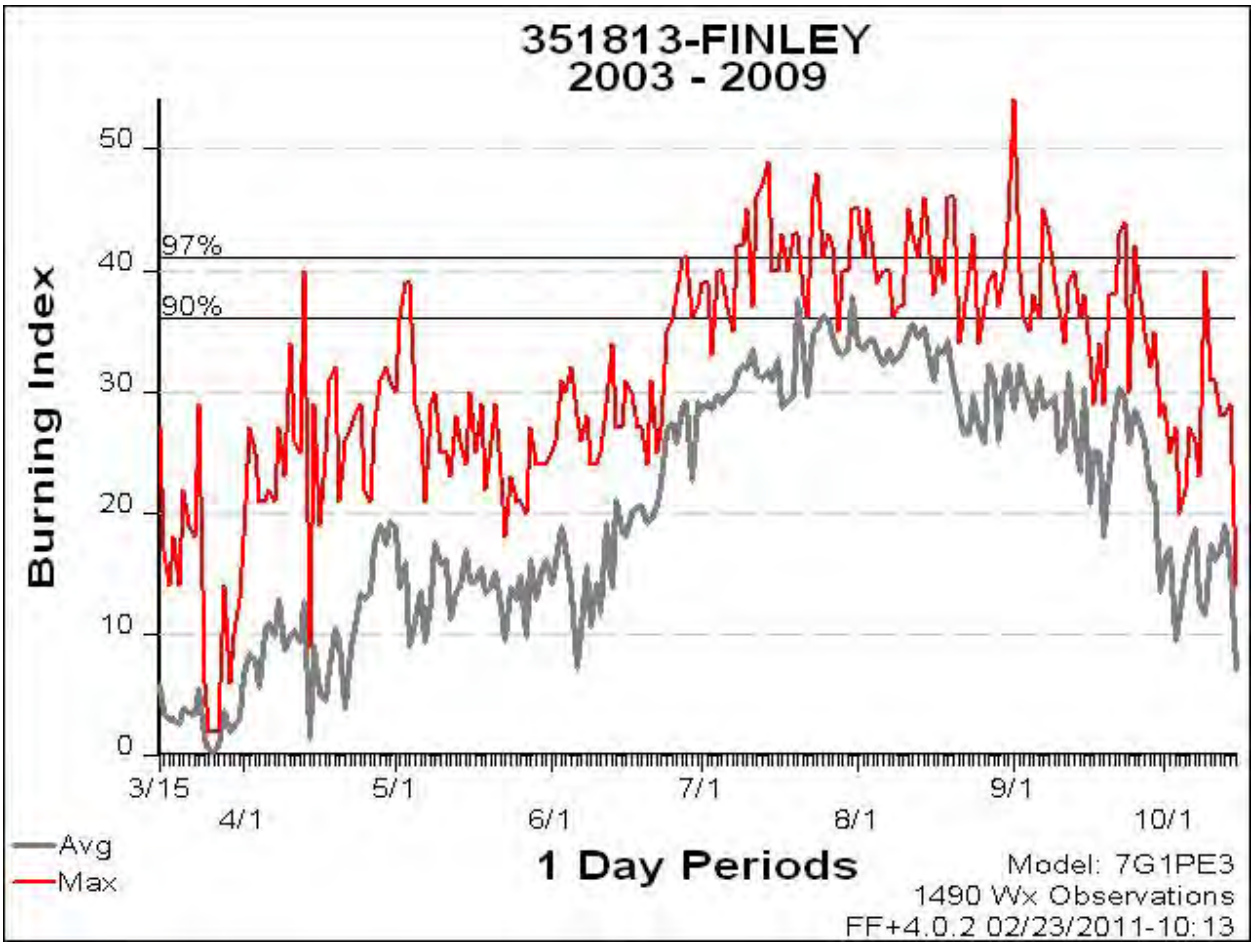
The RA also:

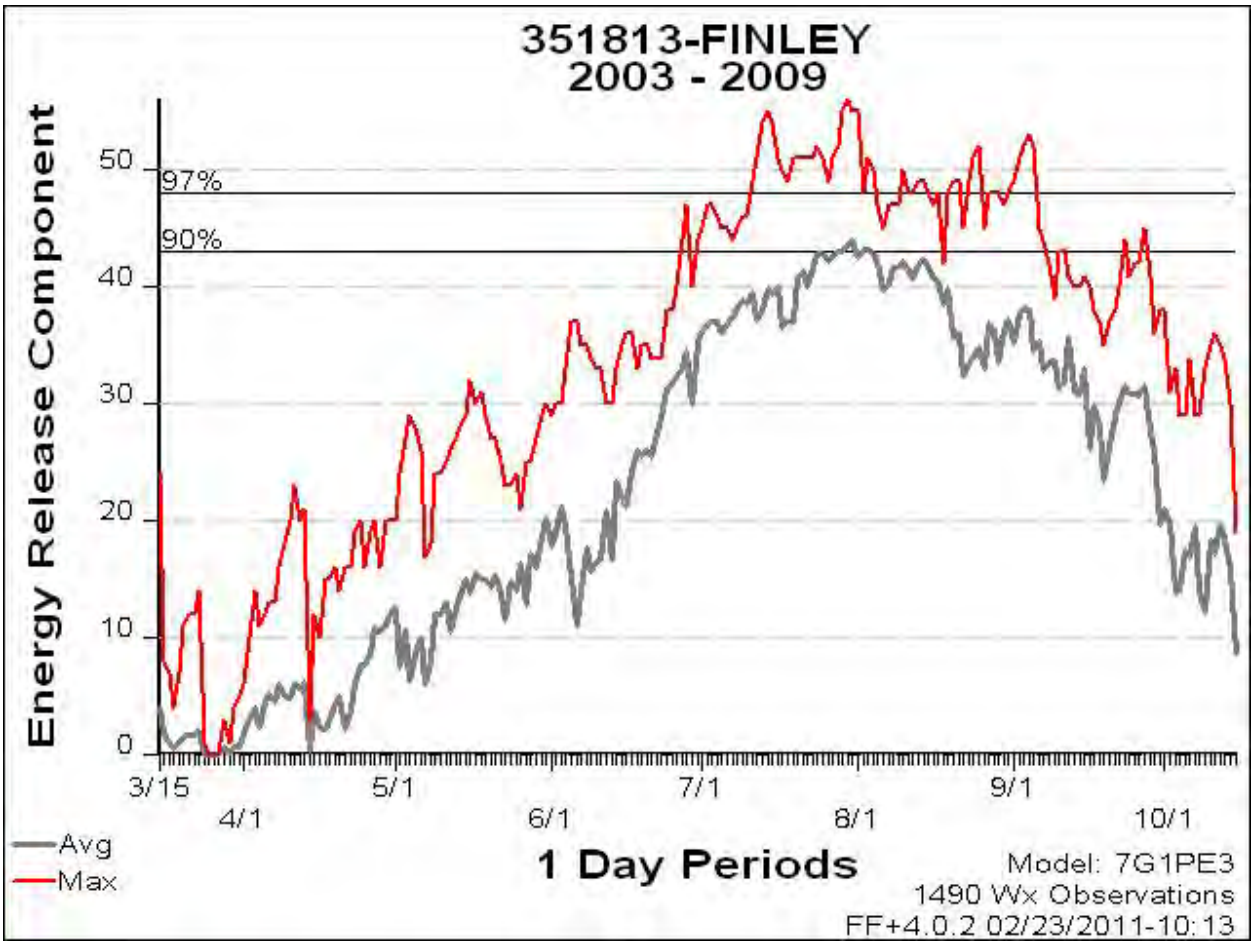
- Assists the planning function in developing fire maps and identifying areas of concern,
- Determines environmental restrictions commensurate with FMP resource protection in the fire area,
- Provides recommendations to fire management personnel and agency administrators for fire suppression rehabilitation needs,
- Documents potential and actual suppression/fire-related resource impacts and the rationale for protection of priority areas, and
- Provides resource information to local IA ICs, dispatchers, or other fire personnel during pre-season training and planning meetings (NWCG 1996).

Appendix C. *Fire Danger Indices*

The fire season at Tualatin River National Wildlife Refuge can begin in July and continue through October during drought years. Fire season can be influenced by both moist Pacific weather systems and drying trends created through a warm easterly flow. The wettest months are November through March, when over 70 percent of the precipitation occurs. There is a pronounced warm, dry period beginning in mid-July and running through late September. This period accounts for less than 10 percent of the average annual precipitation. During this period, temperatures are generally at their highest levels (80 to 90 degrees Fahrenheit) and relative humidity at the lowest (20% to 30%).

