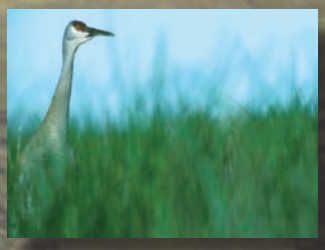
U.S. Fish & Wildlife Service

Klamath Marsh National Wildlife Refuge

Final Comprehensive Conservation Plan and Environmental Assessment

June 2010



Disclaimer

CCPs 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.

Klamath Marsh National Wildlife Refuge

Final Comprehensive Conservation Plan

Prepared by:
U.S. Fish and Wildlife Service
Pacific Southwest Region

Klamath Basin National Wildlife Refuge Complex
4009 Hill Road
Tulelake, CA 96134

Refuge Conservation Planning Branch
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Approved: _____ Regional Director

Date: June 14, 2010

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Contents

Figures and Tables

Chapter 1. Introduction, Purpose and Need, and Planning Background

1.1 Introduction

Klamath Marsh National Wildlife Refuge (Klamath Marsh Refuge or Refuge) is located in south central Oregon in Klamath County at the extreme northern edge of the Klamath Basin (Figure 1-1). The Refuge is situated about 65 miles north of Klamath Falls, Oregon, and about 105 miles south of Bend, Oregon. The Refuge is situated near the east slope of the Cascade Mountain Range between the historic Mount Mazama (Crater Lake—about 15 miles to the west) and the sage-dominated plains of eastern Oregon that begin about 45 miles to the east. The 40,885-acre Refuge is managed by the U.S. Fish and Wildlife Service (Service) and protects one of the largest remaining freshwater marshes in the Pacific Northwest. The Refuge is part of the Klamath Basin National Wildlife Refuge Complex (Complex) headquartered in Tulelake, California, about 90 miles to the south. The Complex office oversees the operations of six refuges within the Klamath Basin, including Klamath Marsh Refuge. The Refuge provides important breeding and migration habitat for migratory birds in the Pacific Flyway. The entire Klamath Marsh Refuge lies within lands that made up the former historic Klamath Reservation. The Klamath Tribes, comprised of the Klamath and Modoc tribes and the Yahooskin Band of Snake Indians, utilize Refuge lands to exercise treaty subsistence hunting, fishing, and gathering rights.

The U.S. Fish and Wildlife Service (Service) prepared this final Comprehensive Conservation Plan (Plan) to guide Refuge management for the next 15 years. The purposes of this Plan are:

- To provide a clear statement of direction for the management of the Refuge during the lifetime of the Plan
- To provide long-term continuity in Refuge management
- To communicate the Service's management priorities for the Refuge to its neighbors and the public
- To provide an opportunity for the public to help shape the future management of the Refuge
- To ensure that management programs on the Refuge are consistent with the legal and policy mandates for the National Wildlife Refuge System (Refuge System) and the purpose of the Refuge as set forth in establishing documentation
- To ensure that management of the Refuge is, to the extent practicable, consistent with Federal, state, and local plans
- To provide a basis for budget requests to support the Refuge's needs for staffing, operations, maintenance, and capital improvements
- To evaluate existing and proposed uses on each of the Refuge to ensure that they are compatible with the Refuge purposes; the Refuge System mission; and the maintenance of biological integrity, biodiversity, and environmental health

1.2 Need for this CCP

No formal management plan currently exists for the Refuge. The National Wildlife Refuge System Improvement Act of 1997 (16 United States Code [USC] 668dd-668ee) (1997 Improvement Act) requires that all refuges be managed in accordance with an approved Plan by 2012. Under the 1997 Improvement Act, the Refuge System is to be consistently directed and managed to fulfill the specific purpose(s) for which each refuge was established and to fulfill the Refuge System Mission. The planning process helps the Service achieve the Refuge purposes and the Refuge System mission by identifying specific goals, objectives, and strategies to implement on each refuge.

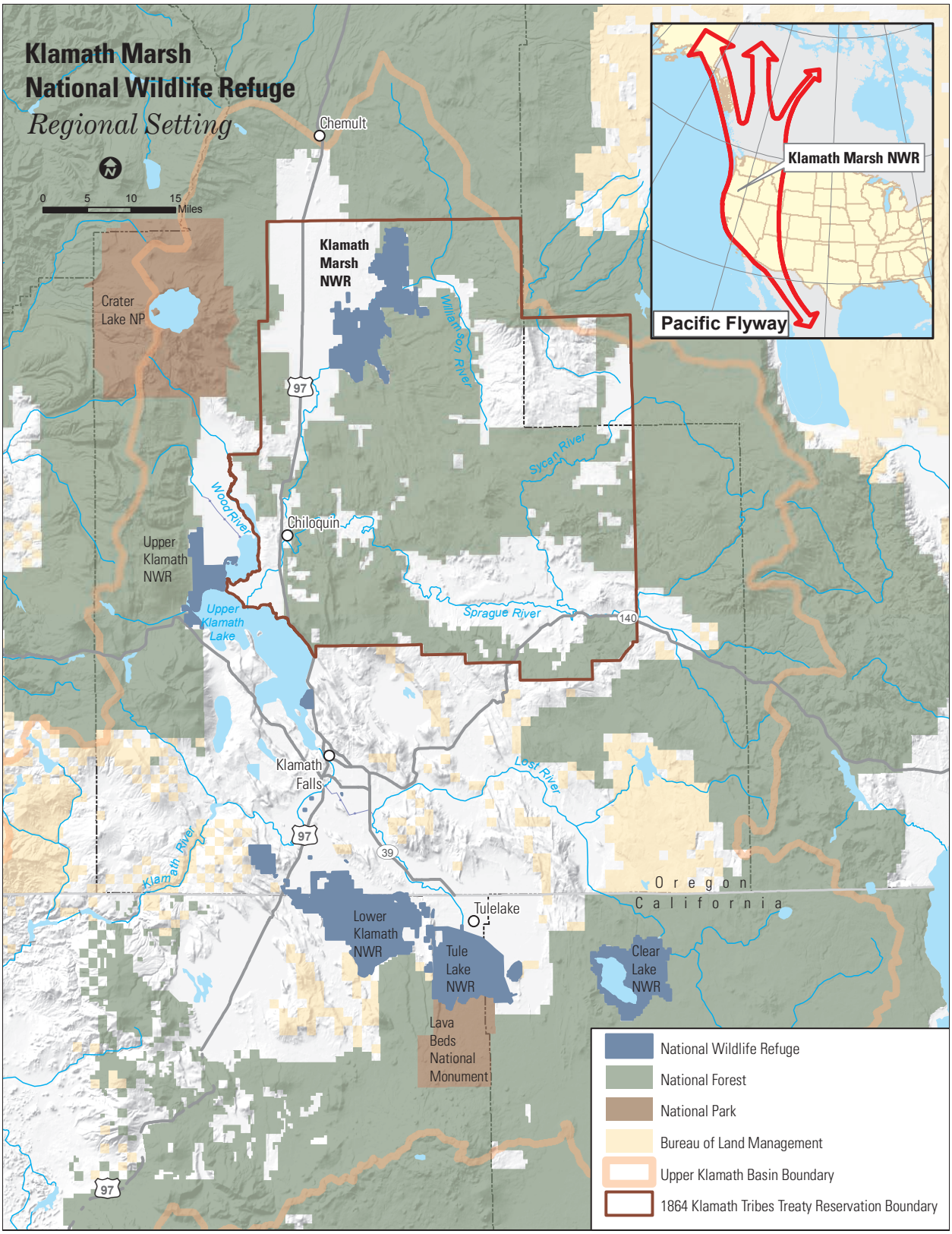


Figure 1-1. Regional setting of the Klamath Marsh Refuge

1.3 The U.S. Fish and Wildlife Service and the National Wildlife Refuge System

1.3.1 U.S. Fish and Wildlife Service (Service)

The Service is the primary Federal agency responsible for conserving, protecting, and enhancing the Nation's fish, wildlife, and plant populations and their habitats for the continuing benefit of the American people. Although the Service shares this responsibility with other Federal, tribal, state, local, and private entities, the Service has specific responsibilities for migratory birds, threatened and endangered species, inter-jurisdictional fish, and certain marine mammals. These are referred to as Federal Trust Species. The Service also manages the Refuge System and national fish hatcheries; enforces Federal wildlife laws and international treaties related to importing and exporting wildlife; assists state fish and wildlife programs; and helps other countries develop wildlife conservation programs.

1.3.2 The National Wildlife Refuge System

The National Wildlife Refuge System is the world's largest collection of lands specifically managed for fish and wildlife conservation. Unlike other Federal lands that are managed under a multiple-use mandate (e.g., national forests and lands administered by the U.S. Bureau of Land Management [BLM]), the Refuge System is managed primarily for the benefit of fish, wildlife, and plant resources and their habitats. The Refuge System consists of more than 550 units that provide nearly 150 million acres of important habitat for native plants and many species of mammals, birds, and fish, including threatened and endangered species.

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" (1997 Improvement Act).

The goals of the National Wildlife Refuge System are as follows.

a. Conserve a diversity of fish, wildlife, and plants and their habitats, including species that are endangered or threatened with becoming endangered
b. 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
c. Conserve those ecosystems; plant communities; wetlands of national or international significance; and landscapes and seascapes that are unique, rare, declining, or underrepresented in existing protection efforts
d. Provide and enhance opportunities to participate in compatible wildlife-dependent recreation (hunting, fishing, wildlife observation and photography, and environmental education and interpretation)
e. Foster understanding and instill appreciation of the diversity and interconnectedness of fish, wildlife, and plants and their habitats

1.3.3 Legal and Policy Guidance

Refuges are guided by the purposes of the individual refuge, the mission and goals of the Refuge System, Service policy, laws, and international treaties. Relevant guidance includes the Refuge Recreation Act of 1962, the 1997 Improvement Act, and selected portions of the Code of Federal Regulations and the U.S. Fish and Wildlife Service Manual. Refuges are also governed by a variety of other Federal laws, Executive orders (EOs), treaties, interstate compacts, regulations, and policies pertaining to the conservation and protection of natural and cultural resources (see Service Manual 602 FW 1 (1.3)). Appendix K provides more detailed descriptions of the laws, Executive orders, and policies that relate to refuge management and use.

The Improvement Act

The 1997 Improvement Act, which amends the National Wildlife Refuge System Administration Act of 1966, serves as an "organic" act for the Refuge System and provides comprehensive legislation describing how the Refuge System should be managed and used by the public. The 1997 Improvement Act's main components include the following.

- A strong and singular wildlife conservation mission for the Refuge System
- A recognition of six priority public uses of the Refuge System (hunting, fishing, wildlife observation and photography, and environmental education and interpretation)
- A requirement that the Secretary of the Interior maintain the biological integrity, diversity and environmental health of Refuge System lands
- A new process for determining compatible uses on refuges
- A requirement for preparing a Comprehensive Conservation Plan for each refuge by 2012

Refuge System Policies

Refuge System policies are found in the land use management series (600) of the U.S. Fish and Wildlife Service Manual. These policies are available online at **http://www.fws.gov/policy/manuals/**. Table 1-1 provides brief descriptions of key policies related to refuge management and use.

This document also includes a draft environmental assessment (EA) (attached as Appendix G) as required under the National Environmental Policy Act of 1969 (NEPA) (42 USC 4321). The purpose of the EA is to evaluate the environmental effects of the Plan on the quality of the human environment. The EA includes the following components.

- A description of the alternatives considered for the Plan
- Identification and analysis of the potential environmental effects of the proposed management program and the management alternatives
- Documentation of the involvement of affected state and Federal agencies, nonprofit organizations, and the public in the Plan process

1.4 Refuge Purposes and History of Establishment

1.4.1 Refuge Purposes

Each refuge in the National Wildlife Refuge System (Refuge System) is managed to fulfill the mission of the Refuge System and the specific purposes for which the refuge was established. The following purposes identified for Klamath Marsh Refuge are defined by language within a number of acts of Congress that grant the U.S. Fish and Wildlife Service (Service) general authority to acquire land for National Wildlife Refuges.

- "...for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." (Migratory Bird Conservation Act, 16 U.S.C. § 715d)
- "...for the development, advancement, management, conservation, and protection of fish and wildlife resources ..." 16 U.S.C. § 742f(a)(4) "... 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 ..." (Fish and Wildlife Act of 1956, 16 U.S.C. § 742f(b)(1))
- "... the conservation of the wetlands of the Nation in order to maintain the public benefits they provide and to help fulfill international obligations contained in various migratory bird treaties and conventions ..." (Emergency Wetlands Resources Act of 1986, 16 U.S.C. § 3901(b))

1.4.2 Regional History and Development

Klamath Marsh has long been a magnet for wildlife and people. For thousands of years, Native Americans have made extensive use of the area's plant and wildlife resources. Within the upper Williamson watershed, the "Klamath Marsh" band

Table 1-1. Key policies related to management of National Wildlife Refuges

Policy	Purpose
Refuge System Mission and Goals and Refuge Purposes (601 FW 1)	Reiterates and clarifies the Refuge System mission and how it relates to the Service mission; explains the relationship between the Refuge System mission, goals, and purpose(s). It also includes the decision making process for determining refuge purposes.
Biological Integrity, Diversity and Environmental Health Policy (601 FW 3)	Provides guidance for maintaining and restoring, where appropriate, the biological integrity, diversity, and environmental health of the Refuge System.
Comprehensive Conservation Planning (602 FW 3)	Describes the requirements and processes for developing refuge comprehensive conservation plans.
Appropriate Use (603 FW 1)	Describes the initial decision process the refuge manager follows when first considering whether or not to allow a proposed use on a refuge. The refuge manager must find a use appropriate before undertaking a compatibility review of the use.
Compatibility (603 FW 2)	Details the formal process for determining if a use proposed on a National Wildlife Refuge is compatible with the Refuge System mission and the purposes for which the refuge was established. Units of the Refuge System are legally closed to all public access and use, including economic uses, unless and until they are officially opened through a compatibility determination. Appendix H contains several final compatibility determinations for uses on Klamath Marsh Refuge.
Wildlife-Dependent Recreation (605 FW 1-7)	Provides specific information and guidance for each of the six priority wildlife-dependent uses: the policy for the use; guiding principles for the use; guidelines for program management; and guidelines for opening the specific program.

of the Klamath Tribe maintained relatively dense settlements along the banks of the Williamson River and the shores of Klamath Marsh. In late summer, members of the Klamath Tribe gathered seeds of wocus, or yellow pond lily, within the extensive network of open water areas of the marsh. Fish, roots, berries, waterfowl, eggs, and mammals also formed an important part of their diet (Coville 1904).

Euro-American history in the Upper Klamath Basin dates from November 1826, when Peter Skene Ogden led an expedition into the upper Williamson watershed. Members of the expedition, who were searching for beaver to use as a valuable trade fur, were largely unsuccessful, but they did encounter Native Americans. The Native American inhabitants were reported to have "dense settlements along the banks of the Williamson River and around the shores of the Klamath Marsh (David Evans and Assoc. 2005). The Klamath Marsh inhabitants probably outnumbered all other native bands throughout the Klamath Basin (Stern 1965).

The accounts of early explorers to the region give us a picture of what Klamath Marsh looked like 150 years ago. Lieutenant Henry L. Abbot surveyed the Klamath Basin during 1854–1855. In his report from the expedition, Abbot described Klamath Marsh as "a strip of half-submerged land, about twelve miles long and seven miles broad . . . covered by clumps of tule and other aquatic plants separated by small sheets of water." Abbot saw "thousands of ducks, plover, and other water birds" at the marsh. F. V. Coville, who explored the area during the early 1900s, estimated that Klamath Marsh contained 10,000 acres of wocus.

The arrival of Euro-American settlers to the Klamath Basin during this period resulted in considerable conflict and bloodshed with area tribes. In an effort to pacify the region, the U.S. Government reached a treaty with the tribes in 1864, establishing the Klamath Indian Reservation (Reservation). The 2.2-million-acre Reservation included much of the Williamson River and Sprague River watersheds and all of Klamath Marsh (Figure 1-1).

After the establishment of the Reservation, the tribal economy shifted away from subsistence hunting and gathering to timber harvest on the forested areas and livestock grazing on the lowlands. Timber harvest began in the area in the mid-1870s and became profitable to the extent that it dominated the land use and economy of the Klamath Reservation and surrounding lands for the next century. By the 1880s, some Indian ranches were running successful cattle operations (Stern 1965). Until arrival of the Southern Pacific Railroad in 1909, the full potential and value of the high-quality ponderosa pine would not be fully realized. By 1911, the railroad line eventually extended to the settlement of Kirk at the south end of Klamath Marsh, and timber harvest fueled a booming economy.

Beginning in 1895, Reservation lands were allotted to individual tribal members under the General Allotment Act of 1887. Each tribal member was entitled to either 80 acres of farmland or 160 acres of grazing land. Many tribal members took their allotments on Klamath Marsh where they had established camps for gathering wocus. Others acquired surrounding allotments, and large ranches were established, including those owned by Mamie Farnsworth and Orie Summers. Numerous allotments were eventually sold by tribal members to private individuals who created several large cattle ranches, including the Yamsi and Kittridge ranches. From 1900 through 1940, a large portion of the privately owned wetlands were converted to agricultural use, including much of the northern part of Klamath Marsh.

Congress passed the Klamath Termination Act in 1954, which gave each adult member of the tribe the opportunity to either (a) withdraw from the tribe and have his or her interest in the tribal property converted to money, or (b) remain in the tribe. The Bureau of Indian Affairs began selling allotments within the reservation to private individuals in 1955. During this same period, state and Federal resource agencies became increasingly concerned over the preservation of the marsh, fearing that more wetlands would be drained and converted to grazing land. On July 5, 1955, the Regional Director of the Service (known at the time as the Bureau of Sport Fisheries and Wildlife) wrote to the management specialists supervising the termination of the Klamath Tribe that the Service wished to preserve "a substantial part" of the Klamath Marsh because of its "value to waterfowl resources." In 1958 Public Law 85-731 expanded the Klamath Termination Act to provide that the Klamath Marsh would be sold to the United States for creation of Klamath Marsh National Wildlife Refuge.