Wildland fire danger in the United States is characterized by a system called the National Fire Danger Rating System (NFDRS). This system has indices that are used to display and provide context to fire danger on a subregional scale. The most accurate way of displaying the relationship of weather and fuels to fire danger in the short term at the refuge is through the NFDRS Burning Index, or BI. The BI is an estimate of the potential difficulty of containment of a wildland fire as it relates to the flame length at the head of the fire. The BI value is a function of the spread component (how fast the fire could spread) and the energy release component (how hot the fire could burn). The BI is scaled such that a BI value of 40 would indicate a predicted average flame length of 4 feet. Wildland fires where the flame length exceeds 4 feet are judged to be too hazardous for hand crews and engines to attack along the direct edge of the fire. The BI may also communicate the relative fire danger in a rating area. The ninetieth percentile defines the index that 90 percent of all BIs are at or below for the time period calculated, and the same is true for the ninety-seventh percentile. When overlaid with historical fire occurrence, a relationship with fire weather can assist with more accurate preparedness planning. A representative NFDRS fire weather station is located 70 miles south of the refuge area at W.L. Finley National Wildlife Refuge. The following graphs display seasonal fire danger trends for the period from 2003 to 2009.


351813-FINLEY
2003 - 2009
Burning Index
50
40
30
20
10
0
97%
90%
3/15
4/1
5/1
6/1
7/1
8/1
9/1
10/1
Avg
Max
1 Day Periods
Model: 7G1PE3
1490 Wx Observations
FF+4.0.2 02/23/2011-10:13


351813-FINLEY
2003 - 2009
Energy Release Component
50
40
30
20
10
0
97%
90%
3/15
4/1
5/1
6/1
7/1
8/1
9/1
10/1
1 Day Periods
Avg
Max
Model: 7G1PE3
1490 Wx Observations
FF+4.0.2 02/23/2011-10:13

Appendix D. *Dispatching Plans*

FIRE DISPATCH PLAN 2012
TUALATIN RIVER NATIONAL WILDLIFE REFUGE

To comply with Service policy these procedures should be followed for wildland fire initial response on our refuges.

1. Call 911 for emergency management services for assistance. Provide dispatcher with fire size up.
2. Inform refuge project leader or refuge manager.
3. Utilize qualified engine bosses that are responding from our interagency partners to supervise suppression activities.
4. Engines require two qualified firefighters to operate. If responding alone, scout fire and complete fire size-up documentation and wait for assistance.
5. Be safe; no fire is worth risking your safety and well being.

You cannot legally participate in any extended attack or prescribed fire activities until you have cleared the work capacity process and fire refresher for 2011.

Elements of Initial Fire Size-up:

- Location of smoke or fire: (plot on map if possible)
- Location, name, and telephone # of reporting party
- Estimated size
- Fuel type: (1) Grass (2) Brush (3) Timber (4) Slash
- Fire behavior: (1) Smoldering (2) Creeping (3) Running (4) Torching (5) Crowning
- Structures threatened: (1) Yes (2) No
- Weather conditions: temperature, sky/cloud cover, wind/speed/direction
- Slope: (1) 0-25% (2) 26-40% (3) 41-55% (4) 56+%
- Potential for spread: (1) Low (2) Moderate (3) High
- Additional resources needed for control

CONTACT INFORMATION

Name	Position	Office Phone	Extension	Cell Phone	Home
Erin Holmes	Project Leader	(503) 625-5944	221	(503) 816-1227	(971) 400-4405
John Gahr	Deputy Project Leader	(503) 625-5944	223	(503) 816-1666	(971) 239-9122
Greg Hagedorn	Zone Fire Management Officer	(541) 757-7236	205	(541) 740-5613	(503) 913-2883
Kolleen Irvine	Law Enforcement Officer	(503) 625-5944	230	(971) 832-1730	N/A
Pam Ensley	Regional Fire Management Coordinator	(503) 231-6174	n/a	(503) 781-7978	N/A
Brian Gales	Regional Fire Operations Specialist	(503) 231-6769	n/a	(541) 778-0372	N/A
Brett Fay	Regional Fuels Specialist	(503) 872-2756	n/a	(503) 347-8194	N/A

Appendix E. *Memorandum of Understanding, Tualatin Valley Fire and Rescue*

Appendix F. *Memorandum of Understanding, Gaston Rural Fire Department*

Appendix G. *Example: Delegation of Authority to Incident Commanders*

Subject: Delegation of Authority to Manage Type VI and Type V Incidents

To: ICT5, ICT5(T), ICT4, ICT4 (T) Fill in Name

From: ********, Project Leader, U.S. Fish and Wildlife Service, Tualatin River National Wildlife Refuge
You are delegated authority to manage the suppression of Type V Incidents to which you are assigned and qualified as Incident Commander, in accordance with the following guidelines, priorities, and constraints, until such time as you are relieved of command by my representative or me.

Goals and constraints for managing Type V Incidents are as follows:

- Ensure the safety of firefighters and the public.
- Adhere to the 10 Standard Fire Orders, LCES, and 18 Situations at all times.
- Protect life and property.
- Be cost efficient when ordering resources.
- Follow all guidelines that pertain to the use of retardants and foam.
- Maintain communication with Hanford Fire Dispatch and Complex Duty Officer at all times.
- Be considerate of cooperating agency policies when assisting in fire suppression on non-Service lands.
- Use appropriate management response suppression tactics as defined in the Fire Management Plan.
- Maintain accurate records for fire reporting and documentation.
- Protect fire origin and order an investigation on fires where cause may be other than lightning.
- Conduct regular tailgate safety sessions to discuss job hazards and what measures are necessary to mitigate accidents to injuries. Document, as needed and submit any safety records to Chris Schulte, or his acting.
- Utilize information/processes in the “Incident Response Pocket Guide” and “Wallet Card.”

Fire Management Officer, Greg Hagadorn, or his designee have been assigned as my representative. He, or his acting, is authorized to make decisions and recommendations regarding the management of Type V and Type VI Incidents within the level of authority delegated to me.