1.4.3 Refuge Establishment and Land Acquisition

Overview of Refuge Land Acquisition Process: The Service, in its quest for protecting wildlife and wildlife habitats for the Refuge System, conducts in-depth evaluations of certain areas of interest identified in existing resource plans, or brought to our attention by individuals. Teams made up of biologists, researchers, planners, and realty specialists evaluate a myriad of factors that determine a refuge acquisition boundary including, but not limited to, biology and ecology of an area, existing land uses, land values, area economy, and the needs of the people. Recommendations are provided to decision makers on establishment of new refuges, additions to existing units, and/or expansion of refuge boundaries that define important and/or sensitive areas that could be protected and managed as a unit of the Wildlife Refuge System. These proposals are then approved by the Service's Director or Regional Director, depending on the size of the project and whether or not a new refuge is being established.

Once the refuge boundary is approved the Service proceeds to contact all the landowners within the boundary to determine if they are interested in selling their land. If the landowner expresses an interest in selling to the Service, a professional real estate appraiser will conduct an appraisal to

determine the market value of the property. When the value is determined, we meet with the landowner to present the value. If the landowner agrees with our offer, the purchase agreement is signed and we begin the process of acquiring the property. Generally, the Service acquires title to a property in simple fee (full ownership). Other options may be available on a particular project such as conservation easements, leases, or life-use reservations. Owners sometimes choose to donate all or a portion of their land because of tax advantages or as a lasting memorial.

Funds for the acquisition of National Wildlife Refuges generally come from three accounts established by law: The Migratory Bird Conservation Fund, the Land and Water Conservation Fund, and the North American Wetlands Conservation Fund. Sources of revenue for these accounts include Federal duck stamp sales, refuge entrance fees, U.S. Fish and Wildlife Service violation fines, import taxes on arms and ammunition, offshore oil and gas leases, and Congressional appropriations.

Klamath Marsh National Wildlife Refuge Establishment: With the support of the Oregon Department of Fish and Wildlife (known at the time as the Oregon Game and Fish Commission), the Service (known at the time as the Bureau of Sport Fish and Wildlife) submitted a proposal to the Migratory Bird Conservation Commission (Commission) to establish the Klamath Marsh National Wildlife Refuge. On March 14, 1958, the Commission approved the establishment of the Refuge with an acquisition boundary of 24,418 acres. The initial acquisition boundary included the southern half of Klamath Marsh and fell entirely within the boundaries of the 2.2-million-acre Klamath Indian Reservation.

In 1958, the Service acquired the first four tracts of Refuge land totaling 585 acres. In 1958 and 1959, Congress passed amendments to the Klamath Termination Act, providing that tribal lands be sold to the Service and changing the Refuge name to the Klamath Forest National Wildlife Refuge. On September 7, 1960, 14,361 acres of tribal lands were transferred to the Service. From 1972 through 1980, the Service acquired three additional tracts totaling 1,431 acres (Figure 1-2 and 1-3).

In 1988, the Service completed an environmental assessment that expanded the acquisition boundary of the Refuge by 28,584 acres to include the northern half of Klamath Marsh. During1989–1990, two major acquisitions were finalized: the Nicol Land and Cattle Company Tract, which totaled 18,800 acres, and the Horton Tract, which totaled 2,566 acres.

In 1998, Congress changed the name of the Refuge back to Klamath Marsh National Wildlife Refuge. In 1998 and 1999, two additional tracts were acquired that totaled 3,142 acres. Today the Service owns 40,885 acres within the 49,583-acre acquisition boundary (Figure 1-2 and 1-3, Table 1-2).

1.4.4 Refuge Development

Klamath Marsh Refuge was established in 1958 when the Service acquired four tracts of land totaling 584 acres. The land under current ownership by the Service (over 40,000 acres) has been acquired over a 40-year period from 1958 through 1998 (see Section 1.5.4 and Figure 1-3).

Management of Klamath Marsh Refuge lands from 1958 through 1990 was conducted from the Klamath Basin National Wildlife Refuge Complex (Complex) office, located in Tulelake, California. Staff from the Complex periodically visited Klamath Marsh Refuge during this time to maintain fences, conduct biological surveys, monitor hunting and fishing programs, and enforce haying and grazing permits. Livestock trespass was a recurring issue during the early years, as was maintenance of boundary fences.

The initial posting of boundary and entrance signs for Klamath Marsh Refuge was completed in September, 1961. Public hunting area signs were also placed around public hunting areas, and two entrance signs were erected along Silver Lake Road.

The first Refuge office building and bunkhouse were established in 1962, when a three-room patrol cabin was put at the current location of the headquarters building. Fencing of Refuge boundaries began in 1962 and continued into the late 1990s.

Table 1-2. Klamath Marsh Refuge land acquisition history. See figure 1-2 for tract locations.

Tract #	Owner	Purchase Date	Acres
15	Modoc Lumber Co	8/8/1958	106.08
20	Hood, Fred Jr	10/27/1958	169.48
22	Gray, Grace	10/27/1958	150.99
26	Gray, Richard	10/27/1958	158.35
30, 30a	Klamath Indian Tribe	9/7/1960	14,361.13
16	Lampe et. al. Edward B	8/21/1972	200.83
40	Nicol, Mark et al	3/2/1977	40.00
33	Horton, John	1/23/1980	1,190.49
41, 41a, 41b, 41c, 41d, 41e, 41f, 41g, 41h	Horton, John	1/5/1989	2,491.50
40a, 40d, 40e	Nicol, Mark et al	3/15/1989	12,158.66
51	Horton, John	1/22/1990	74.17
40b, 40c, 40f	Nicol, Mark et al	2/2/1990	6,641.30
43, 43a, 43b	Olson, Larry et ux.	5/15/1998	2,960.00
52	Michael L. Horton	10/19/1999	182.00
		TOTAL	**40,884.98**

A decision, justified for timber and general transport issues, was made by Klamath County in 1966 to pave and raise the level of Silver Lake Road. The Service cooperated by allowing the taking of fill for berms for a distance of 100 feet on either side of the road. Twenty-foot berms were constructed on either side of the road to reduce muskrat damage. The road was completed in about 1969. In 1972, the road was raised another six inches and completely resurfaced.

With the purchase of the lands from the Nicol Land Company in 1989, the Service obtained what now serves as the manager's house, duplex building, Loosley house, Summer's Ranch buildings, and basic maintenance shop buildings. The buildings used at the current Refuge headquarters were built in the early 1980s and provide the Service with much-needed Refuge housing and maintenance facilities.

After 1990, the Service was finally able to station a full-time manager and maintenance worker at the Refuge. Management has since focused on continued posting and fencing of Refuge boundaries; developing habitat management plans; biological monitoring; invasive species management, enhancing Refuge vegetation via prescribed fire, haying, and grazing programs; documenting water rights; conducting water monitoring; climate monitoring; improving water management capabilities; and improving public use opportunities and facilities.

1.5 Refuge Vision and Goals

The vision for the Refuge provides a simple statement of the desired overall future condition of the Refuge. From the vision flow more specific goals, which in turn provide the framework to craft more detailed and measurable objectives that are the heart of the CCP. The vision and goals are also important in developing alternatives, and they are reference points for keeping objectives and strategies meaningful, focused, and attainable.

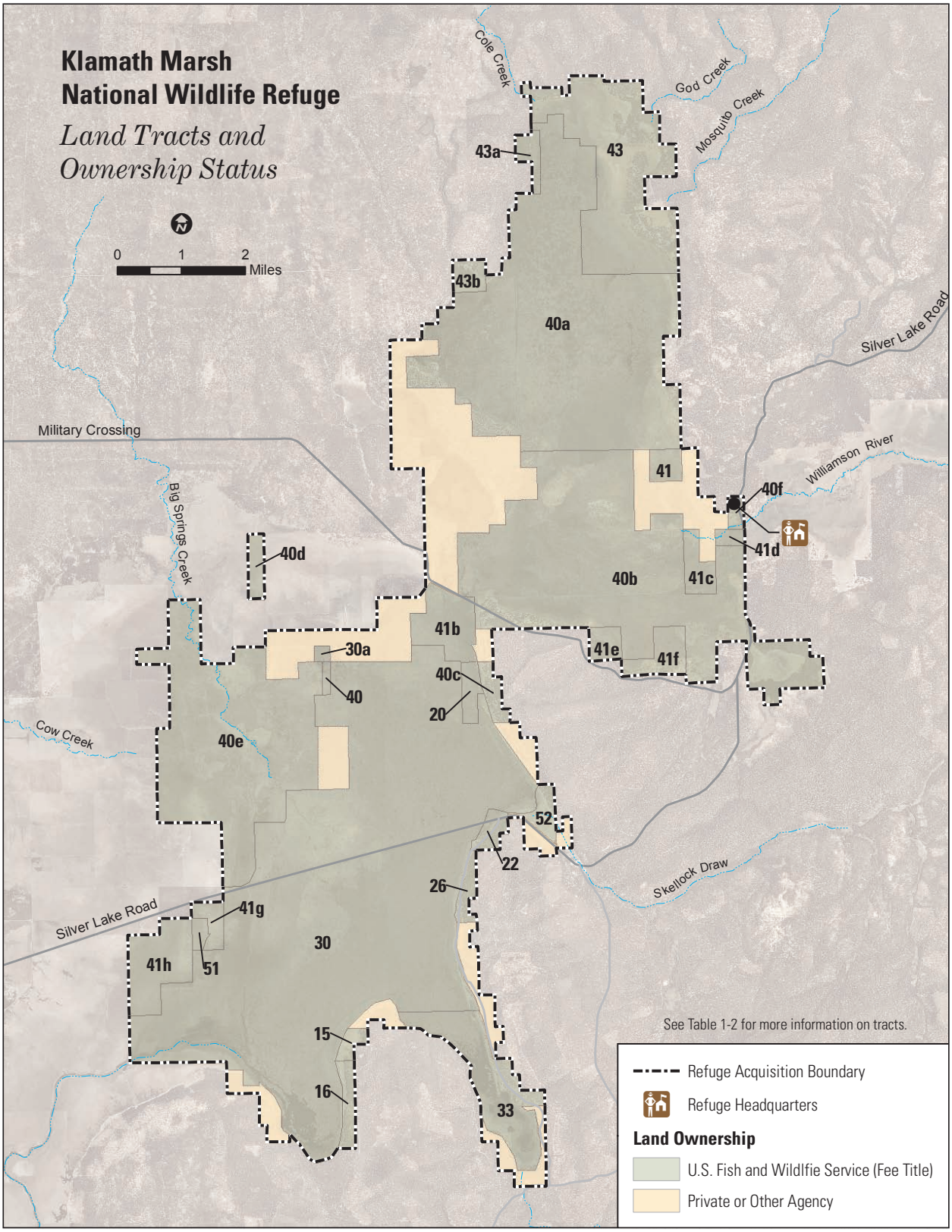


Figure 1-2. Land tracts acquired within the Klamath Marsh Refuge acquisition boundary

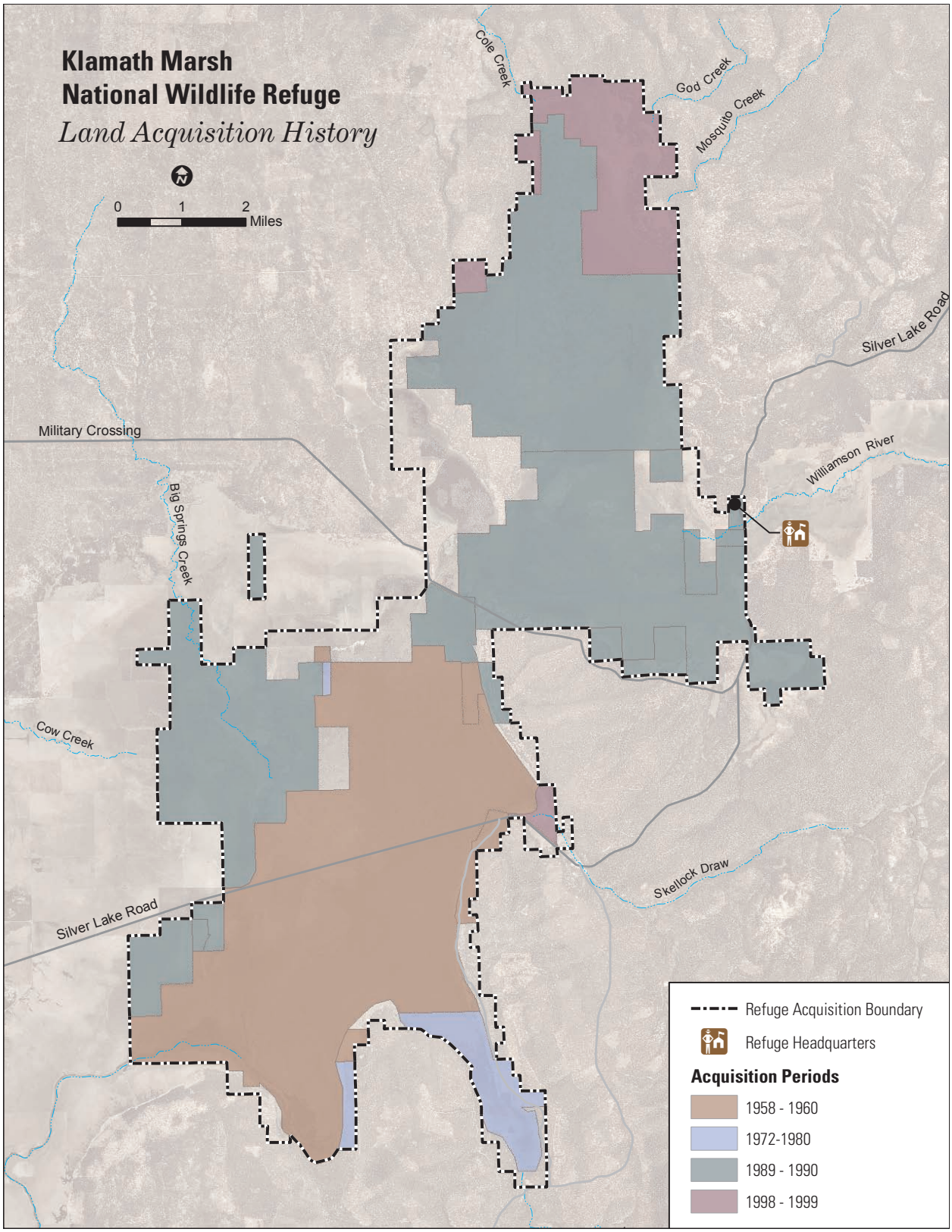


Figure 1-3. Klamath Marsh Refuge land acquisition history

1.5.1 Refuge Vision Statement

Klamath Marsh National Wildlife Refuge lies on a 7,000-year-old layer of volcanic ash and rock in the transition zone between the Great Basin Desert and the snow-capped eastern Cascades Mountains of Oregon.

The expansive 40,885-acre Refuge protects one of the largest and most pristine high-elevation marshes in the Intermountain West.

The eastern slope of the Cascades has lost extensive amounts of natural wetlands, making the Refuge an integral component in preserving the biodiversity of the region. This large, contiguous block of wetlands provides important nesting and migratory habitat for a diversity of Pacific Flyway birds. The emergent wocus (yellow pond lily) marshes, sedge meadows, and riparian habitats are encircled by stately pine forests, forming habitats that support over 250 species of wildlife, including spotted frogs, yellow rails, sandhill cranes, and Rocky Mountain elk.

Klamath Marsh Refuge is also located within the headwaters of the Upper Klamath watershed. The Refuge wetlands play a key role in affecting the water quantity and quality of the Upper Klamath Basin by attenuating water flows and modifying water chemistry, the balance of nutrients, and water temperatures.

The Refuge will continue to work with others to preserve, restore, and enhance the natural hydrology and biological integrity of Klamath Marsh and the associated uplands as habitat for migratory birds and other indigenous wildlife. Refuge staff will use or mimic natural processes to restore and/or maintain habitats that support naturally occurring wildlife, fish, and unique species. Adaptive management techniques will be used to respond to changing environmental and climatic conditions.

Successful implementation of management actions will result in a naturally functioning hydrological marsh that includes a complex interspersion of bulrush, cattail, wocus, and open water that supports a diversity of migrating and nesting waterbirds such as black tern, American bittern, wood duck, redhead, marsh wren, and common yellowthroat. Native sedge meadows will be structurally diverse and support healthy nesting populations of species like yellow rail and sandhill crane. Refuge forests will be dominated by open stands of old-growth ponderosa pine with healthy regenerating aspen stands interspersed within the marsh and forest transition zone supporting species like the pygmy nuthatch and white-headed woodpecker. Grassland meadows are maintained through prescribed fire, haying, and grazing, providing habitat for species like vesper sparrow, meadowlark, and sandhill crane.

Though it is remote, this unspoiled landscape draws a variety of visitors. Current and future generations have the opportunity to participate in wildlife-dependent recreation and education that emphasizes self-reliance, solitude, and a close relationship and respect for the environment. Refuge staff, visitors, and the community will have the chance to learn about and understand the historical and present cultural significance of the marsh.

1.5.2 Refuge Goals

The Service defines a goal as a "descriptive, open-ended, and often broad statement of desired future conditions that conveys a purpose, but does not define measurable units" (602 FW 1 of the Service Manual). Refuge goals are a means to achieving refuge purposes. Goals translate to one or more objectives that define these conditions in measurable terms. A well-written goal directs work toward achieving a refuge's vision and ultimately, the purpose(s) of a refuge. Collectively, a set of goals is a framework within which to make decisions.

Emergent marsh: Restore and maintain optimum interspersion and diversity of aquatic vegetation and open water within the emergent marsh community to support migrating and nesting waterbirds.

Riverine and spring riparian habitat. Restore the historic form and function of riverine and riparian systems to benefit native fish and wildlife, including redband trout, spotted frog, and Neotropical migratory birds.

Sedge meadows. Maintain and enhance the natural structure, diversity, and productivity of the seasonally flooded sedge meadows with an emphasis on providing nesting and foraging habitat for rails and sandhill cranes.

Grasslands and wet meadows. Restore and maintain the composition and structure of existing and historic wet meadows and grasslands to benefit species like meadowlark, savannah and vesper sparrows, and sandhill crane.