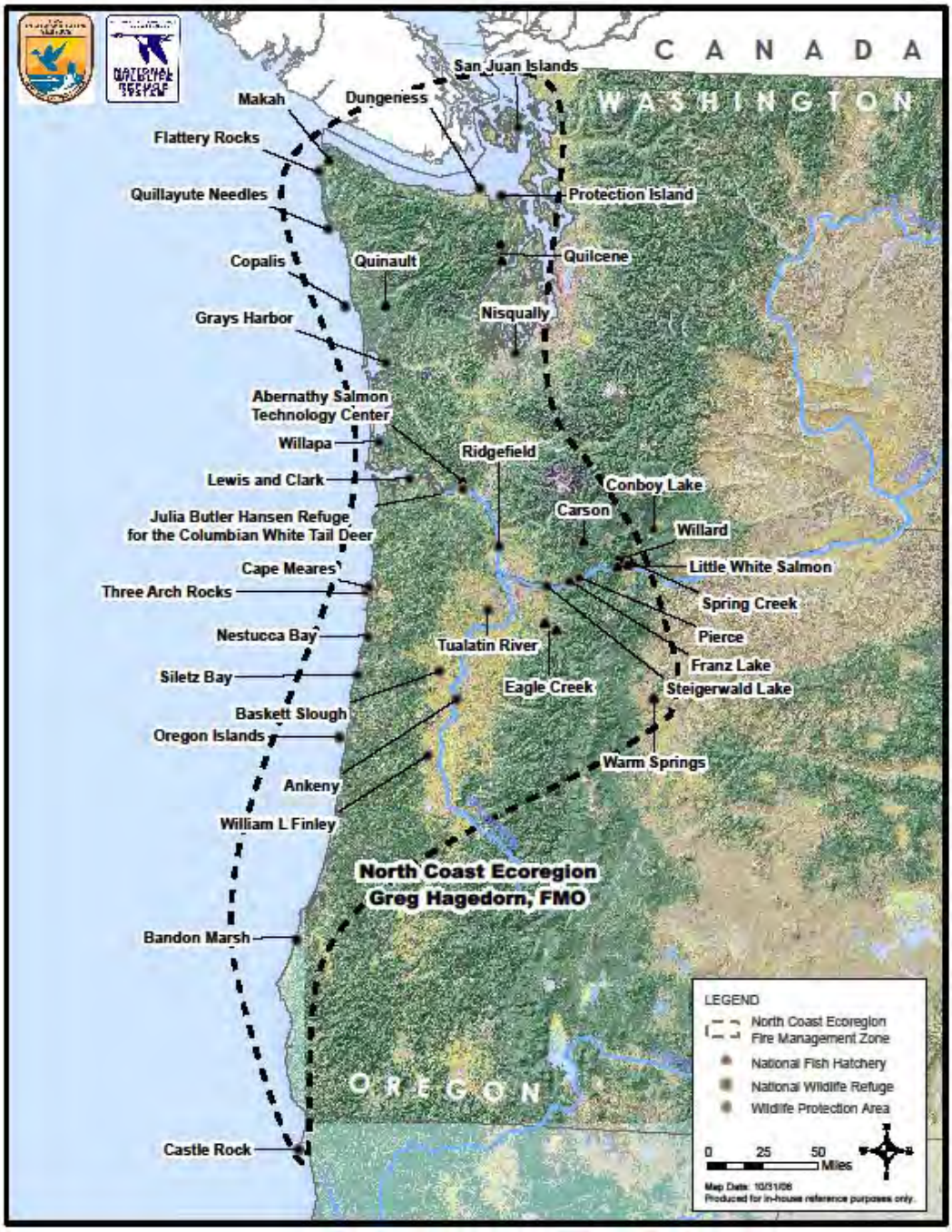
/s/******

Tualatin River National Wildlife Refuge
Project Leader

Appendix H. *Annual Review Check List*

Element	Yes	No	Comment
1. Date FMP was approved _____ • Annual Review yrs 1 – 4 by Refuge Manager • Year 5 of Plan, Contact Complex FMO. FMP requires revision and Regional Director approval.			
2. Will the FMP continue to adequately provide for firefighter and public safety as the first priority in every fire management activity this year?			
3. Does this FMP continue to support land and resource management Plans? • Completion of CCP or new habitat management plan might require more extensive FMP revision.			
4. Were there any significant fire management activities from the previous year that were not adequately addressed within the scope of this FMP?			
5. Does the direction in this Plan remain economically viable given the values needing protection, and the costs to administer?			
6. Does this FMP continue to be based on best available science?			
7. Does the FMP provide for adequate response to wildland fire (wildfire) and prescribed fire (if applicable)? • Directories/Contact List(s) updated • Agreements and Operating Plans current • Staffing/equipment meet Service policy and ready • Annual work and Prescribed Burn Plans completed • Seasonal Assessment made by Complex FMO			
8. Were there additional lands added to the refuge last year? • Total acres to amend _____ • Burnable acres _____			
9. If additional lands were added, will environment compliance requirements (EA for this FMP) adequately allow for fire management program activities to be conducted if appropriate?			
10. Based on FMO advice, are there changes in national fire policy or direction that now conflict with direction within the FMP? • Policy changes warrant an amendment. • Policy changes are significant – need for immediate revision. • Policy changes can be incorporated within the 5-year revision.			
11. Considering the responses above, can this FMP be amended without further review? • If yes, attach amended information, including maps. Refuge Manager approval. Notify the Complex FMO. • If no, most likely the FMP and/or environmental compliance require Plan revision and Regional Director approval. Contact Complex FMO for assistance.			

Appendix I. *Zone FMO Area of Responsibility*



Document continues on the following page.

Appendix P
Maps

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Appendix A
Appropriate Use Findings