Ponderosa forest. Maintain the structure and diversity of existing old-growth ponderosa pine stands and restore mature and old-growth characteristics to second-growth and other degraded stands.

Aspen. Enhance and maintain the natural regeneration of existing aspen stands.

Protection and monitoring. Conserve and protect the natural diversity of migratory birds, resident wildlife, fish, and plants through protection of lands, invasive species management, and biological, water, and climate monitoring programs.

Cultural resources. Preserve cultural resources of the refuge, and connect visitors and the community to the area's past and present to ensure that visitors gain an understanding and appreciation for the cultural significance of Klamath Marsh.

Recreation. Nurture an understanding of and appreciation for wildlife and other natural resources of Klamath Marsh National Wildlife Refuge by providing opportunities for compatible wildlife-dependent recreation while maintaining the primitive uncrowded nature of the area.

Environmental education and interpretation. Provide interpretive and education services that emphasize the natural setting and function of Klamath Marsh and its role in the Refuge System.

1.6 Existing Partnerships

In "Fulfilling the Promise" (USFWS 1999) the Service identified the need to forge new and non-traditional alliances and strengthen existing partnerships with states, tribes, non-profit organizations, and academia to broaden citizen and community understanding of and support for the Refuge System. The Service recognizes that strong citizen support benefits the Refuge System. Involving citizen groups in Refuge resource and management issues and decisions helps managers gain an understanding of public concerns. Partners provide support for Refuge activities and programs, raise funds for projects, act as advocates for wildlife and the Refuge System, and provide support on important wildlife and natural resource issues.

A variety of people, including but not limited to scientists, birders, anglers, hunters, farmers, outdoor enthusiasts, and students, are keenly interested in the management of Klamath Marsh Refuge, its fish and wildlife species, and its plants and habitats. This is illustrated by the partnerships that have already developed. New partnerships will be formed with interested organizations, local civic groups, community schools, Federal and state governments, and other civic organizations as funding, staff, and opportunities become available. The following is a list of existing partnerships.

- The Klamath Tribes—management of cultural resources and wildlife habitat
- Oregon Department of Fish and Wildlife—wildlife and fish surveys, habitat management, public use management
- Animal and Plant Health Inspection Service (APHIS)—monitoring and control of clearwinged grasshoppers
- Klamath County Department of Transportation—weed management, road maintenance
- U.S. Forest Service—habitat management, wildlife surveys, wildfire and prescribed fire management
- Adjacent private landowners—easements, wildlife habitat management
- Klamath Basin Audubon Society—bird monitoring and public use
- U.S. Geological Survey (USGS)—spotted frog and migratory bird monitoring
- The Nature Conservancy—habitat management and monitoring
- Klamath Bird Observatory—monitoring and environmental education
- Local school districts—environmental education
- Volunteers and Friends Groups—maintenance, monitoring, cleanup projects

Chapter 2. Comprehensive Conservation Plan Process

2.1 Introduction

The National Wildlife Refuge System Improvement Act of 1997 (1997 Improvement Act) requires that every Refuge in the system prepare a Comprehensive Conservation Plan (Plan). Both the U.S. Fish and Wildlife Service (Service) and the public benefit from this requirement, as the Plan process helps ensure that each refuge fully evaluates, develops, and achieves its long-term vision and goals. Once a Plan is approved, the Refuge must follow the management priorities provided in the approved Plan. The procedural provisions in the Council on Environmental Quality's Regulations for Implementing National Environmental Protection Act (NEPA) require all Federal agencies to integrate the NEPA process with other planning as early as possible. In accordance with these regulations, the refuge planning policy states that each Plan will comply with the provisions of NEPA by concurrently preparing an environmental assessment (EA) or environmental impact statement (EIS) to accompany or be integrated with the Plan. The purpose of integrating the two processes is to provide a systematic interdisciplinary approach; identify and analyze the environmental effects of the proposed actions; describe appropriate alternatives to the proposal; involve the affected state and Federal agencies, tribal governments, and the affected public in the planning and decision making process; and fully integrate all Refuge proposals that may have an impact on the environment.

2.2 Klamath Marsh NWR Planning Process

The Comprehensive Conservation Plan and EA for Klamath Marsh Refuge are intended to comply with the requirements of the 1997 Improvement Act and the National Environmental Policy Act (NEPA). Refuge planning policy guided the process and development of the Plan, as outlined in Part 602, chapters 1, 3, and 4 of the U.S. Fish and Wildlife Service Manual.

Service policy, the 1997 Improvement Act, and NEPA provide specific guidance for the planning process, such as seeking public involvement in the preparation of the Environmental Assessment (EA) document. The development and analysis of "reasonable" management alternatives within the EA include a "no action" alternative that reflects current conditions and management strategies on the Refuge. Management alternatives developed as part of this planning process can be found in Appendix G: Environment Assessment.

The comprehensive conservation planning process for Klamath Marsh Refuge, which began in August 2006, is described in the following sections.

2.2.1 The Planning Team

The Plan process requires close teamwork with Refuge staff, planners, and other partners to accomplish the necessary planning steps, tasks, and work to generate the Plan document and associated EA. Two teams were formed.

Core Team

The core team is the production entity of the Plan. The members are responsible for researching and generating the contents of the Plan document; this team participates in the entire planning process. The team consists of Refuge staff, planners, and Geographic Information System personnel. Facilitated by the Refuge planner, the Klamath Marsh Refuge core team meets regularly to work on the Plan. Team members also work independently on their respective Plan sections based on their area of expertise. Work on the Plan occurs in addition to regular workloads (Appendix E).

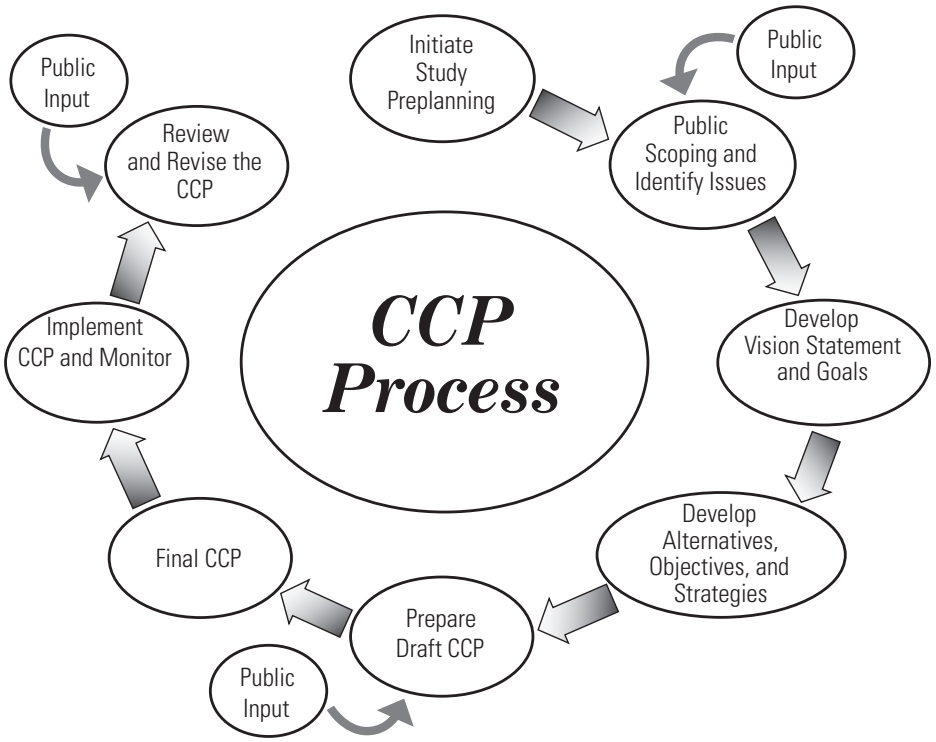


Figure 2-1. CCP Planning Process

Expanded Team

The expanded team serves as the advisory and coordination component of the Plan, which is significant because of the Refuge's basis and history of working in close partnership with other local, state, Federal, and private agencies and organizations concerned with the Klamath Marsh Refuge and its watershed. The Klamath Marsh Refuge expanded team is composed of the core team, other Service and Federal personnel, the Klamath Tribes, and State of Oregon personnel—each of whom provides overview, discussion, and coordination during the planning process (Appendix E).

2.2.2 Pre-Planning

Pre-planning involved formation of the planning teams, development of the Plan schedule, and gathering of data. During 2005, the Service and several of its agency and tribal partners performed a Wildlife and Habitat Review and a Visitor Services Review to identify important Refuge issues, concerns, and data gaps. Members of the planning team identified a preliminary list of issues, concerns, and opportunities that were derived from wildlife and habitat monitoring and field experience with the past management and history of the Refuge. The core team determined procedures, work allocations, and outreach strategies, and created a preliminary mailing list.

2.2.3 Public Scoping

Public involvement is an important and necessary component of the Plan and NEPA process. Public scoping meetings allow the Service to provide updated information about the Refuge System and about Klamath Marsh Refuge. Most importantly, these meetings allow the Refuge staff to hear public comments, concerns, and opportunities. These

public meetings provide valuable discussions and identify important issues regarding the Refuge and the surrounding region.

The Refuge hosted public scoping meetings in Klamath Falls and Chiloquin, Oregon. Each meeting began with a presentation about Refuge resources and an overview of the Plan process. Meetings provided an open forum for public comments and ended with a breakout session that allowed attendees to visit different tables—each with printed information that addressed Refuge management, wildlife and habitat, and public use. In addition to comments made and noted on flip charts at the meetings, comments were also received by postcard mailers, email, and letters. These comments were analyzed and used to further identify Refuge issues and revise Plan strategies.

2.2.4 Public Outreach

During the planning process, Refuge staff continued to actively participate with the various working groups and agency teams concerning Klamath Marsh Refuge (Appendix D). The staff also met with interested parties and local groups to explain the Refuge and the planning process, and to listen to their concerns.

Information letters called "Planning Updates" were mailed to the public. These periodic publications were created to provide the public with updated Refuge information and progress on the Plan process. The Planning Updates were also made available on the Refuge and on the Service's Region 8 refuge planning Web page and at various outreach meetings. Appendix I contains a list of individuals and organizations that were sent a copy of the Draft Plan or planning updates, or who attended scoping meetings.

2.2.5 Issues, Concerns, and Opportunities

This section represents input from managers, planning team members, agencies, tribal interests, organizations, and individuals concerning issues to be considered in the future management of Klamath Marsh National Wildlife Refuge. During the winter of 2006–2007, meetings were conducted, news releases circulated, Web site information posted, and informational mailings sent out to interested parties to gather input and comments. The public had an opportunity to attend public scoping meetings in Klamath Falls (February 6, 2007) and Chiloquin, Oregon (February 7, 2007). Approximately 38 people attended the two meetings. Additional scoping meetings were held with resource agencies, county commissioners, and congressional aides; a scoping meeting was conducted with the Klamath Tribes in December of 2006. Verbal comments were recorded during scoping meetings and additional comments were received in response to an "issues workbook" provided by the planning team. Over 180 people provided written comments by mail or email, or provided verbal comments during personal conversations with the Refuge and planning staff. Of the 180 comment letters, approximately 140 were essentially the same and resembled a form letter that was posted on a Web site for Oregon Wild (Oregon Natural Resources Council). On January 29, 2007, the *Federal Register* published the "Notice of Intent to Prepare a Plan and Environmental Assessment." The scoping comment period ended March 15, 2007.

The diversity of issues is reflected in the summaries that follow. The issues identified during scoping provided a basis for forming the alternatives considered in the Environmental Assessment. The issues and comments that we received were also important in formulating the objectives and strategies in the Plan which will guide Klamath Marsh Refuge management for the next 15 years.

The issues are stated as questions that closely resemble the form in which they were brought up in the scoping process. Subsequent text highlights background information about the issue and the concerns/comments raised by respondents.

Climate Change. *How will the Refuge be affected by climate change and what can the Service do about it?*

Background. The Intergovernmental Panel on Climate Change (IPCC) concluded that "warming of the climate system is unequivocal." The potential for rapid and lasting climate warming poses a significant challenge for fish and wildlife conservation (IPCC

2007). In the Northwest, scientists at Oregon State University, the University of Washington, and other study centers have already observed measurable warming (Oregon Department of Energy 2004). The Climate Impacts Group of the Joint Institute for the Study of the Atmosphere and Ocean at University of Washington reports that, over the last century, the regional average temperature increased by 0.8°C (1.5°F). Precipitation has increased both east and west of the Cascades. East of the Cascades, the increases are dominated by changes from April to July. West of the Cascades, the largest increases are in November, which has overtaken December as the wettest month. While precipitation has increased, there has been a decline in snow water equivalent in the spring (Oregon Department of Energy 2004). Likewise, the timing of the peak snowmelt has advanced 10 to 40 days earlier in most of the western United States during the last 50 years, according to Dr. Edward Miles of the Climate Impacts Group (Miles 2004). Mayer (2007 & 2008) has clearly documented changes in temperature, precipitation, and snowpack in the Klamath Basin with associated changes in streamflows (see Section Appendix O). The Refuge has developed some preliminary monitoring programs (climate, water, biological) to begin assessing the potential impacts of climate change. The key to responding to climate change at the Refuge will be adaptive management, where we learn from our monitoring, continually assess changes, and adapt our management to what works. On a national level, the Service has developed a draft Strategic Plan for responding to climate change and has held regional workshops throughout the United States to address future impacts.

Comments. Concerns were vocalized by several respondents about the future impacts that climate change may have on the Refuge and Northwest ecosystems and that climate change should be considered when developing the Refuge's Plan.

Refuge Boundary and Future Land Acquisition: *How can the Service ensure protection of water supplies and healthy wildlife habitats within the Refuge to provide long-term benefits for its species and habitats?*

Background. The approved Refuge acquisition boundary encompasses 49,583 acres, of which 40,885 acres have been acquired and are managed by the Service.

Comments. Several comments encouraged the Service to expand the approved acquisition boundary to include wetlands north and west of the Refuge, meadows and riparian areas to the east and southwest, and uplands along the Peninsula. One area specifically identified for acquisition was Big Springs, including its wetland and riparian areas. Big Springs is an important riparian and wetland region adjacent to the Refuge and directly linked to the Refuge's wetland hydrology. Acquisition and protection of ranch lands west of the Refuge was suggested as a means to provide a possible upland buffer around the Refuge and to protect and enhance grassland and shrub habitats. Future land exchanges between the U.S. Forest Service and the Refuge were suggested by some respondents to make the Refuge boundary easier for visitors to identify and to facilitate general management and jurisdiction issues between the agencies. It was conveyed that the current boundary is very hard to understand and maintain because of its irregular boundaries.

Some comments suggested that future acquisitions within the Refuge's current acquisition boundary should be prioritized, with an emphasis on acquiring lands owned around The Peninsula region. Others suggested acquiring lands that provide an opportunity to improve watershed function or otherwise protect, enhance, or restore conservation values found on the Refuge; and/or provide a buffer against management practices or developments that could be detrimental to fish and wildlife populations on the Refuge.

Several comments expressed a need for the Plan to support coordination and cooperation with neighboring landowners, agencies, and tribal entities, which would enhance and facilitate the successful management of Refuge resources.

Some individuals encouraged the Refuge to improve its boundary posting with signs that are clearly visible to the public and correspond to the Refuge brochure.

Another comment suggested that all boundary signs include the Refuge office phone number in case visitors have questions or need assistance.

Numerous comments noted concern about the future status of water rights for the Refuge and urged the Service to continue to pursue and clarify water right claims that would support the Refuge's needs.

Hydrology and Water Management. *Should the Service restore the natural hydrology of the Williamson River through the Refuge? If so, to what extent?*

Background. The Williamson River enters Klamath Marsh Refuge along its east central boundary, just south of the Refuge headquarters. After the Williamson enters the Refuge, it is diverted via several irrigation cannels and ditches to disperse water to wetland units. A majority of the diversions were created by former private landowners prior to the Service acquiring the lands. The diversion ditches have been used and maintained by the Refuge to facilitate flooding of areas to create wetlands.

Comments. The condition of the Williamson River flowing through the Refuge, the status of the Refuge's wetland hydrology, general water quality, and Refuge water management practices were major issues identified in written comments and during meetings.

Several comments expressed a need to ensure that all proposed Plan alternatives examine downstream impacts on water quality and quantity. Many recognized that Klamath Marsh plays an important role in affecting downstream water quality and quantity, and that land management practices implemented by the Refuge may affect the amount of water delivered downstream of the Refuge. Determining historic Williamson River flows was suggested as a means to evaluate potential future downstream impacts of proposed alternatives. Some stated that downstream water quality in the Williamson River would be improved if more water flows out of the marsh.

Many people expressed concern about the impacts of water uses and diversions occurring around and upstream of the Refuge; they felt the Plan should identify current water use issues surrounding the Refuge that may be affecting the health of the marsh and river system. It was noted that within the Refuge, water flow measurement devices and water diversion structures need to be checked to ensure the Refuge complies with state regulations and to facilitate future water right determinations.

Numerous comments supported restoring the natural hydrology of the marsh, thus restoring and enhancing the Refuge's wetland, riparian, and riverine habitats. Several recognized the importance of removing Refuge water control structures (barriers) in the Williamson River to restore historic fish passages for species like redband and bull trout. Many recognized the lack of fish passage and screening diversions as a problem on the Refuge. Several believed the historic irrigation diversions may no longer be necessary, are hazardous to native fish and marsh restoration, and are inconsistent with current Refuge management programs. The current condition of the Williamson River as it flows through the Refuge does not allow for natural processes of the river and the adjacent riparian zone to function. Suggestions for restoring the natural hydrology of Klamath Marsh and the Williamson River included the following.

- Identifying barriers and constraints to the historic hydrologic regime
- Protecting and restoring riparian habitats
- Protecting groundwater levels
- Removing irrigation ditches and diversion structures within Refuge boundaries
- Securing water rights in Klamath Basin adjudication necessary to support Refuge management
- Monitoring climatic data and water management activities to better understand the impacts of Refuge management on populations of wildlife and plants
- Putting the river back in a more natural (sinuous) channel
- Reconnecting the river with its floodplain

Overall, there was a desire to see the Williamson River restored to a more natural state by eliminating barriers and diversions. It is widely

believed by many interested constituents that restoring the Williamson River will improve conditions for native fish species, especially trout. Some were concerned that funding to complete future restoration work may not be available.

Several believed that the historic existence and function of a natural dam at Kirk Reef needed to be researched as part of determining future management alternatives.

Maintaining sufficient water in Refuge wetlands to support wildlife was a concern. At least one person believed that maintaining water in Wocus and Little Wocus bays should be a priority in drier years. At one meeting, concern was expressed that more water has been retained in the northern portion of the marsh since the 1990s, causing the southern portion of the Refuge to become drier.

One landowner expressed concern regarding the Refuge's current water management operations, which flood private lands along the northwest boundary of the Refuge. The Plan needs to address impacts to adjacent landowners in future Refuge water management operations.

One letter commented that the water quality benefits from providing spring storage of water on the Refuge should be evaluated.

It was recommended that the cumulative impacts to water quality and quantity within the Williamson Watershed and Refuge boundaries should be evaluated under each management alternative.

Invasive Species. *How will invasive plant and animal species on the Refuge be controlled?*

Background. Invasive plant populations pose a major threat to native plant communities on the Refuge. Current management has been successful in minimizing the overall impact of these species within the Refuge with chemical and mechanical treatments. It is estimated that less than 500 acres of the Refuge is invaded with invasive plant species. Primary species of concern include perennial pepperweed, Canada thistle, cheat grass, hemlock, and reed canary grass.

Comments. The public, tribes, and various agencies expressed concern about the control of invasive species. They requested that the Service recognize that invasive species are a significant issue and that control of both invasive plants and animals should be addressed in each alternative. Specific species mentioned for control included reed canary grass, meadow foxtail, dalmatian toadflax, common mullein, perennial pepperweed, St. John's wort, Canada thistle, bullfrogs, and brook trout.

Although a native species, one person mentioned goldenrod as a threat to grassland areas and adjacent private lands, stating that this species reduces the forage value of grasslands for livestock. Control of this plant species on Refuge lands was requested to assist with adjacent private land control measures.

The use of herbicides or pesticides was a concern for several respondents, who requested that the impacts of any management actions using herbicides and/or pesticides be evaluated in the Plan. One individual requested that the use of all pesticides be banned on the Refuge.

It was recommended that each alternative in the Plan identify prevention and mitigation actions that would be taken if new infestations were discovered.

Endangered, Threatened, Endemic, and Sensitive Species. *What management actions will the Service take on the Refuge to protect and restore populations of threatened and other sensitive species?*

Background. Klamath Marsh Refuge provides habitat for two Federal candidate species (Oregon spotted frog and fisher) and 24 state wildlife and fish species of special concern.

Comments. Several comments indicated that the Plan should fully review special status species on the Refuge and consider the impacts of any proposed management actions on those species. Each Plan alternative should include provisions for monitoring impacts to special status species. There was a comment that non-native species, such as bullfrogs and brook trout, may be predators on native and special status species (i.e., spotted frogs) at various locations, including Big Springs Creek.

Special status species that were mentioned in specific comments include bald eagle, bull trout (federally threatened), Oregon spotted frog (Federal

candidate), Klamath large scaled sucker (state sensitive), Miller Lake lamprey (state sensitive), yellow rail (state sensitive), and Klamath redband trout (state sensitive)..

Various agencies recommended that proposed alternatives include monitoring activities focused on impacts to special status species and potential mitigation measures for any negative impacts that may result. Furthermore, in the cumulative impacts evaluation, the distributions and current conditions of all special status species found within the Refuge should be considered.

Fishery Management. *How can the Service improve Refuge habitat for native fish species?*

Background. There has been virtually no active management for fishery resources. One partial fish survey has been completed with the assistance of Oregon Fish and Wildlife that provided a general list of species present. Current water control structures are not constructed to facilitate fish passage.

Comments. Several comments supported restoring the natural hydrology, including removal of water control structures (barriers) on the Williamson River through the Refuge to improve habitat and fish passage (see Hydrology and Water Management). One comment supported removing non-native brook trout in Big Springs Creek and reintroducing native redband trout and other native fish species. Another comment indicated the need for a comprehensive baseline fishery survey.

Several agreed that restoration of fish passage within the Williamson River by removing barriers and/or establishing fish passageways should be a priority.

Research and Monitoring. *Will the Service continue to support or expand ongoing research on key habitats and wildlife species and address other biological data shortfalls?*

Background. Monitoring and surveys have been completed on the Refuge since the 1960s. Surveys have been completed for waterfowl, Canada goose nesting pairs, bald eagle nest production, Oregon spotted frog egg masses, yellow rail, and sandhill crane. Surveys and research have been completed on passerine birds, fish species, grasshoppers, and vegetation. The lack of a full-time biologist at the Refuge has negatively affected the Refuge's ability to fully recognize its research and monitoring potential.

Comments. Few scoping comments related to this issue were received. One person wanted to know if the Service will continue to support ongoing research on key habitats (aspen) and wildlife species (yellow rail). A few others wanted to know if the Plan would provide for a mechanism such as adaptive management to address information gaps.

Haying and Grazing. *How will the Service manage the Refuge's sedge meadows to improve habitat for spring migratory waterfowl, nesting sandhill cranes, and nesting yellow rails? How will the effects of this management be monitored?*

Background. Haying and grazing operations have occurred on lands within the Refuge acquisition boundary since the early 1900s. After the Refuge was established in 1958, haying and grazing operations have continued on certain Refuge lands for the primary purpose of improving habitat conditions for wildlife. Haying and grazing operations are completed by private permittees and regulated by special use permits that designate locations, dates, acreage, and anticipated wildlife benefits.

Comments. Comments regarding the use of haying and grazing to improve habitat were mixed. In general, some fully supported these practices to modify vegetative conditions, and others would like to see these practices discontinued or minimized. There was a concern that letting the land rest or remain undisturbed was detrimental to maintaining vigorous and productive vegetative conditions and lack of vegetation management may result in a corresponding decline in wildlife numbers and diversity.

It was important to several groups that haying and grazing be clearly justified as supporting wildlife purposes and that commercial activities be closely monitored to ensure they don't exceed specified limits. Concern was expressed that these operations were being conducted more to benefit local permittees than to enhance wildlife habitat. Several groups suggested that other options (i.e., burning, grasshopper grazing, and native mammal grazing) be used instead of livestock grazing or haying. It was suggested that the Service reassess the impacts

of grazing and haying operations on Refuge habitats and that new compatibility determinations be created for these uses.

Several people who supported grazing suggested that high intensity and short duration grazing would result in greater improvements to vegetation vigor and health than long duration and dispersed grazing would. Grazing and burning were mentioned by several as viable options for reducing overly dense or decadent vegetation that needs rejuvenation.

Concerns about the impacts of grazing on water quality, sediment loads, and aquatic plant species diversity were expressed by several groups. The compaction of soils by hooves, the addition of cow fecal material, the potential introduction of non-native plants, and selective grazing preferences by cows were listed as potential negative impacts.

In a broader sense, several individuals were concerned that limiting the Refuge to only a few management tools would significantly limit the ability of the Refuge manager to enhance and maintain healthy wildlife habitats. It was stated that a wide range of management options need to remain available—including grazing, haying, timber thinning, and fire—to allow effective and adaptive management to be implemented.

Cattle trespass on Refuge lands was a concern that several individuals would like to see addressed in the Plan. Some suggested that cattle trespass issues should be dealt with in a timely manner and that permittees who violate grazing permits or have chronic trespass cows should be removed from consideration as future permittees.

Willow and aspen stands were identified as plants that are negatively impacted by such operations and that should be protected from haying or intensive grazing operations.

Forest Management. *What forest management tools will the Service use to reduce hazardous fuels, protect existing old-growth stands, increase the habitat value of second- and third-growth stands, and improve regeneration of aspen stands?*

Background. During the last century, wildland fire suppression and timber harvest dramatically altered the historic composition of forested habitats surrounding Klamath Marsh. Extensive timber harvest, which started in the early 1900s, resulted in the reduction of old-growth forest stages and large diameter trees and snags. Beginning around 1920, wildfires were actively suppressed in and around the Refuge. Areas that were open park-like stands of large trees with clumps of small trees have transitioned into dense, overstocked young stands with several canopy layers (USFS 2000). Native grasses and forbs, which dominated the understory in historic ponderosa pine communities, have been largely replaced with shrub species such as bitterbrush and currants. High fuel loading has increased the risk of unnatural stand-replacing wildfires, and high tree densities can cause stress and associated mortality on remaining old-growth ponderosa pines. In the absence of wildland fires, lodgepole pine has encroached into the dry and wet meadows of the Refuge such as Abraham Flat. Furthermore, conifer encroachment, fire suppression, and past grazing practices have severely limited recruitment of young aspen trees. Many existing stands are in decline with little evidence of new recruitment.

Comments. A number of comments have been received pertaining to forest management from the public, environmental organizations, and other agencies. Some were concerned with the impacts of forest management practices (i.e., logging) on wildlife. Others had specific recommendations for forest management on the Refuge. One person stated that logging should be prohibited on the Refuge; others suggested that larger diameter trees should not be thinned.

Several comments related to the desired future condition of the forests on the Refuge—suggesting that the Service should focus on returning forest stands to their historic species composition and stand structure with the appropriate fire return interval. Commenters also suggested that the Service should determine the historical range of variation in ponderosa pine stands as well as an understanding for their future condition.

A few commenters suggested that the Service manage for a diversity of forest habitats and successional stages to benefit particular species

of wildlife. Others felt that the Service should include some provision for highly dense stands of conifers. One person suggested that the Service should prevent lodgepole encroachment into aspen stands; several others said that willow, aspen, birch, and cottonwood stands should be expanded where possible. Another stated that the Service should manage bitterbrush to reduce the wildfire hazard while maintaining a sufficient amount for mule deer forage. Finally, one commenter suggested that the Refuge would benefit from plans being developed by Fremont-Winema National Forest and the Nature Conservancy to develop desired future condition maps for forested areas adjacent to the Refuge.

It was suggested that the Plan review the following potential issues related to selected logging: sensitive area impacts; timing to minimize adverse impacts; preserving the capability for natural regeneration of trees; effects of large woody structure removal; and measures to prevent invasive species following selected logging. Several urged planting of native seed and seedlings during fire rehabilitation and after mechanical treatments for fuel reductions in ponderosa pine forests as necessary to complete forest restoration.

Fire Management. *How will the Service implement an effective fire management program to improve and/or maintain Refuge habitats while still meeting local, state, and Federal smoke management and air quality requirements? How will the Service manage wildfire on the Refuge? How—and to what extent—will the Service restore fire as a natural process within Refuge plant communities?*

Background. The Refuge has used prescribed fire since 1991 to enhance wetland and upland vegetation and reduce wildfire fuels.

Comments. Several comments supported the use of prescribed fires to improve and maintain refuge habitats. Some suggested the Plan should thoroughly evaluate the effectiveness and the impacts of prescribed burning as a management tool on Refuge habitats. Other comments supported prescribed burns on a one-year to two-year year rotation in wetland and grassland areas to encourage more migratory bird use of the Refuge. Some people thought that prescribed burning was a more effective vegetative management tool than mechanical options like haying or grazing.

One comment indicated that management of ponderosa pine forests should be conducted in a manner to return stands to their historic species composition and stand structure and that prescribed fires should be used at the appropriate fire intervals to create this desired condition. The comment also stated that, if necessary, fire management in forested areas should include planting of native seeds and seedlings as part of the fire rehabilitation. There was support from the U.S. Forest Service for cooperation with the Service on prescribed burns, particularly in areas where the agencies manage contiguous lands. Some comments advocated a much greater use of fire, including implementation of "managed wildland fire" (allowing wildfires to burn in areas that are designated for future prescribed burns).

Some agencies provided comments about impacts of prescribed fires to air and water quality, saying that prescribed burns should be evaluated for their potential affect on sensitive areas, sensitive populations, and air quality protection areas (e.g., Crater Lake and Gearhart Wilderness Area). The agency comments also stated that any prescribed burning should be conducted in accordance with the Oregon Smoke Management program.

Wetland Management. *Should the Service restore the vast areas of densely vegetated emergent marsh to a more historical mix of emergent vegetation, floating leaf (wocus), and open water? If so, how and to what extent?*

Background. Approximately 30,000 acres of wetland and wet meadow habitat occur in the Refuge. There has been a general perception that the condition and health of these habitats have declined because of an increase in dense stands of bulrush and cattails. Management of wetlands has included haying, grazing, and burning to reduce plant densities and revitalize growth.

Comments. A general comment was made indicating that managing wetlands to insure they are functioning properly within the context of their ecosystems should be a top priority on national wildlife refuges.

Numerous comments implied that there has been a gradual encroachment of emergent vegetation into open water areas, resulting in a significant reduction of open water and floating leaf vegetation (wocus) within the marsh. This change in structure and vegetative diversity has resulted in a corresponding decrease in diversity and numbers of many migratory bird species and has had a significant effect on the subsistence rights of the Klamath Tribes. There was some speculation about what has caused this transition. Suggestions included alteration of the natural hydrology, including irrigation ditches, on the Refuge; reduced water inputs into the marsh; accretion of peat from the long-term accumulation of vegetative material; climate change, and possible lowering of Kirk Reef in the past, which reduced the water levels in the marsh (see Hydrology and Water Management summary).

Several comments questioned whether the Plan would evaluate this encroachment of emergent vegetation into the open water areas. There were also questions about whether the Plan will evaluate a potential need to increase emphasis on the management of wet meadows on the Refuge. Finally, there was a comment that the Plan should evaluate the impacts of any management actions on wetlands.

Comments overwhelmingly favored increasing the amount of open water and wocus habitat on the Refuge to "historic" levels (i.e., a hemi-marsh condition). One commenter asked the Refuge to consider creating an impoundment (levee and water control structure) on the Williamson River at the southwest corner of the Refuge that could be used to elevate and regulate marsh water levels to restore a hemi-marsh condition.

Several comments concerned current management of marsh vegetation. One person stated that vegetation in the marsh is excessively overgrown, lowering its value for wildlife. Another stated that overly dense amounts of rank and dead vegetation in wetlands and wet meadows are not good for wildlife, specifically sandhill cranes. Finally, one comment indicated that management actions identified in the Plan should include restoring nutrient cycles in wetland and riparian areas.

Clearwinged Grasshopper Management. *How will the Service manage clearwinged grasshopper populations on the Refuge?*

Background. Clearwinged grasshoppers, widely distributed throughout North America, are a native invertebrate that occur throughout portions of Oregon. The species is considered a pest by the agricultural community. Because it feeds on small grains and grasses, major outbreaks can cause significant economic impacts to ranchers and farmers. As a native invertebrate, this species provides an important food source for a variety of wildlife species and influences Refuge vegetative conditions through grazing. Since the 1960s, this species has been monitored and/or treated on Refuge and private lands to reduce economic impacts to adjacent private landowners. Methods of control have included chemicals such as Malathion, Carbaryl (Sevin®), Dimilin®, and Nosema. The species has known egg bed locations on Refuge and adjacent private lands. Egg beds on Refuge lands are being identified, mapped, and monitored on an annual basis.

Comments. The control of grasshopper outbreaks on the Refuge is controversial, as reflected in the scoping comments. Some respondents would like to see these populations remain untreated on Refuge lands, while others believe treatment is needed to reduce economic impacts to adjacent private landowners. Several requested that the topic of grasshopper control, impacts of current pesticide control measures, and possible long-term solutions to this problem be explored in the Plan, especially recognizing the periodic nature of outbreaks.

Several individuals stressed that the Plan should recognize grasshoppers as a native part of the ecosystem and acknowledge their importance as a grazer and food source for wildlife. In contradiction, a few stated that the Refuge has served as a reservoir for grasshopper populations that have caused economic losses to neighboring rangelands.

A few individuals suggested that early intervention would be a desirable method of control when a population outbreak is likely. Additionally, it was suggested that the treatment strategy devised

in 1995 and evaluated in the 2004 Compatibility Determination should serve as a starting point for evaluating this issue in the Plan. Other suggestions to inhibit future outbreaks included reducing the available egg-laying habitat by removing irrigation ditches, improving grass and forb growth in egg bed areas, and flooding the areas that provide egg-laying habitat. Alternative biological control measures, such as the use of Nosema (a pathogen) or Green Guard (a bio-pesticide), were recommended as potential future control methods.

For lands adjacent to the Refuge, it was suggested that private landowners should implement grazing management operations that improve the density and vigor of grasslands to reduce the availability of egg-laying habitat. As part of a long-term solution, the Refuge was encouraged to acquire and improve lands within the acquisition boundary to further reduce the availability of egg-laying habitat.

Visitor Services. *What kind of visitor services and use levels should the Refuge seek to provide over the next 15 years, and how should the Service manage these uses to maintain compatibility with Refuge purposes?*

Background. Klamath Marsh Refuge currently receives 2,000–4,000 visits per year. Due to the remote nature and large size of the Refuge, and the limited staff, this number is only an estimate. Nearly all Refuge visits involve wildlife-dependent recreation—with the great majority of visits focusing on wildlife observation and photography. The refuge also hosts relatively small numbers of waterfowl hunters, anglers, and visitors experiencing Refuge educational and interpretive services.

Comments. Several comments expressed a strong desire to preserve the remote nature and "feel" of Refuge recreational experiences as a unique aspect of Klamath Marsh. Some respondents felt that to maintain the character and uniqueness of the Refuge, visitor services should not be increased. Other respondents felt the Plan should consider methods of encouraging more people to visit the Refuge to build a base of support, while emphasizing high quality, uncrowded recreational opportunities. Concern was expressed that any proposals to increase public use on the Refuge should first evaluate impacts on wildlife before such use increases or facility development is considered. Several people commented that wildlife, cultural resources, and tribal uses should have first priority on the refuge.