Appendix B
Compatibility Determinations

Appendix C
Implementation

Appendix D
Wilderness Review

Appendix E
Biological Resources of Concern

Appendix F
Statement of Compliance

Appendix G
Integrated Pest Management

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Glossary

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Contributors

Appendix J
Acquisition History

Appendix K
Public Involvement

Appendix L
Hydrological Modeling

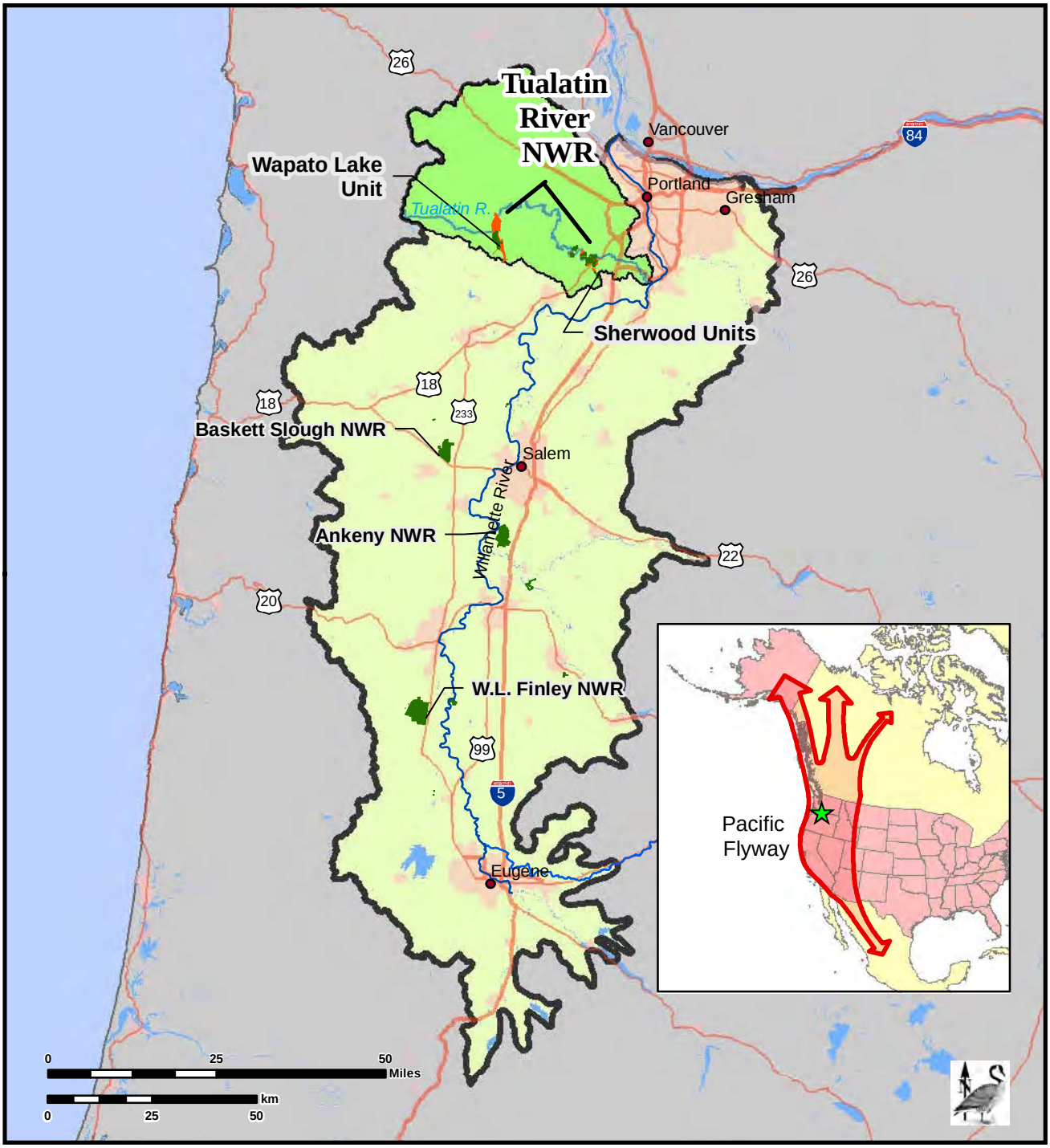
Appendix M
References

Appendix N
List of Refuge Species

Appendix O
Fire Management Plan

Appendix P
Maps

Map 1 ***Willamette Valley Ecoregion, Regional Context***



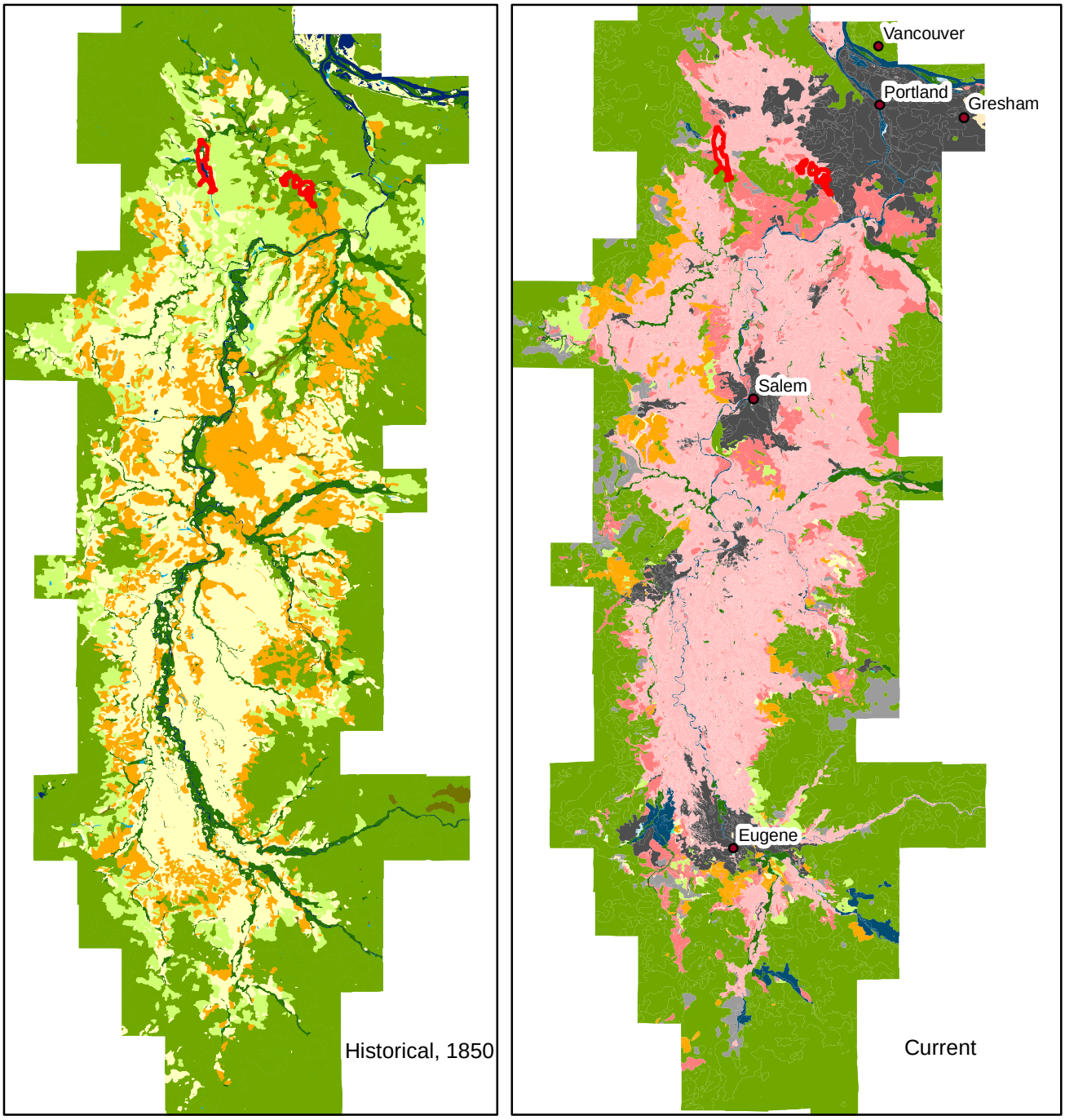
LEGEND

- Tualatin River NWR Approved Boundary
- USFWS Refuges
- Tualatin River Watershed
- Urban Growth Boundary
- Water
- Willamette Valley Ecoregion

Map Date: 2/08/2012 File:12-160-1.mxd

The back sides of maps are blank to improve readability.

Map 2 ***Willamette Valley, Historical (1850) and Current Land Cover***



Legend

- TRNWR Approved Refuge Boundary
- Closed forest; Riparian & Wetland
- Closed forest; Upland
- Woodland
- Emergent wetlands
- Prairie
- Oak Savanna
- Shrubland
- Water
- Disturbed Forest or Shrub
- Cultivated or Pasture
- Developed