Hunting and Fishing. *What portions of the Refuge should be open to hunting and fishing? How will the Service address future demands for hunting and fishing while being sensitive to tribal uses of Refuge lands?*

Background. The area of Klamath Marsh Refuge south of Silver Lake Road is open to waterfowl, coot, and snipe hunting as designated by state and Federal regulations. Walk-in hunting and motorless boats are permitted in hunting areas, which include Wocus Bay and Little Wocus Bay. Waterfowl hunting varies greatly from year to year depending on the extent of water in the marshes during the fall. In low water conditions, Little Wocus Bay may provide some hunting opportunities, while Wocus Bay is often completely dry. Hunter use of the Refuge has been estimated as nearly non-existent in extreme drought years to over 100 waterfowl hunter visits during wet years. Portions of Klamath Marsh Refuge, including the borrow ditches adjacent to Silver Lake Road and the shoreline of Wocus Bay, are open to fishing. Fishing from boats is prohibited. Based on observations by past Refuge managers, fishing on the Refuge is nearly non-existent. The tribes have subsistence hunting, fishing, and gathering rights throughout the Refuge and surrounding area.

Comments. State Department of Fish and Wildlife comments noted a potential for additional opportunities for waterfowl and big game hunting exist on the Refuge, including areas north of Silver Lake Road, that were acquired after the designation of hunting areas on the original Refuge. Likewise, it was noted that the Williamson River and Big Springs Creek offer opportunities for additional sportfishing on the Refuge. The same comment suggested that the Refuge Plan should explore options to maintain wildlife at optimum levels while enhancing public enjoyment of wildlife. State Fish and Wildlife and U.S. Forest Service representatives expressed a willingness to cooperate in fisheries surveys and new on-refuge sportfishing possibilities.

Several people commented that hunting should not be allowed on the Refuge because one of the Refuge's purposes states that it is an "inviolate sanctuary" for migratory birds. They felt that this seeming inconsistency with Refuge purposes should be resolved in the planning process. Other commenters felt that species and habitat preservation should be taken into account before other uses, including hunting, are implemented. Tribal comments expressed a concern that existing and proposed hunting, fishing, and other programs should be carefully evaluated and allowed only if they don't interfere with traditional tribal uses on Klamath Marsh and surrounding areas.

Wildlife Observation and Photography. *How will the Service provide compatible wildlife-viewing opportunities that maintain the current uncrowded and remote nature of visitor experiences?*

Background. The Refuge has good wildlife observation and wildlife photography opportunities. It also provides scenic and panoramic views along Silver Lake Road, Military Crossing, and the Wocus Bay Road (Forest Service Road 690). Wildlife observation is the primary public use activity on the Refuge, yet many users consider this Refuge a well-kept secret. Developed wildlife-viewing sites consist of small gravel pull-offs along Silver Lake Road and the Wocus Bay overlook, which has three interpretive panels. A canoe area is available for visitor use at the south end of Wocus Bay from July 1 through September 30 each year.

Comments. Most comments supported maintaining the uncrowded nature of current recreational opportunities on the Refuge. Comments ranged from those requesting no increase in visitor service opportunities to others supporting modest public use facility and program development. As with the consideration of other public and commercial uses on the Refuge, some comments suggested that any proposal to increase public use on the Refuge should evaluate impacts on wildlife before use increases or facility development is allowed, with wildlife given first priority. Several people expressed the desire to maintain the current low level(s) of public use and rustic character of Refuge visitor services. Some comments favored non-consumptive public uses over consumptive recreation (e.g., hunting and fishing).

The following suggestions were made at meetings or in written comments.

1. Evaluate the need for better trails.
2. Provide additional opportunities for activities supporting wildlife compatible uses, including nature study, bicycling, canoeing, horseback riding, and hiking, which are restricted to roads.
3. Consider developing more pullouts along Silver Lake Road to enhance wildlife observation.
4. Provide a small visitor center to enhance visitor services.
5. Evaluate the potential to develop photo blinds.
6. Consider developing a birding trail and/or motorized vehicle route with maps.
7. Limit motorized public use to the extent possible.

Interpretation and Environmental Education. *How will the Service provide for an appropriate level and variety of interpretive and educational services while being sensitive to tribal uses of Refuge lands?*

Background. Current interpretive resources at the Refuge consist of interpretive and information panels at the headquarters site and interpretive panels at Forest Service Road 690 turnoff and the Wocus Bay overlook. These panels interpret the key wildlife and cultural resource values of the Refuge and recognize the importance of the marsh as a natural resource base utilized by Native Americans. Management techniques, such as prescribed fire, are also interpreted on the panels. The printed Klamath Basin National Wildlife Refuges brochure and Web page also interpret Refuge resources and issues to a wider audience. The Refuge responds to requests for environmental education programs on a case-by-case basis.

Comments. In addition to the facilities and programs mentioned previously in the Wildlife Observation and Photography section, agencies and individuals had suggestions for improving interpretive and educational services. Tribal members felt that the Service should provide Refuge visitors information concerning tribal treaty rights so that potential conflicts between tribal members and other Refuge users can be avoided. Another comment suggested the Refuge should have

its own brochure that explains Refuge regulations and includes a detailed road and boundary map. It was suggested that interpretive and educational materials be prepared that focus on the uniqueness of Klamath Marsh.

Law Enforcement and Vehicular Access. *How will the Service provide effective law enforcement on Refuge lands?*

Background. An on-site law enforcement officer that is dual function—meaning multiple responsibilities in addition to law enforcement—has been stationed on the Refuge from 1990 to present. Prior to 1990, coverage for law enforcement patrols of the Refuge originated from the Klamath Basin Complex office in Tulelake, California. Additional Service support is available from the Klamath Basin Complex and Region. The Oregon State Police enforce regulations within the area and have a long history of protecting resources in and around the Refuge. The tribes have a law enforcement officer that patrols and enforces tribal law within and around the Refuge.

Comments. Issues were raised by agencies and individuals related to law enforcement concerns and motorized access. Several people commented that the large size, extensive road access, limited law enforcement presence, and remote nature of the Refuge make effective law enforcement difficult to impossible and felt that roads should be closed if they facilitate illegal hunting or cultural resource damage. Further, they felt that Refuge staff should work with Fremont-Winema National Forest to gate or eliminate some roads, particularly in the Wocus Bay and Little Wocus Bay areas, to protect wildlife and cultural resources. Finally, other law enforcement issues, including poaching and illegal coyote shooting, should be addressed in the Plan.

Other Recreational Use. *Will the Service consider allowing additional or restricting current non-wildlife-dependent recreational activities on the Refuge? If so, which activities?*

Background. Non-wildlife-dependent recreational activities are those that do not require the presence of wildlife to enjoy the specific activity. Activities currently permitted on the Refuge that are not necessarily wildlife-dependent include cycling, snowshoeing and cross-country skiing along designated Refuge roads, and canoeing at Wocus Bay.

Comments. Two comments stated that allowing additional visitor activities, including bicycling, horseback riding, and hiking, could be beneficial to the Refuge if these activities were restricted to existing roads. Another comment supported the creation of additional non-motorized wildlife observation opportunities, including hiking, canoe, and kayak trails.

One person asked if camping—in support of wildlife observation—should be allowed because of the remote nature of the Refuge.

A significant number of comments concerned road management and vehicle access on the Refuge. There was a question about whether the Plan will address the amount of Refuge closed to foot access and the impacts of vehicle access and roads. Many people asked if the Plan would evaluate the impacts of roads and other recreational access on wildlife and cultural resources and the possible need to close some roads. Some thought the impacts of current and proposed roads should be evaluated, as should the criteria for proposed road closures. Many comments favored limiting roads to only those necessary for Refuge purposes, limiting motorized public use to the extent possible, and closing roads if they facilitate illegal hunting or cultural resource damage. Several comments indicated that the Refuge should work with the Fremont-Winema National Forest to gate or eliminate some roads, particularly in the Wocus Bay and Little Wocus Bay areas, to protect wildlife and cultural resources. A few comments said that the Refuge should develop and maintain public access to wildlife resources where practical and compatible with the primary purposes of the Refuge. Finally, there were comments supporting cooperation with the Klamath Tribes to close a road to an important cultural site.

Cultural Resource. *How will the Service protect and manage cultural resources on the Refuge?*

Background. Klamath Marsh Refuge is recognized by the Service as extremely important spiritually and culturally to the Klamath Tribes. Current cultural resource protection measures on the Refuge include fencing, interpretative panels to

educate visitors about the importance of the area to the Klamath Tribes, law enforcement patrols, and reducing roads in sensitive areas.

Comments. It was requested by some that the Plan address the significance of cultural resources in such a way as not to put those resources at risk. It was also suggested that the Refuge should develop a protection, monitoring, and patrol plan for archaeological sites and resources.

Administration and Operation. *How will future funding for operating, staffing, and administering the Refuge be addressed in the Plan, and how will future volunteer programs be supported?*

Background. Service staff stationed on the Refuge includes a Refuge manager and maintenance worker. Additional assistance for administrative, public use, biological monitoring, maintenance, and fire programs is provided by the Klamath Basin Refuge Complex Office in Tulelake, California. Year-round Refuge housing is only available for one position, and a duplex provides housing for several seasonal staff. Volunteers are welcome if staffing is available to provide supervision.

Comments. Multiple comments encouraged the Refuge to address the volunteer program in the Plan—specifically, expanding opportunities or providing future incentives.

Concerns were raised in meetings and through comment letters regarding funding for the Refuge and how the plan would address future staffing and project funding needs. Numerous comments cited the need for a full-time biologist and additional support for maintenance operations. Some commented that managers should not initiate new programs if sufficient funds aren't available to support them.

Long-term management of Refuge lands was identified as a concern, and several believe that lands within the Refuge system should always remain under the management of the U.S. Fish and Wildlife Service.

Tribal Subsistence Rights. *How will the Service address tribal subsistence rights on the Refuge?*

Background. The courts have recognized that the Klamath Tribes have subsistence hunting and gathering rights within the boundary of their former reservation lands, which includes the entire Klamath Marsh Refuge. The U.S. Fish and Wildlife Service is committed to working with the tribes on a government-to-government basis as required by policy and executive orders, and to develop the best possible Plan with regards to tribal concerns and issues.

Comments. Several tribal and non-tribal participants expressed concern that the Plan should recognize the unique status of the Klamath Tribes concerning subsistence hunting and gathering rights, and their long-standing cultural and spiritual ties to the marsh.

Several comments also indicated that during the Plan process, the Klamath Tribes should be consulted on a government-to-government level to address proposed management actions within the Plan.

There was concern by the tribes regarding the primary purposes for which the Refuge should manage the land. Managing for the subsistence needs of the tribes by maintaining healthy populations of fish, wildlife, and wocus was emphasized during meetings.

The 15-year lifespan of the Plan was a concern for some tribal interests, who requested that if Plan projects negatively affect tribal subsistence rights or cultural resources, the Plan be modified to moderate such negative impacts.

Multiple comments expressed concern that the tribes are able to hunt and gather resources during a majority of the year and concern about hunting techniques. Several comments urged that tribal members should not be able to harvest game using spotlights at night or harvest doe deer or cow elk during the critical carrying, calving, fawning, and/or young-rearing periods. Several wanted to know what the tribes are allowed to do on Refuge lands and requested that information be contained in the Plan.

2.2.6 Development of the Refuge Vision

A vision statement is developed or reviewed for each individual refuge unit as part of the Comprehensive

Conservation Plan process. Vision statements are grounded in the unifying mission of the National Wildlife Refuge System and describe the desired future conditions of the refuge unit in the long term (more than 15 years). They are based on the refuge's specific purposes, the resources present on the refuge, and any other relevant mandates. Please refer to Chapter 1 Section 1.5.1 for the Klamath Marsh National Wildlife Refuge vision statement.

2.2.7 Determining the Refuge Goals, Objectives, and Strategies

The purpose for creating the Refuge is established by law (Chapter 1). The 1997 Improvement Act directs that the planning effort develop and revise the management focus of the Refuge within the Service's planning framework, which includes the U.S. Fish and Wildlife Service (Service) mission, the National Wildlife Refuge System (System) mission, ecosystem guidelines, and refuge purposes. This is accomplished during the Comprehensive Conservation Plan (Plan) process through the development of goals, objectives, and strategies (see Chapter 4 Section 4.3).

2.2.8 Development of the Refuge Management Alternatives

The development of alternatives, assessment of their environmental effects, and the identification of the preferred management alternative are fully described in the environmental assessment (EA) (Appendix G). Alternatives were developed to represent reasonable options that address the specific Refuge issues and challenges. A "no action" or continuation of current management alternative is required by the National Environmental Protection Act (NEPA). Other alternatives studied are briefly described in the following text.

Alternative A: No Action

This alternative, required by the National Environmental Policy Act (NEPA), provides a baseline against which to compare the two action alternatives (alternative B and alternative C). This alternative would continue current Refuge management practices already underway or currently funded. The Refuge would continue the current direction of managing habitat, wildlife, and visitors. In pursuing the habitat goal, Alternative A would manage habitats largely as they are managed at present. No major changes would be initiated by the Service.

The most recent Refuge-wide management plan was completed in 1987. This plan is no longer applicable, given that significant acreage has been added to the Refuge since 1987. Recent management has followed existing step-down management plans, most which need updating:

- Sport Hunting Plan for Klamath Marsh National Wildlife Refuge 1985
- Klamath Forest National Wildlife Refuge Management Plan 1987
- Habitat Management Plan 1991
- Fisheries Management Plan 1992
- Fire Management Plan 2001
- 2003 Klamath Marsh National Wildlife Refuge Fire Hazard Reduction and Wildlife Habitat Enhancement Project Environmental Assessment
- Water Management Strategy, 2008

Alternative B: Optimize Habitat Restoration and Enhance Visitor Services (Preferred Alternative)

Under this Alternative, the Refuge would pursue restoration of the Williamson River and Big Springs Creek channels and affiliated wetlands, as funding becomes available. The Service would pursue restoring the portions of the Williamson River and Big Spring Creek on the Refuge to their historic natural functioning conditions to the extent possible. Management of emergent marsh, meadows, ponderosa pine forest, and aspen habitats would be substantially improved via use of various tools (fire, haying, grazing, herbicides, etc.) to increase habitat value for migratory birds and other wildlife. Opportunities for all non-consumptive priority public uses would be expanded, and hunting and fishing programs would be considered for expansion after river restoration is completed. There would be a focus to increase cultural resources protection, and no units of the Refuge would be recommended for

wilderness designation. The Service would also revise and update the memorandum of understanding (MOU) with the tribes regarding subsistence hunting and gathering. Staffing and funding would levels would need to increase to implement this alternative.

Alternative C: Moderate Habitat Restoration and Limited Visitor Services Improvements

Under Alternative C, the Service would also restore the portions of the Williamson River and Big Springs Creek on the Refuge. Management of emergent marsh, meadows, ponderosa pine forest, and aspen habitats would be improved using a more limited tool set (fire only for non-forested areas). Opportunities for non-consumptive public uses would only be minimally expanded, and public hunting would be eliminated. Cultural resource protection would be increased, and 11,165 acres would be recommended for wilderness designation. The Service would also revise and update the MOU with the tribes regarding subsistence hunting and gathering. Staffing and funding would levels would need to increase to implement this alternative.

2.2.9 Public Review of the Draft CCP/EA

The Draft CCP/EA was available for public review and comment for a 45-day period from August 4, 2009 to September 18, 2009. The document was distributed to Federal, State, and local agencies; public libraries; potentially affected landowners; private groups, and individuals.

The Refuge hosted public meetings in Klamath Falls and Chiloquin, OR on August 18th and 19th, 2009, respectively. Both meetings were held in the evening from 6:30 p.m. to 8:30 p.m. These meetings were attended by a wide range of people, including staff from Federal, State, and local agencies; representatives of organizations; neighbors of the Refuges; and other members of the general public. Refuge staff made formal presentations and provided time for questions and comments. Hardcopies and CDs of the Draft CCP/EA were available for the public to review and take with them. Meetings attendees were invited to provide comments on the contents of the Draft CCP/EA.

The Refuge received a total of 56 comment letters. Appendix T provides responses to the substantive comments received on the draft CCP. The Final CCP/EA has been modified to meet and address the concerns that were raised, as appropriate.

2.2.10 Selection of an Alternative for Implementation

Following comprehensive review and analysis, the Service selected Alternative B for implementation because it best meets the following criteria:

- achieves the mission of the National Wildlife Refuge System;
- achieves the purposes of the Refuge;
- provides guidance for achieving the Refuge's 15-year vision and goals;
- maintains and restores the ecological integrity of the habitats and populations on the Refuge;
- addresses the important issues identified during the scoping process;
- addresses the legal mandates of the Service and the Refuge; and
- is consistent with the scientific principles of sound fish and wildlife management and endangered species recovery.

Chapter 3. Summary of Refuge Resources and Environment

3.1 Physical Environment

3.1.1 Geographic/Ecosystem Setting

Klamath Marsh National Wildlife Refuge (Klamath Marsh Refuge, Refuge) encompasses 40,885 acres of its approved 49,583 acre acquisition boundary, and is located in south central Oregon along the Williamson River. The Refuge is situated on the east slope of the Cascade Mountain Range between the historic Mount Mazama (Crater Lake), about 15 miles to the west, and the sage-dominated plains of eastern Oregon that are located about 45 miles to the east. The entire Refuge is within Klamath County and at the extreme northern end of the Klamath Basin. Geographically, the Refuge is divided into the upper (north) and lower (south) marsh by the road known as Military Crossing (Figure 1.1).

Biogeographers have divided North America into provinces, natural regions that share similar climate, soils, topography, and vegetation. The Upper Klamath River Basin is within the geologic provinces of the Cascade Range and Modoc Plateau. The Cascade Range extends northward through Oregon and Washington into British Columbia, and the Modoc Plateau extends into Oregon and southeastward into Nevada. Most of the Cascade Range is a fairly well-defined province; but in the Upper Klamath Basin, the separation between it and the Modoc Plateau becomes harder to define. Major characteristics of the Modoc region include a dominance of volcanism recent enough that volcanic forms are still present, such as Crater Lake and Mount Shasta, and the presence of broad and flat basalt plains or plateaus. The Upper Klamath Basin region supports some large and geographically old wetlands (USFWS 1998).

The U.S. Fish and Wildlife Service's ecosystem approach to natural resource management has identified 52 different ecosystems within the United States. Klamath Marsh National Wildlife Refuge lies within the Klamath/Central Pacific Coast ecosystem. This ecosystem encompasses the entire Klamath River drainage from south central Oregon to the northwest coastal region of California (USFWS 1998).

The entire Klamath Marsh Refuge lies within lands that made up the Klamath Tribes' former reservation (Figure 1-1). This reservation is comprised of about two million acres and was established through an 1864 treaty between the United States and the Klamath and Modoc tribes and the Yahooskin band of Snake Indians. Termination of Federal supervision of the tribes, per the Klamath Termination Act of 1954 and subsequent government actions, resulted in the conveyance of former reservation lands to Federal and private entities. Portions of the former reservation lands were purchased by the U.S. Fish and Wildlife Service (Service) for the creation of Klamath Marsh Refuge (see sections 1.4.2 and 1.4.3).

3.1.2 Climate

Situated on the downwind side of the Cascade Mountain and only 15 miles east of historic Mount Mazama and Crater Lake, there is significant weather variability within a relatively small geographic area surrounding the Klamath Marsh. While long-term weather data has been not collected directly on Klamath Marsh Refuge, the National Oceanic and Atmospheric Administration maintains Cooperative Climate Stations near Chiloquin (Chiloquin 7 NW), about 18 miles to the southwest at a 4,160-foot elevation, and near Chemult (Chemult 2 N), about 15 miles to the north-northwest at a 4,760-foot elevation. The edge of Klamath Marsh is situated at about 4,515 feet above sea level. The U.S. Fish and Wildlife Service began collecting weather data remotely in June 2002 at a station located about one mile south of the Refuge headquarters (NOAA 2008).

The Refuge's climate is characterized by long, cold winters and short, warm summers; however, freezing temperatures can occur virtually any day of the year. From 1981 through 2002, the average span of frost free days (32 degrees Fahrenheit) in the summer ranged from 23 days (Chemult 2 N) to 73 days (Chiloquin 7 NW). Average maximum temperatures (1980 through 2005) in July ranged from 81.7 to 82.5 degrees Fahrenheit, while average minimum temperatures in January ranged from 19.6 to 15.5 degrees Fahrenheit, respectively, for stations Chiloquin 7 NW and Chemult 2 N.

Air masses from the Pacific Ocean, greatly modified after passing over the Cascade Mountains, and air masses moving down from western Canada are the major weather factors influencing the area and result in a much drier climate than that of western Oregon. The majority of the precipitation falls during the winter months of November through March, while the driest months are typically June through September. Total average annual precipitation (1980 through 2005) ranged from 20.23 inches (Chiloquin 7 NW) to 25.09 inches (Chemult 2 N), while total average annual snowfall ranged from 63.5 to138.4 inches, respectively. Annual snowfall at Crater Lake National Park, just 15 miles west of Klamath Marsh Refuge, averaged 523.5 inches per year from 1931 through 2005. Prevailing winds are southerly from November through February, westerly from March through July, and northerly from August through October. Wind speeds average from 4.4 miles per hour in September to 7.3 miles per hour in March but are calm 17 to 33 percent of the time (USDA Soil Conservation Service 1985). Klamath Marsh is located in Oregon Climate Division 5, the High Plateau. Average annual precipitation in Climate Division 5 for the period 1980–2005 is 24 inches per year, but there is a considerable range in precipitation within this climate division, which includes Crater Lake National Park as well as the Klamath Marsh.

3.1.3 Air Quality

Air quality on the Klamath Basin can be described in terms of climate, regulatory requirements, and ambient air quality conditions. Climate and meteorology describe the atmospheric conditions, which affect the general air quality. Air quality regulations define the limits and controls on emissions necessary to maintain good air quality in the region. Ambient air quality provides a measure of the ambient concentration of various pollutants that affect air quality. This section defines the regulatory requirements for the Klamath Basin.

Federal and state governments have each established ambient air quality standards for several pollutants. Most standards have been set to protect public health. However, standards for some pollutants are based on other values, such as protecting crops and materials and avoiding nuisance conditions.

Federal Air Quality Standards

The 1990 Clean Air Act amendments divide clean air areas into three classes and specify the increments of sulfur dioxide (SO2) and particulate pollution allowed in each. Klamath Marsh Refuge is designated as a Class II quality area. By definition, Class II areas are set aside under the Clean Air Act but are identified for somewhat less stringent protection from air pollution damage than Class I areas. Allowable increments of new pollution are modest. Crater Lake National Park, located about 15 miles west of the refuge, is designated as a Class I area.

The primary means by which the protection and enhancement of air quality is accomplished is through implementation of National Ambient Air Quality Standards (NAAQS). The U.S. Congress has promulgated these standards to regulate ambient air quality throughout the nation. The pollutants regulated under NAAQS include nitrogen dioxide (NO2), sulfur dioxide (SO2), carbon monoxide (CO), particulate matter less than 10 microns (PM10), and ozone (O3). Areas where measured concentrations of these pollutants are above the NAAQS are defined as nonattainment areas. All others are defined as attainment. Klamath Marsh Refuge occurs in a region that has been classified as an attainment area for all NAAQS criteria pollutants (Environmental Protection Agency 2008).

3.1.4 Hydrology, Water Rights, & Water Quality

The following information is summarized from the Klamath Marsh Hydrology and Water Rights report (Mayer et al. 2007). The entire report can be found in Appendix O.

Inflows to the Klamath Marsh come from precipitation, surface water sources, and groundwater discharge.

Precipitation

See Section 3.1.2 Climate for a summary of the area's precipitation patterns.

Surface Water

The two main surface water sources for the marsh are the Williamson River and Big Springs Creek. The main source, the Williamson River, emanates from springs and seeps east of the marsh near Yamsey Mountain. It enters the Refuge on the east side, near the Refuge office. U.S. Fish and Wildlife Service staff measure flows continuously at the two channels where the river enters the Refuge. Generally, river flows are greatest during the winter and spring, with lower flows in the summer and fall. Once on the Refuge, a network of channels and canals distribute Williamson water to the northeast section of the Refuge, north of Military Crossing.

South of Military Crossing, the river lacks a defined channel. It spreads out to feed wetlands north and south of Silver Lake Highway, finally forming a channel and exiting the Refuge at the southwest corner. Historically, the lower marsh was wetter than the upper marsh, with the largest expanse of permanent water. However, in recent years, the upper marsh has been wetter. Sedimentation in the river channel downstream of Military Crossing in the 1990s may prevent water from moving to the lower marsh, causing the upper marsh to be wetter now (Walt Ford, former Refuge Manager, personal communication, 2002).

Big Springs Creek, the second major surface water source, enters the marsh on the west side—south of Military Crossing. The stream originates from springs in the forested pumice plateau at the southwestern edge of the marsh. A large spring identified as "Big Springs" marks the headwater spring at an approximate elevation of 4,535 feet msl (LaMarche 2002). There is a long period of miscellaneous measurements and two recent periods of continuous measurements for this stream.

Compared to the Williamson River, annual flow at Big Springs is quite variable. At times, Big Springs can be a major source of inflow for the marsh; however, at other times, the stream does not flow at all. The lack of continuous flow measurements for any length of time prevents a meaningful estimation of the annual mean or coefficient of variation. The stream was reportedly dry from 1931–1951 (Leonard and Harris 1974); it was relatively dry during the early 1990s and has been for the past five years. However, the stream reportedly flowed continuously during a relatively wet period from the 1950s to the 1970s, with a low-flow discharge of 20–80 cubic feet per second (Norvelle et al. 1981). Flows were also fairly high and continuous during the late 1990s (Walt Ford, former Klamath Marsh Refuge Manager, oral communication, 2004).

Several other streams exist to the west (Sand, Scott, and Bear creeks) and northwest (Miller, Sink, and Cottonwood creeks) of the marsh, but none of them currently reach the marsh as surface flow. Whether they did historically is questionable, although Evans (2005) refers to them as tributaries of the Williamson River. During wet years, the northern area of the upper marsh receives water from several intermittent streams (Three Creeks; God, Mosquito, and Lane creeks) that flow in the spring.

At the southwest corner of the marsh, the Williamson River re-forms and meanders in a well-defined channel through 14 miles of fairly flat land and through an open pond, known as Soloman Flat, before reaching a natural basalt plug at Kirk Reef. This basalt sill acts as a control for river flow and marsh water levels. The outflow from the marsh is dependent on both water surface elevations in the marsh and inflow to the marsh. During summer, the water level in the river and wetland usually drops below the elevation of the basalt sill, causing the river to stop flowing at this location until water levels increase again in response to fall rains. Historically, the river flow at Kirk Reef has stopped during the summer in about 70 percent of

years. There has been considerable discussion and speculation regarding the possible alteration of the basalt sill at Kirk Reef sometime in the past. It is believed that the sill was lowered from its historic level, but this question is still unresolved.

Hydrographs of the Williamson River at Kirk Reef from 1955 through 2006 show wet and dry cycles at approximately five- to seven-year intervals and an overall declining trend from the 1950s to the present. This declining trend mirrors the decrease in precipitation observed in Oregon Climate Division 5. The decrease in outflows from the marsh, as observed at Kirk Reef since the 1950s, is likely due to the decrease in winter precipitation observed since the 1950s in Oregon Climate Division 5.

The variability in annual outflows from the marsh is much greater than the variability in annual inflows into the marsh and likely reflects the greater variability in unmeasured spring discharge and groundwater seepage into the marsh. On average, 70,000 acre-feet more water exits the marsh in a given water year than flows into it from the Williamson River (Mayer et al., 2006). Some of this excess water exiting the marsh is tributary inflow, including flow from Big Springs, and some is precipitation falling directly on the marsh. However, there is also is a large evapotranspiration demand that is satisfied before the water outflows from the marsh. If the vegetation within the 41,000 acres of marsh has an annual evapotranspiration (ET) rate of three acre-feet per acre, this equates to an evapotranspiration requirement of at least 120,000 acre-feet per year. The fact that there is still a considerable outflow in many years from the marsh—even after evapotranspiration needs are met—suggests there is a sizeable groundwater contribution to the marsh in addition to the surface water inflows.

Groundwater

The entire marsh is an area of groundwater discharge. Precipitation, in the form of rain or snow, falls in the surrounding mountains, infiltrates the groundwater system, and discharges to the marsh. The western margin of the basin is the primary zone of groundwater recharge because of the high precipitation in the Cascades. Snowmelt and rainfall in the Cascades readily move underground before rising to the surface at Klamath Marsh. South of the marsh, the basalt sill at Kirk Reef restricts drainage from the marsh, causing water to pond up behind it. Groundwater appears to be an important component of the marsh water budget and may even exceed surface water inflows by some estimates (Norvelle et al. 1981).

Several observation wells in the Klamath Marsh area have been monitored by OWRD or U.S. Geological Survey (USGS). None of these wells have a long period of record. Most have been monitored since about 2000.

Marsh Levels

The water surface elevations of the marsh vary seasonally and annually, integrating all the climatological and hydrological stresses affecting the marsh. More than marsh inflows and outflows, the Klamath Marsh water surface elevation record underscores the marsh's response to wet and dry year cycles rather than individual years. For instance, in 2001, marsh levels were basically unchanged from the prior year, despite 2001 being the second driest winter and water year on record in Climate Division 5 since 1895. However, by 2005, following six years of below average precipitation, the annual minimum water surface elevation had dropped by about two feet. The marsh levels did not respond to the extremely dry year in 2001 but did respond to a sequence of dry years from 2000 through 2005.

Annual minimum elevations appear to be more affected by wet and dry cycles than the annual maximums. Maximum water surface elevations in winter and spring vary about two feet over the 1992–2006 period, from 4,512.86 feet in 1992 to 4,514.74 feet in 1999. Minimum water surface elevations in summer and fall vary about four feet over the same period, from 4,509.43 feet in 1994 to 4,513.11 feet in 1999. The greater range of minimum elevations is related to several factors. First, the outflow from the marsh increases with increasing marsh elevation, thereby buffering or limiting maximum water levels in the marsh. Second, marsh evapotranspiration should be relatively constant from year to year, while analyses

suggest groundwater discharge is highly variable—depending on whether the area is in a wet or dry precipitation cycle. In dry cycles, groundwater discharge will not be available to replenish the surface water lost to evapotranspiration in the marsh, causing minimum water levels to drop. This implies that dry cycles will affect summer and fall water levels more than winter and spring water levels. This has implications for the biological resources and management of the marsh.

Water Quality

Klamath Marsh National Wildlife Refuge is located within the Williamson River Sub-basin, one of three hydrologic units within the Upper Klamath Lake Drainage Basin. The Upper Klamath Lake Drainage Basin does not meet several water quality standards and has stream segments listed for temperature, dissolved oxygen, chlorophyll-a, pH, and habitat modification. The Federal Clean Water Act requires a Total Maximum Daily Load (TMDL) to be established when a waterbody does not meet water quality standards. A TMDL is a plan that determines how a waterbody will attain and maintain water quality levels specified in water quality standards and how much pollution can be added to a waterbody without exceeding water quality standards. The Oregon Department of Environmental Quality (ODEQ) established a TMDL for the Upper Klamath Lake Basin in May 2000 (ODEQ 2008).

The TMDL addresses temperature, dissolved oxygen, chlorophyll-a, and pH but not habitat modification. As part of the TMDL, ODEQ identified all Federal, state, and local agencies within the basin that are responsible for contributing pollutants and affecting pollution through their land or water management activities. These agencies are called designated management agencies (DMAs). The U.S. Fish and Wildlife Service (Service) has been named as a DMA because it has legal authority of the 41,000-acre Klamath Marsh Refuge in the Williamson River Subbasin.

Stream temperature and sediment are the major water quality concerns with the Williamson River. Warm stream temperatures are a threat to native fish in the river, primarily redband trout. Suspended sediment can be harmful to fish as well, and it can transport phosphorus and organic matter downstream, contributing to eutrophication concerns in Upper Klamath Lake. Stream temperature and sediment are affected by human activities through reduction of riparian habitat, increase in channel width, alteration of flow, and diversion and withdrawal of water.

In a letter to ODEQ, dated April 1, 2004, the Service explained that most of the Refuge's management activities are expected to improve water quality through the marsh. Prior to ownership and management by the Service, much of the marsh had been managed for cattle ranching and haying. Under these activities, water was diverted through numerous ditches for irrigation, held in the fall and winter, and subsequently pumped off in the early spring to allow for grazing and haying. The marsh was not allowed to hold water and slowly release it throughout the season. The natural hydroperiod of the marsh was interrupted and shortened.

Since the Service acquired the marsh, water and land management have changed. There is much less cattle grazing on the Refuge now than prior to the establishment and expansion of the Refuge. Because of the reduction in grazing and haying, it is no longer necessary to pump off water from areas in the spring. Water is initially diverted at the upstream boundary of the Refuge through either Cholo Slough or the old Williamson River channel. This water is spread throughout the marsh and allowed to outflow naturally throughout the season. The natural hydroperiod of the marsh has been restored to a large extent.

The Refuge is also in the process of reestablishing willows and other riparian vegetation for bank stabilization along the Williamson River and other waterways. This effort will help in terms of water temperatures and sediment reduction.

There are very few (if any) anthropogenic inputs of nutrients or other pollutants within the Refuge, and the marsh probably functions to reduce those inputs from upstream areas. The restoration of natural wetland hydrology and the reduction of cattle grazing at the marsh have probably improved water quality. The Service believes that

its water management at the Refuge has little or no impact on water quality beyond the natural function of the marsh.

Water Resources and Rights

The Service holds both water rights and water right claims for the Klamath Marsh National Wildlife Refuge (Table 3-1, Figure 3-1). In the 1970s, the Service wanted to develop water control and infrastructure on the lower marsh area of the Refuge but was reluctant to do so without certainty regarding water rights. In 1975, the United States filed suit in Federal court for a declaration of water rights in the area of the former Klamath Indian Reservation, including the Refuge (*United States v. Adair)*. In 1986, the parties to the Adair case negotiated a settlement recognizing a Federal reserved water right for the Refuge for "all Klamath Marsh lands now within the Refuge, which has an area of 16,377 acres." This acreage included the original acquisition in the lower marsh. The priority date of the right is 1985 for all parties to the Adair case and 1960 for all others. The settlement left out the exact quantification of the Federal reserved right for the Klamath Basin adjudication; however, it did state that the United States "has a water right of a quantity of water for the proper mix of free water surfaces, emerging vegetation, and meadow essential to the operation of the Refuge for the purposes set forth in the Orders and Laws creating the Klamath Forest National Wildlife Refuge."

In the 1990s, the Service initiated several studies to define the "proper mix" of habitat and quantify the water requirements of this habitat mix (Bidlake 1997; Bidlake and Payne 1997; Weddell 1997; Weddell et al. 1998). This work was used to quantify the volume and timing of water for the Federal reserved water right claim in the Klamath Basin adjudication. In 1997, the Service filed a Federal reserved water right claim (number 300) in the Klamath Basin adjudication for 59,549 acre-feet annually for the "Adair lands" in the lower marsh.

Table 3-1. Water rights for Klamath Marsh Refuge as of June 2008.