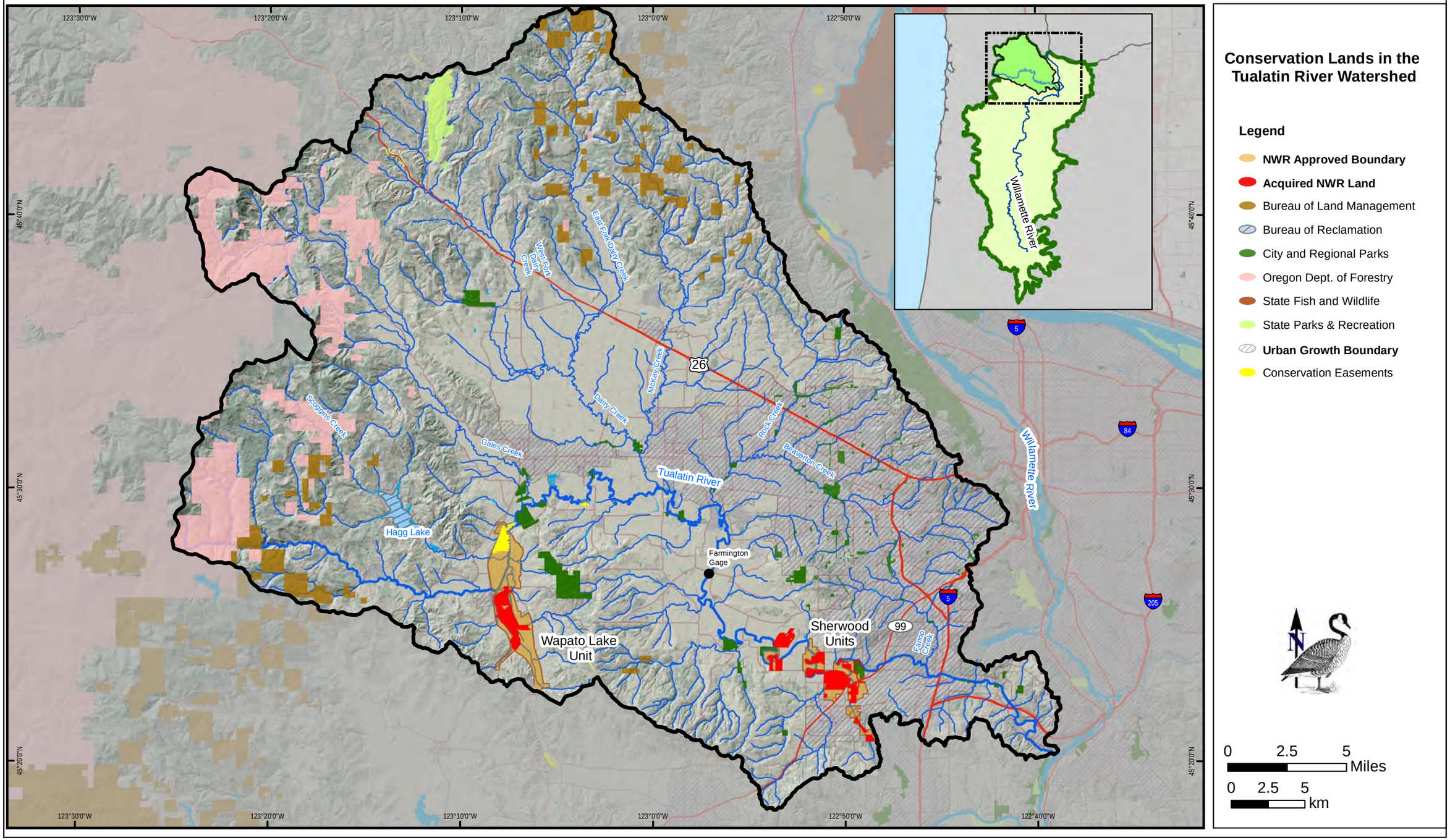
0 5 10 20 30 40 Miles

0 5 10 20 30 km

Map Date:2/08/2012 File: 12-160-2.mxd

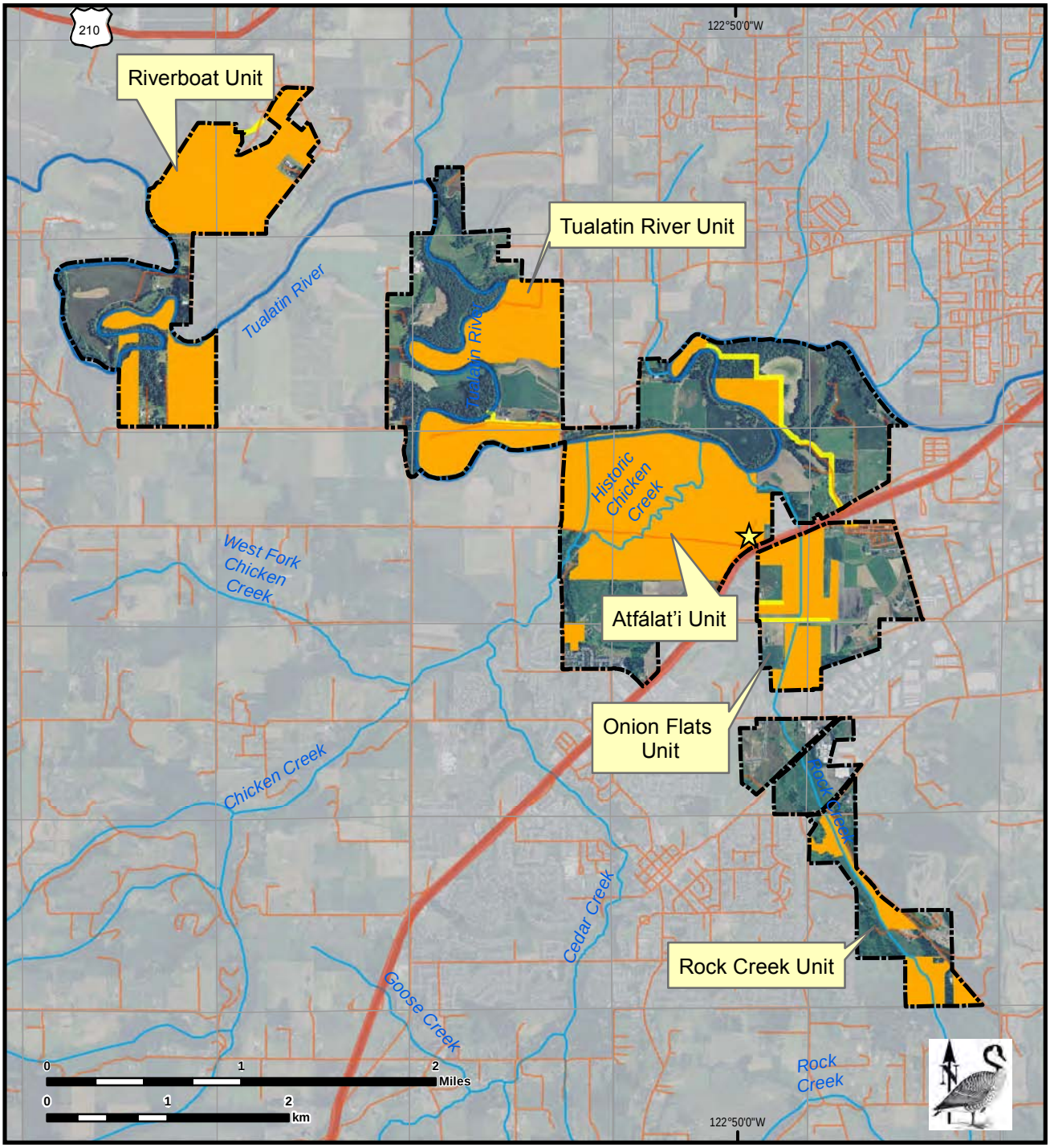
The back sides of maps are blank to improve readability.

Map 3 — Tualatin River Watershed and Conservation Lands



The back sides of maps are blank to improve readability.

Map 4 ***Sherwood Units, Land Status***



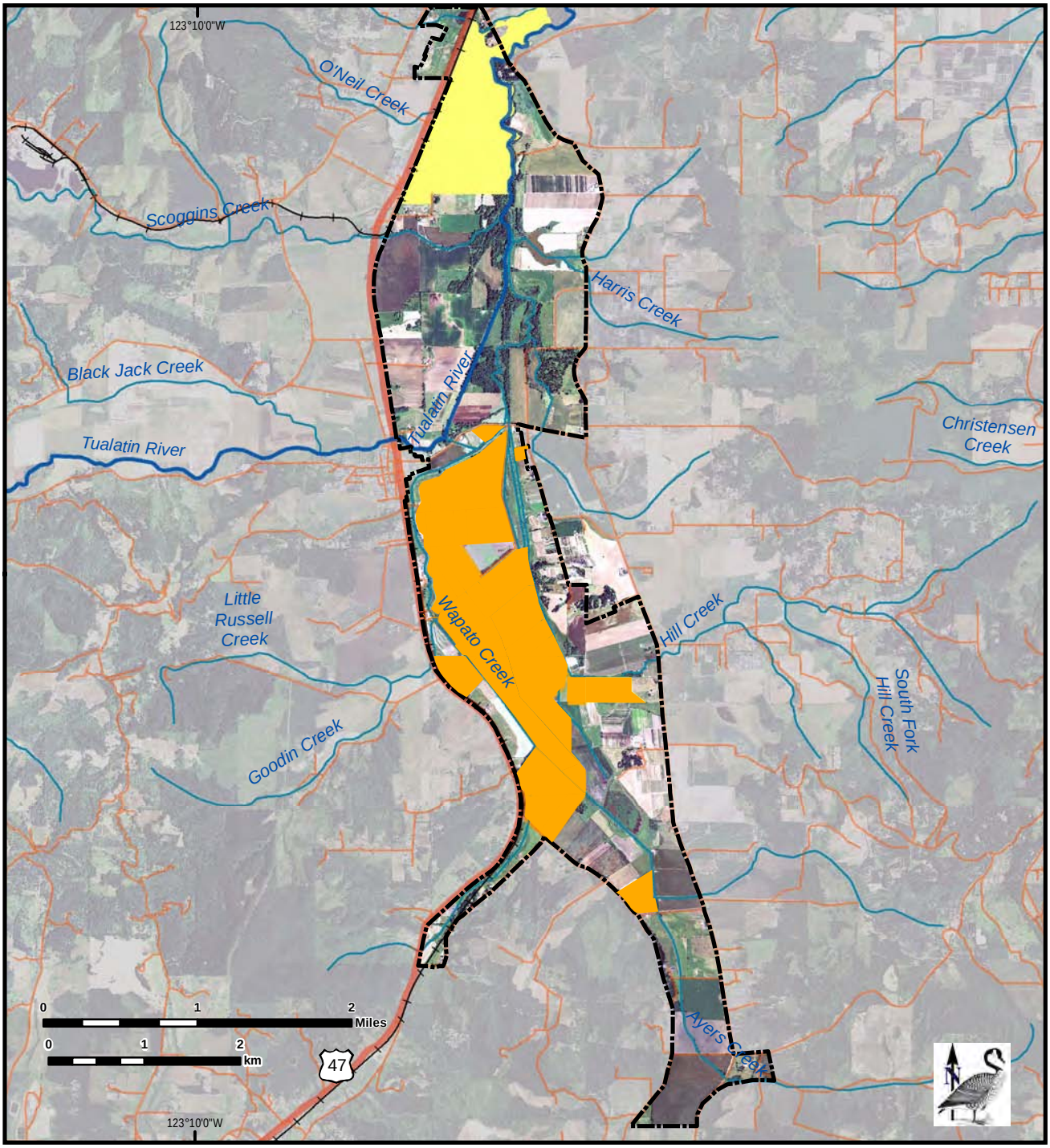
Legend

- Headquarters & Visitor Center
- Approved Boundary
- Managed by the Refuge
- Easements
- Major Highways
- Other Roads

Map Date:2/08/2012 File: 12-160-2.mxd

The back sides of maps are blank to improve readability.

Map 5 ***Wapato Lake Unit, Land Status***



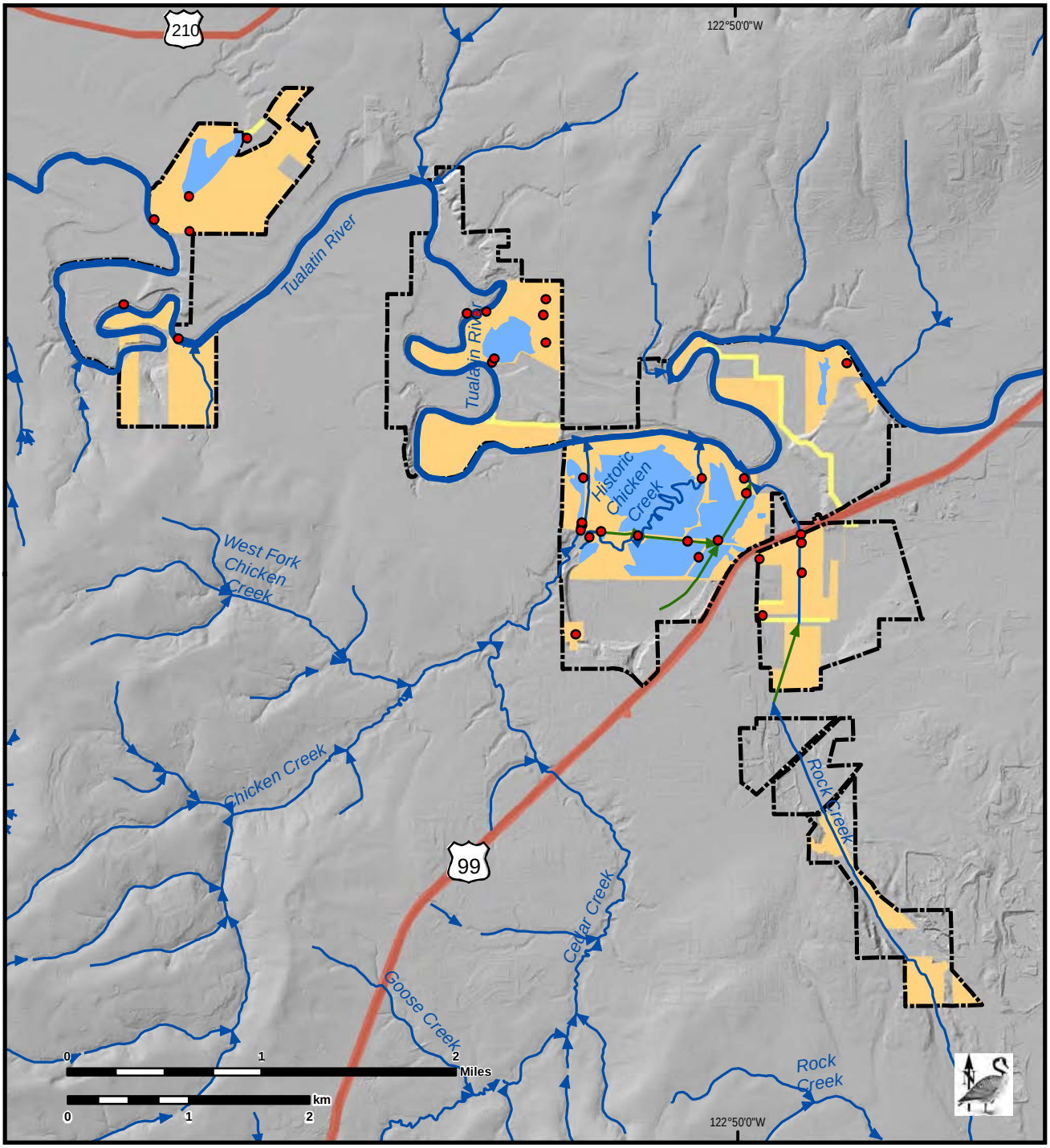
Legend

- Approved Boundary
- Managed by the Refuge
- Natural Resource Conserservation Service Easement
- Major Highways
- Other Roads

Map Date:2/08/2012 File: 12-160-2.mxd

The back sides of maps are blank to improve readability.

Map 6 ***Sherwood Units, Hydrology***



Legend

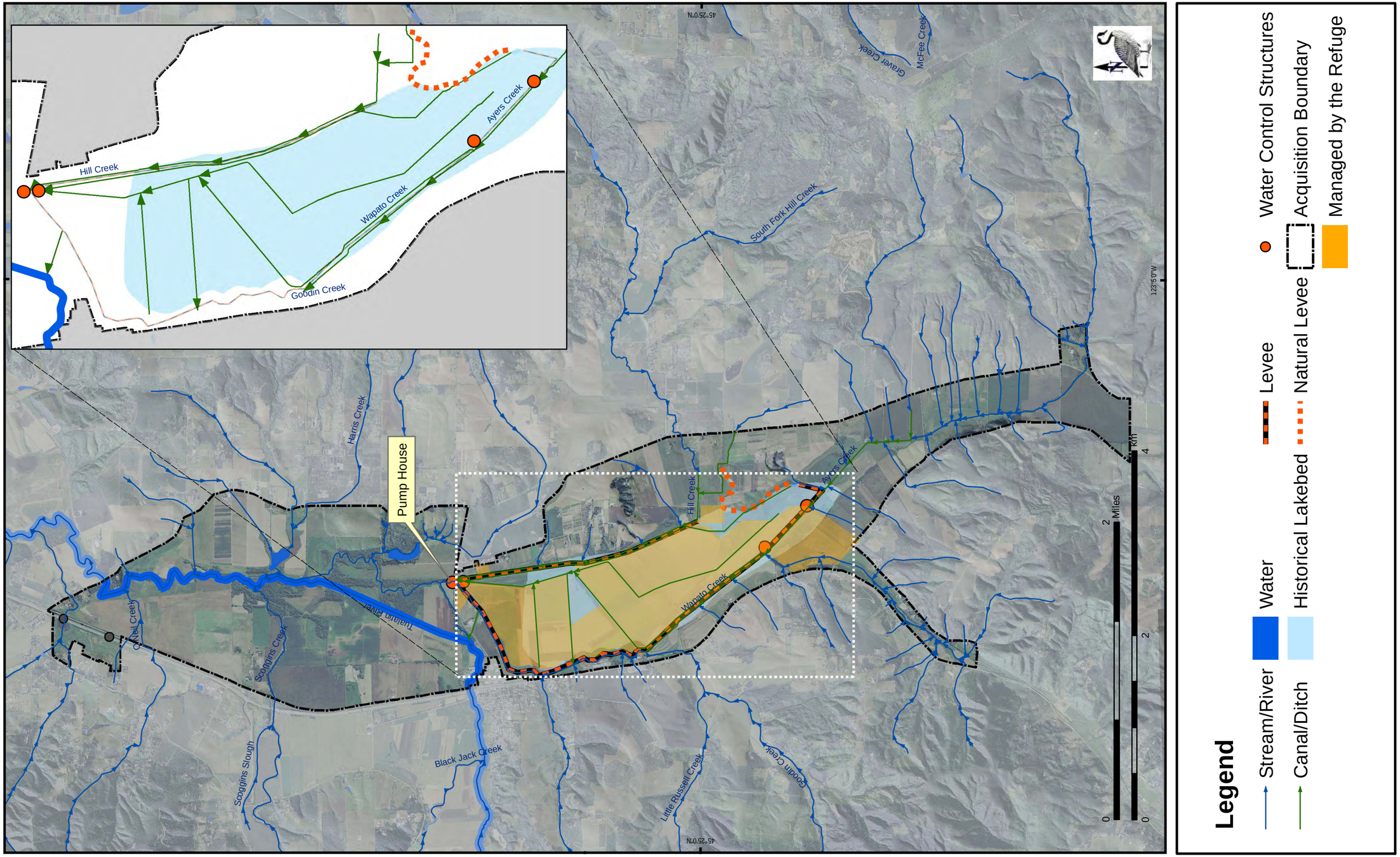
- Stream/River
- Canal/Ditch
- Herbaceous Wetland
- Water Control Structures
- Approved Boundary
- Managed by the Refuge
- Easements

Map Date:2/08/2012 File: 12-160-6.mxd

The back sides of maps are blank to improve readability.