Claim Number	Type of Water Right and Size	Source of Water	Priority Date	Amount Acre feet/year (af/y) Cubic feet/second cfs	Season	Status
Federal Reserve Claim 300	Federal Reserve 15,591 acres	Williamson River	1985–1960	59,549 af/y	1/1–12/31 (use) 10/1–6/30 (diversion)	Under Adjudication
Claim 301	Walton 4,859 acres	Williamson River	1864	60.7 cfs 14,576.7 af/y	Irrigation Season	Under Adjudication
Claim 302	Walton 5,701 acres	Williamson River	1864	71.27 cfs 17,104 af/y 5.0 cfs (stock) 3,613.5 af/y	Irrigation Season 1/1–12/31	Under Adjudication
Claim 303	Walton 69 acres	Williamson River	1864	1.73 cfs 208.2 af/y	Irrigation Season	Under Adjudication
Claim 304	Walton 160 acres	Williamson River	1864	4.0 cfs 480 af/y	Irrigation Season	Under Adjudication
Claim 305	Walton 320 acres	Williamson River	1864	8.0 cfs 960 af/y	Irrigation Season	Under Adjudication
Claim 306	Walton 319 acres	Williamson River	1864	7.98 cfs 957 af/y	Irrigation Season	Under Adjudication
Claim 307	Walton 813 acres	Big Springs Creek	1864	10.2 cfs 2,439 af/y	Irrigation Season	Under Adjudication

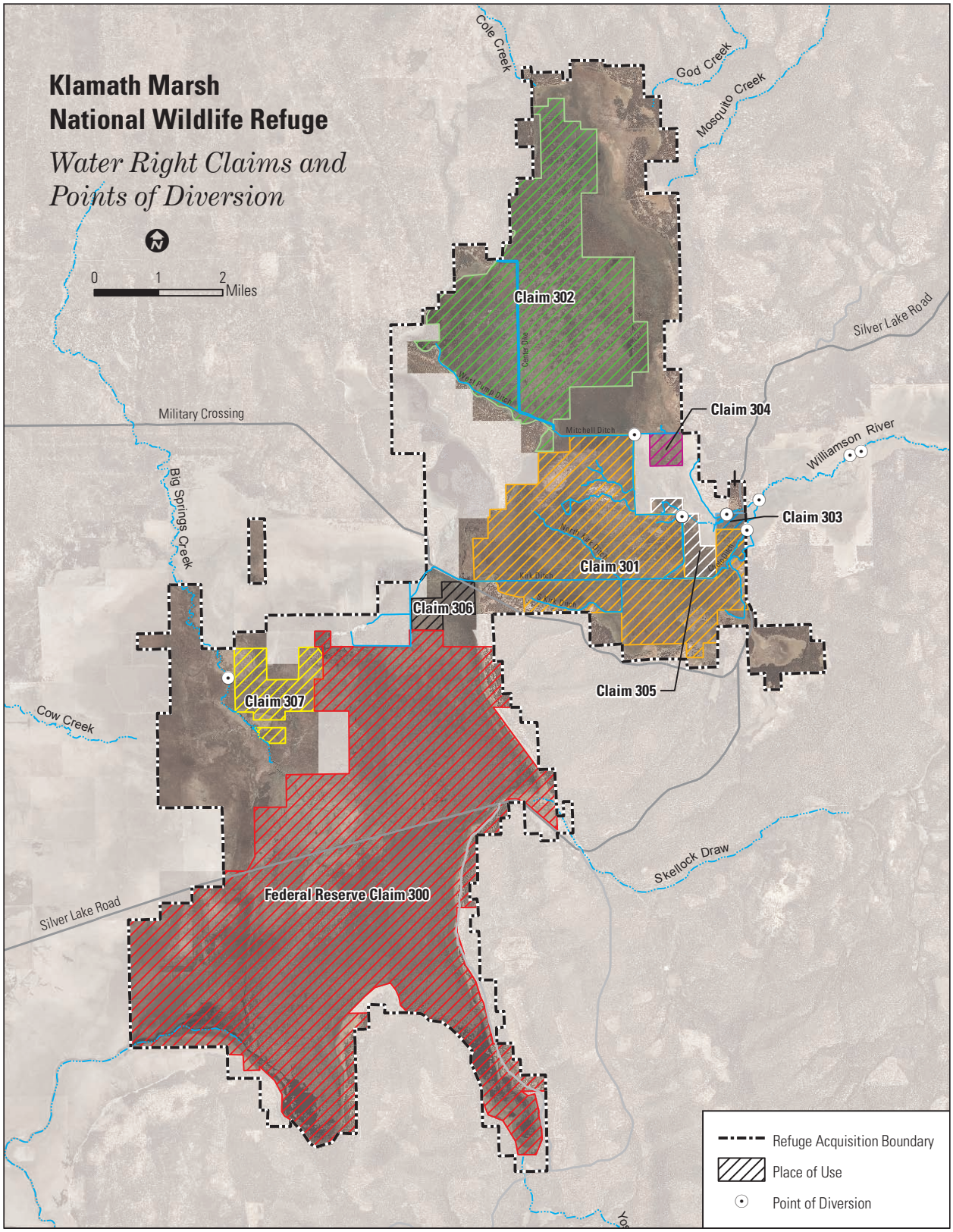


Figure 3-1. Water rights claims and points of diversion

The Service also acquired state appropriative water rights appurtenant to the private ranch lands in the upper and lower marshes that were purchased and added to the Refuge after the Adair decision. The rights are primarily for stock water and irrigation. Because the water use on these lands was developed at the time of Indian ownership or shortly after, and the water has been used continually since that time, these lands are eligible for a Walton water right. The priority date is 1864, the date of establishment of the Klamath Indian Reservation. In 1997, the Service filed seven Walton water right claims (numbers 301–307) in the Klamath Basin adjudication for these lands. The point(s) of diversion, duties, place(s) of use, and purposes of the Walton right claims are generally the same as the existing state appropriative water rights for these lands. The major difference between the Walton rights and the existing state appropriative rights is the earlier priority date of the Walton rights. The total volume of water claimed in the Walton rights is 40,339 acre-feet annually.

Altogether, the total volume of water under all refuge water right claims filed in the adjudication is 99,888 acre-feet annually (Table 3-1). A final decision on the claims is pending (Mayer et al. 2007).

All the Klamath Marsh water rights that have been recorded are for "irrigation use." As defined by Oregon State OAR 690-300-0010 (26), irrigation means "the artificial application of water to crops or plants by controlled means to promote growth or nourish crops or plants. Examples of these uses include but are not limited to watering of an agricultural crop, commercial garden, tree farm, orchard, park, golf course, play field, or vineyard; and alkali abatement." An Oregon judge has decided that this covers application of water to grow waterfowl food as well. Water rights held by Klamath Refuge are required to be exercised once every five years as stated in ORS 540.610(1) "Whenever the owner of a perfected and developed water right ceases or fails to use all or part of the water appropriated for a period of five successive years, the failure to use shall establish a rebuttable presumption of forfeiture of all or part of the water right." The Refuge has a steady record of using all water rights on an annual basis.

3.1.5 Climate Change and Water Resources

Climate change is expected to significantly affect water resources in the western United States by the mid twenty-first century (Barnett et al. 2008). Climate change is generally predicted to result in increased air and water temperatures, decreased water quality, increased evaporation rates, increased proportion of precipitation as rain instead of snow, earlier and shorter runoff seasons, and increased variability in precipitation patterns (Adams and Peck 2002). Several studies have suggested the impacts of climate change are already being felt in the form of declining snowpack, earlier spring snowmelt, and earlier stream runoff in the western United States over the past few decades (Hamlet et al. 2005; Stewart et al. 2005; Knowles et al. 2006). Winter precipitation and snowpack have been shown to be strongly correlated with streamflow in the Pacific Northwest (Leung and Wigmosta 1999).

Increasing temperature trends are the major drivers of these observed trends, particularly at the moderate elevations and relatively warm winter temperatures characteristic of the Pacific Northwest (Hamlet et al. 2005; Stewart et al. 2005). Temperatures are uniformly projected to continue increasing over the next few decades, about 0.2˚C per decade globally for the next two decades (IPCC 2007). Projections of changes in precipitation with climate change vary widely among models. However, some investigators report that increasing temperatures will result in decreasing April 1st snowpacks that will offset any precipitation increases in the region (McCabe and Wolock 1999; Hamlet et al. 2005).

Two recent reports have examined climatologic and hydrologic information for the marsh and the Upper Klamath Basin. Mayer et al. (2007) showed that hydrographs of both the inflow and outflow at the marsh are strongly correlated with five- to seven-year wet/dry cycles in precipitation. The cycles are superimposed over a long-term declining trend extending for several decades. Inflow and outflow at the marsh are lower now than at any time during the period of record.

Mayer (2008) focused on a broader area of the Upper Klamath Basin and expanded upon the

climatic and hydrologic datasets used by Mayer et al. (2007). He found that, similar to Klamath Marsh, inflows and tributary flows at Upper Klamath Lake show wet/dry year cycles superimposed over a long-term declining trend as well. The declines are particularly notable when examining the late summer/fall baseflow period of the year. Irrigation season (April–September) net inflow to UKL and tributary flow to UKL (an independent measure of inflow) are estimated to have declined about 20 to 25 percent in the period 1961 to 2006. A decline of this magnitude represents a serious challenge in terms of water supply for the Klamath Basin and may be one reason that water conflicts in the region have escalated in recent years.

Climatic trends are likely responsible for much of the observed decline in flow at all these sites. Both reports examined climatic trends as well and documented decreasing precipitation, increasing winter and summer temperatures, and decreasing snowpack in the basin. Winter precipitation (October–March) from several datasets show declines over the past several decades, although not all the declines were statistically significant and not all stations showed consistent declines. Obviously, decreasing precipitation will result in lower river flows.

Increasing temperatures and decreasing snowpack could be responsible for some of the declines as well. Warmer winter temperatures will mean more precipitation falling as rain rather than snow and an earlier snowmelt in the mountains. Warmer summer temperatures will mean increasing evaporative losses from the lake and increasing ET and consumptive use for wetlands, riparian vegetation, and crops.

At most snowcourse locations in the western U.S., April 1st snow water equivalent (SWE) has been found to be the maximum annual value of snowpack and is highly correlated with streamflow (MaCabe and Dettinger, 2002). Mayer (2008) reported that April 1st SWE in the southern Cascades has declined since the 1930s based on data from two high elevation sites near Crater Lake National Park. Trends in the April 1st SWE at the two sites may be related to warmer winter temperature as well as decreasing precipitation.

Finally, Van Kirk and Naman (2008) also reported decreasing snowpack and late season baseflows in the lower Klamath Basin over the last several decades. While it is not possible to link the precipitation, snowpack, and temperature trends directly to climate change, these are the kinds of changes that are increasingly being observed around the West. It is also not possible to predict with certainty whether or not these trends will continue in the future. However, there is much information to suggest that they will.

Climate-induced declines in flows almost certainly have and will have profound effects on the marsh and the entire Klamath Basin. Some of the vegetation and habitat changes documented later in this chapter may be attributed to flow declines and the resulting decreases in marsh water levels. To the extent that these climatic and hydrologic trends are irreversible, further changes in vegetation and habitat can be expected.

The appropriate response to climate change at the marsh will be adaptive management, where changes and responses are continually assessed through monitoring, and management is adapted and implemented based on what is needed and what has been successful. Several important questions related to climate change will need to be addressed through management and planning at the Refuge. How can we incorporate climate change projections to support management decisions at the marsh that will be climate intelligent? What management strategies do we anticipate will be needed to address the impacts from projected changes? What additional biologic, climate, and water monitoring, if any, is needed at or near the Refuge? What level of protection and conservation of water resources (quantity and quality) is required to achieve the desired biological outcomes at the marsh? How can we model and predict these outcomes?

3.1.6 Geomorphology and Geology

The western edge of the upper Williamson River Basin follows a series of high volcanic peaks along the eastern flank of the Cascade Range. These peaks, including Mount Thielsen (9,182 feet), Mount Scott (8,926 feet), and Crater Peak (7,265 feet), were

formed in the Pliocene and Pleistocene eras (USFS 1998). Of most significance for Klamath Marsh was the former Mount Mazama (estimated at 12,500 feet), which erupted almost 7,700 years ago in one of the most climatically significant volcanic events of the Holocene in the Northern Hemisphere. Atmospheric disruption may have produced a temperature depression of about 0.6 to 0.7 degrees Celsius at mid- to high-northern latitudes for one to three years after the eruption (Zdanowicz et al. 1999). The eruption buried Klamath Marsh and the surrounding area under significant amounts of ash and pumice, ranging from a few feet at the eastern edge of Klamath Marsh to about 75 feet along Highway 97 (Cumming and Melady 2002). Subsequent to the eruption, the mountain collapsed and formed the Crater Lake caldera, which then filled with water. The eruption removed the estimated upper one-third of the mountain (USFS 1998).

Eastern slopes of the Williamson River Basin are bounded by a series of low ridges formed along a series of northwest trending faults. Late in the Pliocene and early in the Pleistocene, the area was fractured by a series of northwest trending faults. Volcanic cones such as Sugarpine Mountain (6,393 feet) to the north, Yamsay Mountain (8,196 feet) to the east, and Solomon Butte (5,763 feet) to the south developed along these faults (USFS 1998).

While Klamath Marsh existed before Mount Mazama's eruption, the event contributed an enormous amount of sediment to the basin, filling the Williamson River canyon, many stream beds, and outlets. For a short time, these blockages created a lake over Klamath Marsh that reached an elevation of about 4,600 feet and covered a surface area of about 220 square miles. The debris dam was eventually overtopped, and the lake drained (USFS 1998; Evans 2005).

Since 1865, there have been 44 earthquakes within a 100-kilometer (62-mile) radius from the center of Crater Lake. The highest magnitude, 4.3 on the Richter Scale, was recorded on three separate occasions: 1920, 1931, and 1948. The Crater Lake area does not appear to be the center of any significant seismic activity over the past century (USDI 1992).

3.1.7 Soils

Soils located within Klamath Marsh National Wildlife Refuge are largely influenced by volcanic activity in the region, most recently by volcanic rock, ash, and lava spewed by Mount Mazama's last eruption about 7,700 years ago. A Bureau of Indian Affairs (BIA) interim soils report (*Soils of the Klamath Indian Reservation, 1958*) includes the Klamath Marsh Area, but it was never published. There is an ongoing National Cooperative Soils Survey (NCSS) being conducted jointly by the Natural Resources Conservation Service (NRCS) and the U.S. Forest Service (USFS) in northern Klamath County, which includes the Klamath Marsh area, but it has not yet been completed. The following information is summarized from the Bureau of Indian Affairs Interim report and from field investigations conducted to date as part of the NCSS.

There are six major soil series within the Klamath Marsh National Wildlife Refuge boundary: Yamsay, Mazama (which will be re-named "Moyina" in the NCSS), Chinchallo, Kirk, Lapine, and Shanahan. Yamsay and Mazama soils are the predominant soils in the Refuge and are found in the seasonal/permanent marshes. Chinchallo and Kirk soils are found in meadows in the northeast, east, and southwest portions of the Refuge. Lapine and Shanahan soils are found in the forested areas in the northwest.

Yamsay soils are predominantly sedimentary peat, occasionally interbedded with thin layers of diatomaceous silts, are very poorly drained, and have frequent, very long ponding. The principal vegetation that grows on Yamsay soils is bulrush and sedge, which are believed to be the source responsible for the accumulation of the muck and peat on Klamath Marsh. Yamsay soils occur in wet meadow and tule meadow habitat types. Mazama soils contain peat and muck but have higher proportions of diatomaceous sediments in the upper 100 centimeters than do Yamsay soils. Mazama soils also frequently have a contact with pumiceous sands between 100 and 150 centimeters. Mazama soils are very poorly drained and occur in wet meadow habitat types but frequently become drained well enough in the late summer and fall months to afford

limited grazing. Native vegetation on Mazama soils includes reeds, sedges, and rushes.

Chinchallo soils consist of diatomaceous sediments deposited over pumice and are poorly drained. They lack the thick layers of peat and muck that Mazama soils have below the diatomaceous sediments. Native vegetation occurring on Chinchallo soils includes meadow grasses, sedges, reeds, and rushes. Chinchallo soils occur on dry meadow, moist meadow, and wet meadow habitat types. Kirk soils are derived primarily from pumice and diatomaceous sediments that lay above pumiceous coarse sands and paragravel. The surface diatomaceous sediments are thinner than in the Chinchallo and Mazama soils, and are often mixed with pumiceous sand. The Kirk soils found around the edges of the marsh frequently have a very dense subsurface layer. Kirk soils are somewhat poorly drained and occur in dry meadow habitat types. Native vegetation consists largely of annual and perennial grasses, sedges, rushes, and reeds.

Lapine soils are characterized as excessively drained gravel and sand over pumice cinders and ash. Native vegetation consists primarily of ponderosa pine with an understory of grasses and shrubs. Shanahan soils are also well drained and support native vegetation similar to Lapine soils but lack the high pumiceous gravel content of Lapine soils.

Ditching and drainage of wetland areas and subsequent intensive grazing likely had a negative impact on soils in certain areas through compaction, erosion, etc.

The NCSS of Northern Klamath County, including the Klamath Marsh Refuge, was initiated by the USFS and NRCS in 2003 and is scheduled to be complete within 5–8 years. The Service is a cooperating agency in the NCSS and is a co-signer of the Memorandum of Understanding that initiated the soil survey.

3.1.8 Environmental Contaminants

There is one known contaminant site on the Refuge that may need future additional remediation. In 2003, the firm Geo Engineers supervised the removal of one 55-gallon drum of used oil, the removal and disposal of one 100-gallon above ground storage tank, and the removal of 31 tons of railroad ties and petroleum contaminated soil from the vicinity of a former privately owned pump station that was used for water management. The site is located along the north side of the Peninsula where it intersects with a center dike. The exact volume of contaminated soil present at the site is unknown but appears to be limited to the area near one of the two pumps. In 2007, Geo Engineers supervised the injection of RegenOx, an oxygen release compound in an effort to degrade the residual petroleum contamination. The treatments were only partially successful, and testing indicates that concentrations of petroleum contaminated soils still exceed state risk-based concentration levels. Future excavation of the area may be warranted to properly remediate the site. A 2009 report was received with recommendations and is currently being evaluated. Several other sites have been identified and remediated in past years in accordance with state and Federal regulations. These sites were generally associated with buildings and/or operations associated with cattle management.

When additional lands are acquired for the National Wildlife Refuge System, including any potential future acquisitions at Klamath Marsh Refuge, these lands are surveyed prior to acquisition through a Level I Contaminant Survey to document potential environmental contaminants associated with the site and, if necessary, to negotiate their remediation with the seller prior to purchasing the land. If previously unknown contaminated sites are discovered on Refuge lands, they will be remediated in accordance with state and Federal regulations.

Non-point sources of pollution can occur in the area from runoff from agricultural and forest lands, eroding stream banks, and from roads and building sites. Any pollutants from these non-point sources can be carried to surface or groundwater via rainfall, snowmelt, and irrigation return. A major non-point source of water quality impairment is increased heat input due to vegetation removal, seasonal flow reduction, changes in channel shape, and alteration to the floodplain. Channelization and river bank instability may alter gradient, width-depth ratio, and sinuosity, causing undesirable changes in the sediment transport regime, erosion and depositional characteristics, and water temperature.