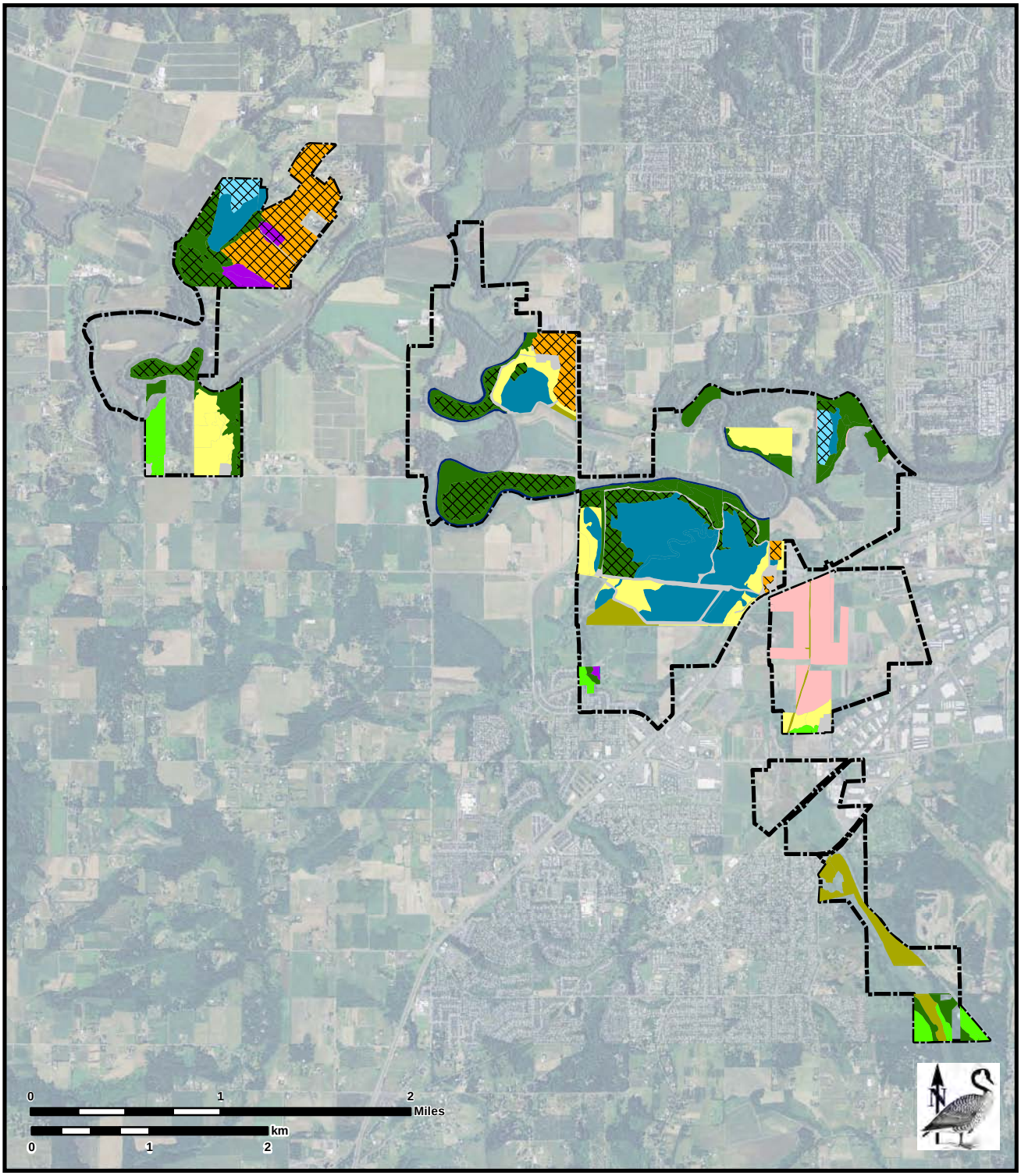
Map 7

Wapato Lake Unit Hydrology



The back sides of maps are blank to improve readability.

Map 8 ***Sherwood Units, Habitat Alternative 1***



Legend

- Habitat Currently in Restoration
- Water
- Herbaceous Wetland
- Prairie - Wet
- Riparian Forest
- Mixed Forest
- Scrub-Shrub Wetland
- Oak Savanna & Prairie
- Ruderal Wetland
- Ruderal Upland
- Cultivated
- Developed
- Approved Boundary

Ruderal communities are vegetation resulting from succession following anthropogenic disturbance of an area. They are generally characterized by unnatural combinations of native species or primarily invasive nonnative species, such as disturbed range lands

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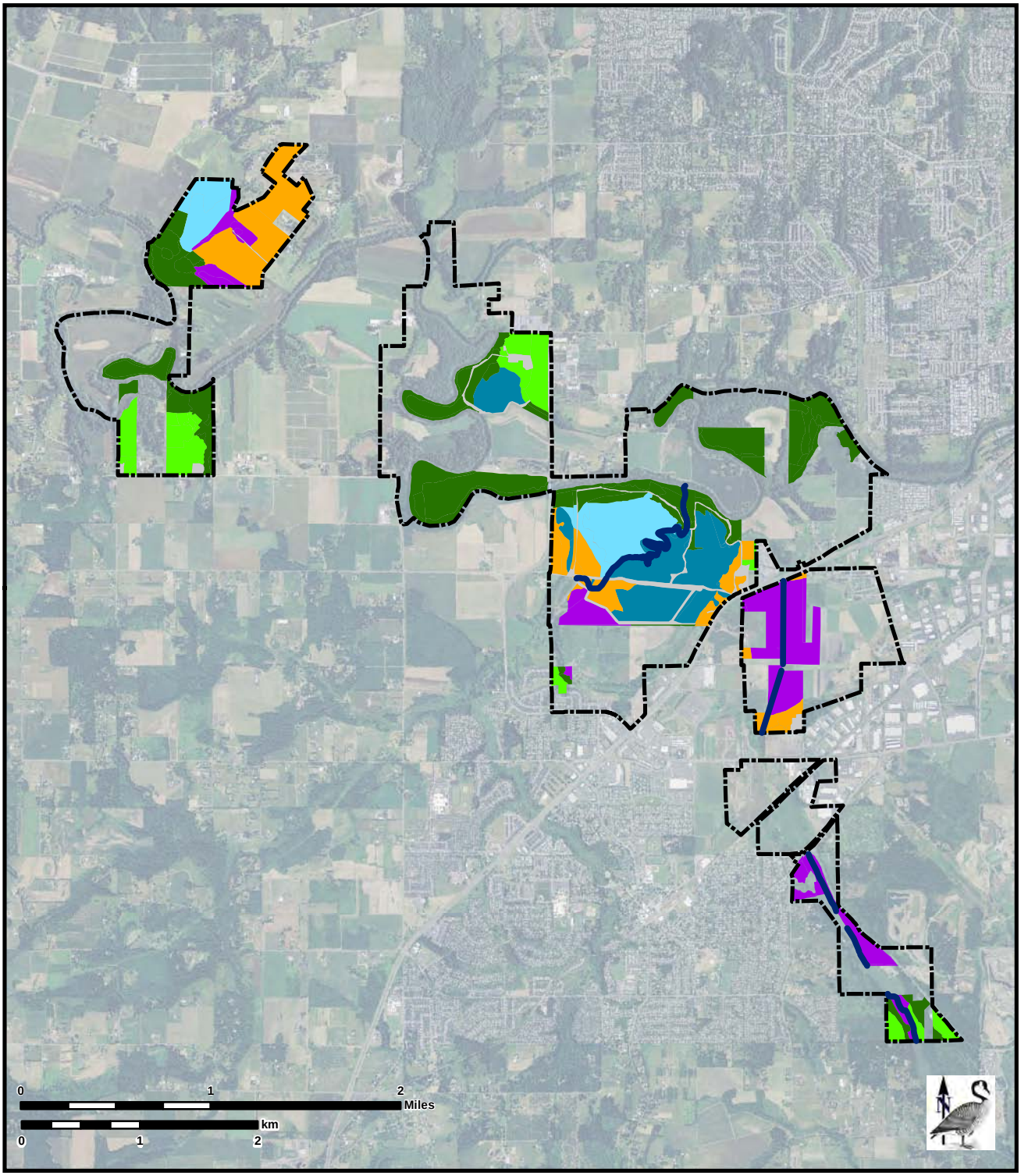
Map 9 ***Sherwood Units, Habitat Alternative 2***



Legend

- Developed
- Herbaceous Wetland
- Mixed Forest
- Oak Savanna & Prairie
- Prairie - Wet
- Riparian Forest
- Scrub-Shrub Wetland
- Approved Refuge Boundary
- Restored Streams

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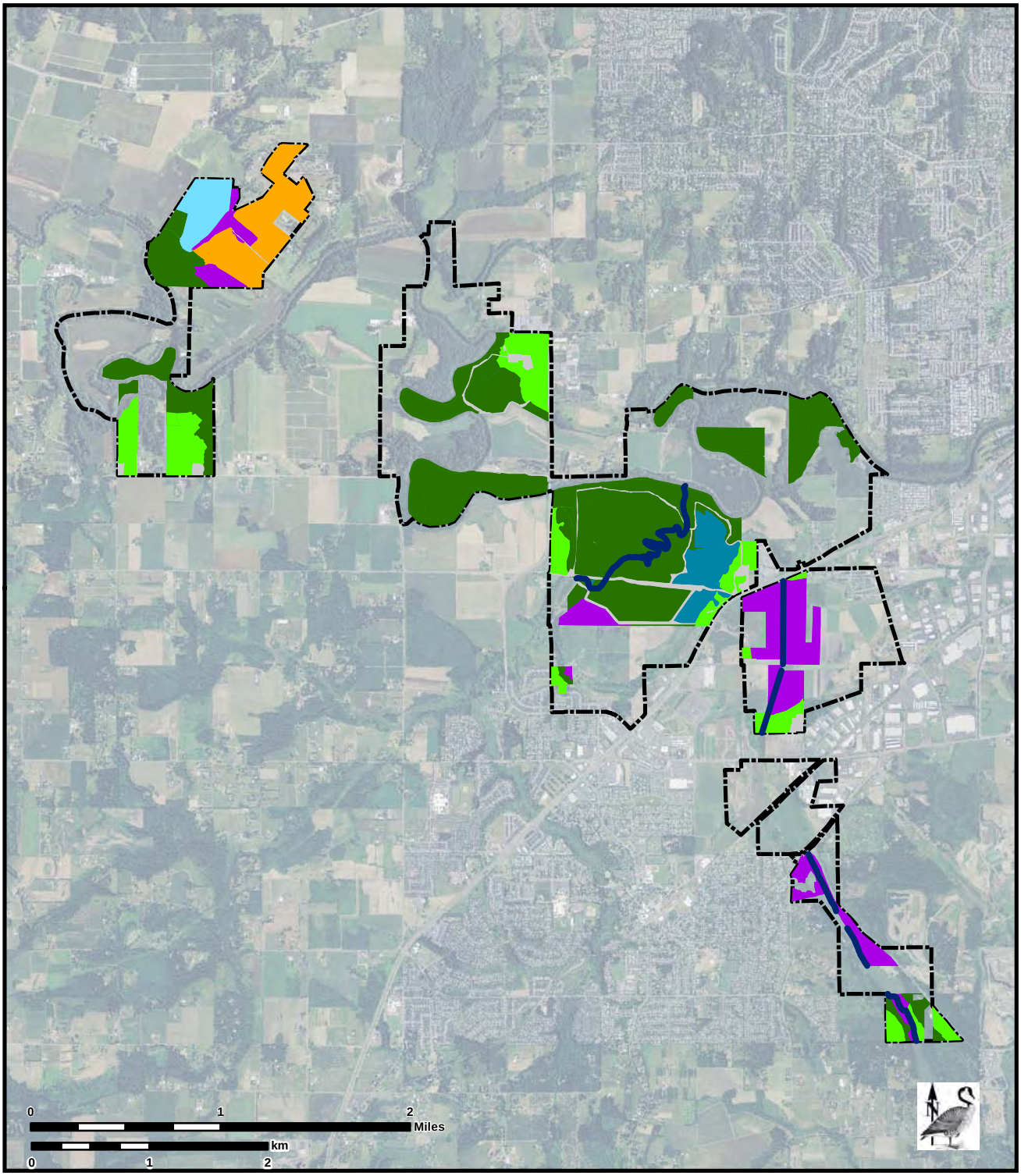
Map 10 ***Sherwood Units, Habitat Alternative 3***



Legend

- Developed
- Herbaceous Wetland
- Mixed Forest
- Oak Savanna & Prairie
- Prairie - Wet
- Riparian Forest
- Scrub-Shrub Wetland
- Approved Refuge Boundary
- Restored Streams

Map Date:2/08/2012 File: 12-160-10.mxd

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Map 11 ***Atfálat'i Unit, Public Use, Alternatives 1 and 3***

Restroom
Trailhead
Observation Deck
Photo Blind
Study Site
Bus Stop
Visitor Info
Wildlife Center
Trails
Approved Refuge Boundary
Outside of Approved Refuge Boundary
Inside Approved Boundary

Map Date:2/08/2012 File: 12-160-11.mxd

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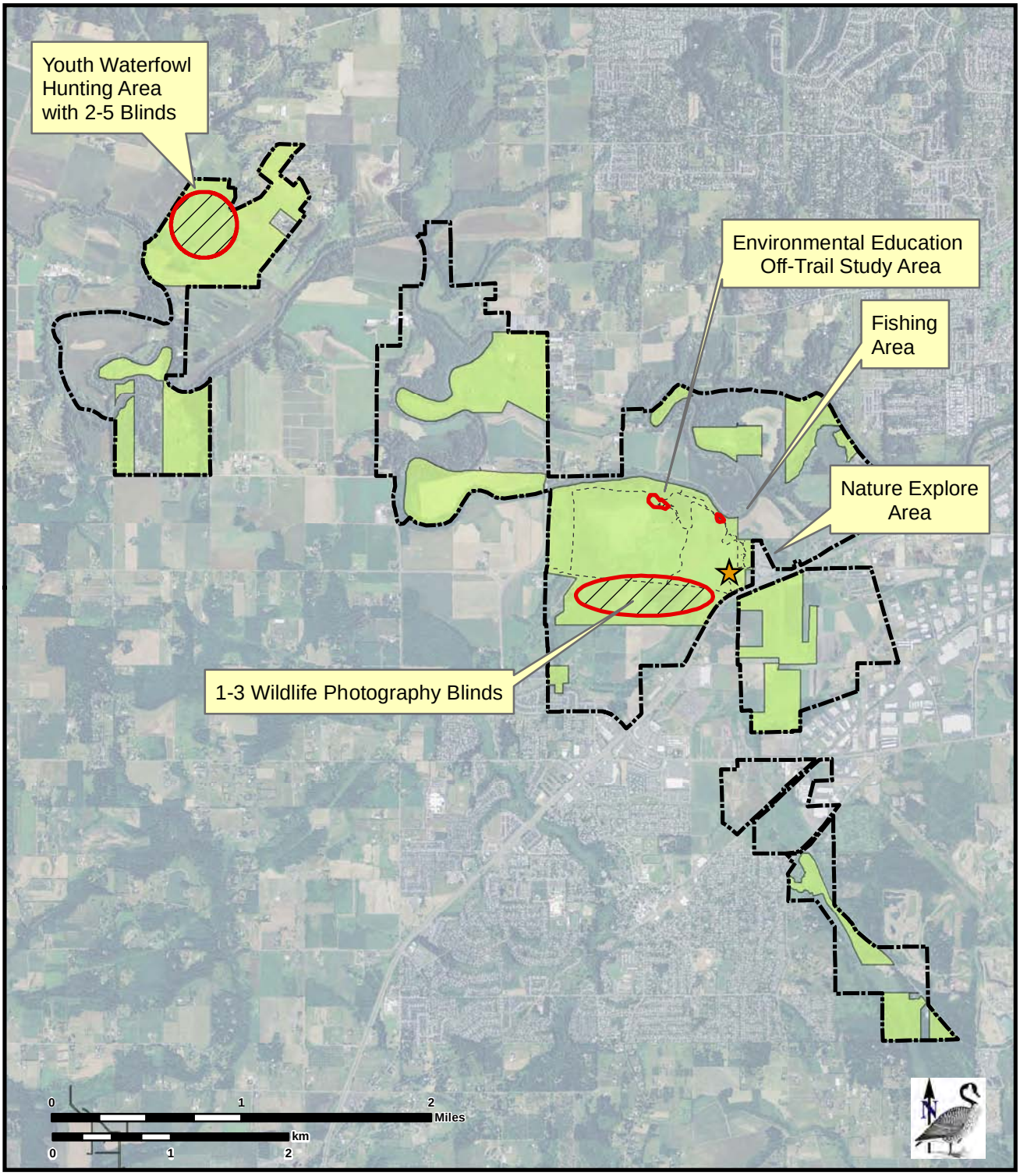
Map 12 ***Sherwood Units, Public Use Opportunity Areas for Alternative 2***



Legend

- Wildlife Center
- Approximate Public Use Opportunity Areas
- ExistingTrails
- Approved Refuge Boundary

Map Date:2/08/2012 File: 12-160-12.mxd

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Rough-skinned newt
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