3.2 Vegetation and Habitat Resources

3.2.1 Overview of Klamath Marsh Habitat Changes

The vegetation and hydrology of the Klamath Marsh National Wildlife Refuge area has changed significantly over time. A historical overview of these changes is important when considering future management directions. The following provides a brief description of vegetation changes and hydrologic changes that have occurred from 1850–2000.

In his report on exploration and surveys of the Klamath Basin, undertaken from 1854 through 1855, Lieutenant Henry L. Abbot described the Klamath Marsh area as "a strip of half submerged land, about twelve miles long and seven miles broad…covered by clumps of tule and other aquatic plants separated by small sheets of water" (Abbot 1855). Coville (1904) would later note "one of the plants growing abundantly in the marsh and less extensively in some of the bays of the lake… was the great yellow water lily." Coville (1904) estimated that in 1902, Klamath Marsh contained 10,000 acres of this plant, forming "a solid growth of wokas (wocus)." A BIA report (Klamath Agency 1913) on conditions in the Klamath Marsh in 1912–1913 described a 30,000-acre marsh as " the main center of the marsh, consisting of an area about 15 miles in length and an average width of 3 miles, is, however, at all times engulfed with water and covered with tule, American sloughgrass, and wocus." In 1955, prior to the Refuge's establishment, the area was described as "consisting of 9,900 acres of shallow marsh and 15,000 acres of deep marsh (USDI and USFWS 1955). By 1963, the Klamath Marsh Refuge had been established and had acquired almost 16,000 acres (Figure 1-3). The area was said to include 920 acres of open water; 8,966 acres of marsh; 4,345 acres of wet meadow, consisting of "*Carex, Deschampsia, Scirpus*, etc…"; and 995 acres of grasslands and forests (O'Neil 1963). Thus, by 1963, the ratio of emergent vegetation to open water was nearly 10 to 1. A further decline in open water was noted in 1975 when Refuge vegetation was described as "dominated by dense stands of hardstem bulrush, while open water–vegetation interspersion was virtually non-existent, with an estimated 10 percent of the marsh consisting of open water" (Refuge Annual Narrative1975). History indicates that although the same types of plant communities have persisted over time (open water with wocus, bulrush, sedge, rush, willow, grasses, and ponderosa pine), the extent and distribution of these community types have changed dramatically since the turn of the century (Figure 3-3 vs. Figure 3-2).

The Williamson River enters the Refuge below the Refuge headquarters building. Prior to channelization and diversions created in the early 1900s, the Williamson river—as it entered the Refuge—would spread out and form narrow sloughs and waterways that fed the wetlands as far north as the Three Creeks area. In wet years, the north end of the marsh would become completely saturated, and water would overflow to the south around the Peninsula, once again forming a channel at military Crossing. South of Military Crossing, the river spread out to feed wetlands north and south of Silver Lake Highway, finally forming a channel and exiting the southwest corner of the Refuge. From here, the river widened to form a pond at Solomon Flat and continued to flow south to the Kirk Reef region, where a natural lava flow rock barrier still exists today. The size and height of the natural lava dam at Kirk Reef that historically existed remains unresolved.

The channelization and diversion of the Williamson River by private agriculture in the early 1900s diverted the Williamson River from the northern Refuge wetlands and essentially dried up some 16,000 acres of wetland habitat north of Military Crossing Road. These diversions allowed agriculture to graze thousands more acres even during abnormally wet years. The diversions also provided the ability to irrigate these meadows and marshes during dry years. Creation and enhancement of Silver Lake Highway and Military Crossing roads in the early 1900s also created new barriers to water and sediment flows, contributing to changes in the Marsh's hydrology.

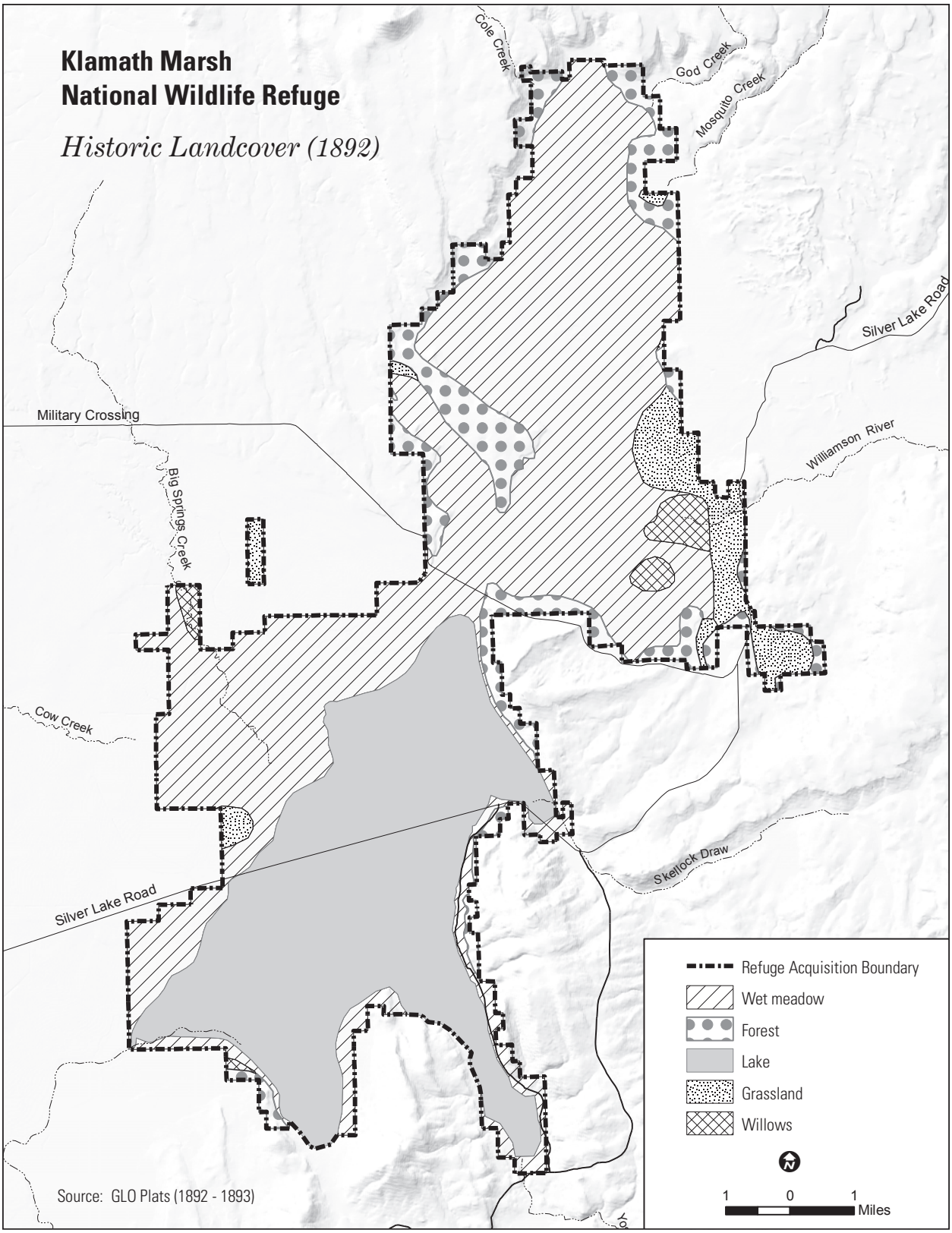


Figure 3-2. Historic landcover (1892-1893) on Klamath Marsh Refuge

Management of Refuge wetland habitat types since 1990 has primarily consisted of haying, grazing, and prescribed fire. The Refuge has tried to utilize the existing water management systems (diversions, canals, and water control structures) to maintain wetlands and to return some of the Williamson River back to its historic channels and sloughs. Although these management strategies have been reasonably successful on a small scale, there have been major habitat shifts since the early 1900s, resulting from climate change, along with other factors (e.g., long-term drought, drainage, ditching, and increased water development above and near the Refuge). Existing sedge meadows are relatively healthy, diverse, and unchanged since Refuge establishment; however, the interior portions of the marsh have undergone shifts from open water with yellow water lily and submergent plants to closed stands of emergents (cattails and bulrush). The more open marsh of the 1800s and early 1900s supported extensive stands of wocus (yellow pond lily) with various submerged aquatics that were used by a diversity of fish and wildlife, were extremely important food sources, and were culturally important to the Klamath tribes.

3.2.2 Vegetation Mapping

A diversity of plant communities occurs on the Refuge, from wetlands to upland forests. The plant communities for the Refuge have been recently classified by the U.S. Fish and Wildlife Service and U.S. Bureau of Reclamation using a combination of aerial photography, field sampling, geographic information system (GIS) modeling and remote sensing (Miliken 2008). The methods employed to generate a vegetation layer for the Refuge was not without problems, and the final map and affiliated acreages could be improved in the future with additional field sampling and the use of additional imagery. The problems and errors associated with the mapping process are documented in Miliken's 2008 report.

The general classifications of vegetation occurring on the Refuge include wetlands, forests, upland shrub and grasslands, riparian, and freshwater aquatics (riverine/springs). Within each of these general classifications are more specific vegetation communities. Table 3-2 lists the general vegetation classifications and corresponding acreage estimates of specific vegetation communities. A listing of plant species currently known to occur on the Refuge is listed in Appendix J.

Table 3-2. Vegetation classifications and acreage estimates occurring on Klamath Marsh Refuge based on Miliken's 2008 vegetation analysis.

Wetlands	Emergent Aquatics	13,021
	Submergent And Floating Leaf Aquatics (open water)	1,008
	Sedge Meadows	13,889
Forests	Ponderosa Pine	998
	Lodgepole Pine	787
	Aspen	18
Upland Shrub and Grassland	Grassland/Shrub	10,959
Riparian	Willow	195
Freshwater Aquatic	River and Springs	10
TOTAL		**40,885**

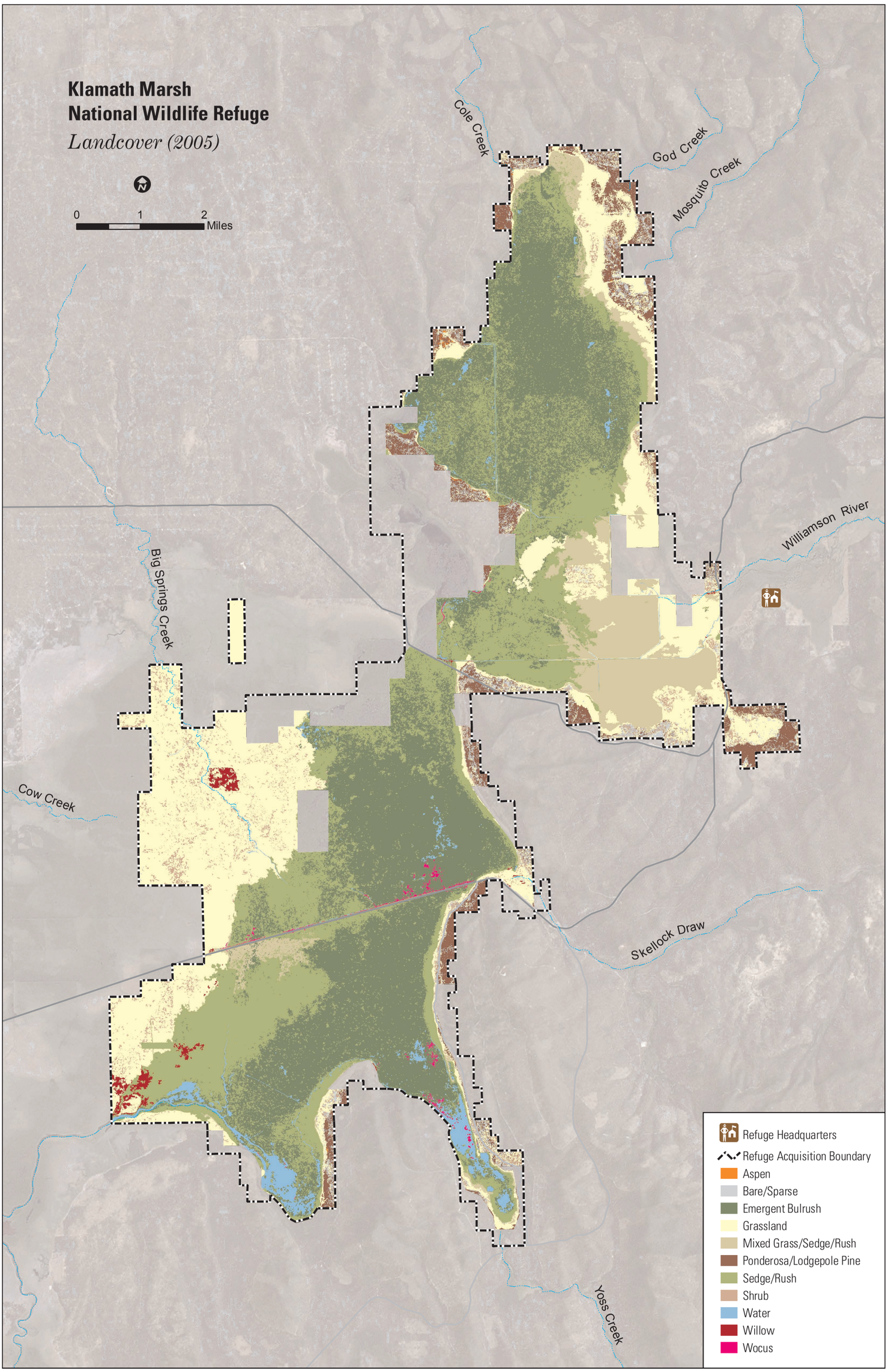


Figure 3-3. Current landcover

3.2.3 Vegetation Communities

Klamath Marsh Refuge is unique within the National Wildlife Refuge System because it is situated within a landscape characterized by relatively unaltered hydrology and intact native plant communities. Klamath Marsh Refuge contains native wetland and forest plant communities that were present before substantial human alteration of the landscape. The following summarizes the general habitat classifications and vegetation communities.

Wetlands

Wetlands are vegetative areas that are covered with water during all or part of the year. Permanent wetlands on the Refuge include marshes that contain water year round, while seasonal wetlands are flooded for only portions of the year and include seasonal ponds and wet meadows.

Wetlands provide important habitat for migrating and breeding waterfowl, shorebirds, waterbirds, songbirds, mammals, amphibians and reptiles. Wetlands have direct value for people because they improve water quality by trapping sediments and toxins, recharge aquifers, store water, and reduce the severity of floods (ORDFW 2006).

In general, most wetland habitat loss in Oregon has occurred at lower elevations and valley bottoms. The Upper Klamath Basin once had an extensive shallow lake and marsh system, but greater than 75 percent has been lost due to drainage and conversion to agriculture and urban uses, contributing to the complex issues surrounding water use and species conservation in the basin. The remaining wetlands in the Klamath Basin support one of the largest concentrations of waterfowl in North America, with over three million ducks and a half-million geese passing through annually. The area is a critical migratory staging area for 80 percent of all Pacific Flyway waterfowl, and the Klamath Basin provides Oregon's only permanent nesting areas for red-necked grebes and yellow rails (ORDFW 2006).

Wetland habitats are highly diverse, and the following general types occur on the Refuge: emergent aquatics, submergent and floating leaf aquatics, and sedge meadows.

Emergent Aquatics. Emergent aquatic vegetation (emergents) are plants whose roots are anchored under water with much of the plant extending above the water surface. They include plants like broad-leaved cattail and tule or hardstem bulrush. They are plants adapted to low-water velocities and shallow- to deep-water marsh conditions.

Covering approximately 13,021 acres, emergent aquatic habitat is the dominant vegetation type on the Refuge (Figure 3-3). Bulrush is the predominant emergent species comprising this vegetation type along with scattered patches of cattails. Although historically a major component of the Refuge wetlands, the acreage and general density of bulrush in the marsh has increased over the past 100 years.

Emergent aquatic stands of cattail and bulrush provide important nesting and foraging habitat for species like sora rail, American bittern, least bittern, and marsh wrens. However, the increase in the overall acreage and density of these plant species within Refuge wetlands is a management concern. As the cattails and bulrush stands expand in the marsh, they create dense monocultures of one vegetation type with little open water. Subsequently, the diversity and interspersion of vegetation types within the marsh are declining. As a result, the overall value of the marsh to a diversity of waterbirds is slowly decreasing.

Most of the emergent marshes in eastern Oregon are found in the upper portions of the Deschutes and Klamath basins and in the large closed basins of Harney and Lake counties. Significant amounts of the lower Klamath Basin's vast marshes have been drained and converted to agriculture. Losses of emergent marshes in other areas have been less pronounced, but most have suffered from water diversions and degradation by livestock grazing. Nonetheless, emergent marshes in eastern Oregon still provide some of the most important migratory bird habitat in the Intermountain West and play a critical role in sustaining several dozen priority species ranging from tri-colored blackbird and white-faced ibis to eared grebe, American avocet,

trumpeter swan, and northern pintail (Eastern Oregon Working Group and Oregon Habitat Joint Venture 2005).

Submergent and Floating Leaf Aquatics. Submerged aquatic vegetation includes plants that grow below the surface of the water and are usually anchored to the bottom by their roots. Examples are coontail, marestail, and pondweeds (See Appendix J.) Floating leaf aquatic plants are rooted in the lake bottom, but their leaves and flowers float on the water surface. The yellow water lily is a locally abundant example.

This group of plants generates dissolved oxygen, filters suspended material, stabilizes bottom sediments, and cycles nutrients (Rogers and Theiling 1999). Submerged and floating leaf aquatics provide substrate for invertebrate growth and fish habitat, and are important foods for mammals and migratory birds. They are often found in areas of low water velocity, adequate light penetration, and relatively stable water levels.

The distribution of floating leaf aquatics throughout the marsh is generally associated with open water areas. Approximately 1,008 acres of floating leaf aquatics occur in the Refuge (Figure 3-3). The dominant floating leaf species are yellow water lily and pondweed species. With the increase in the emergent marsh vegetation, the acreage of floating leaf aquatics has decreased. The yellow water lily, known by the Klamath Tribes as wocus, is of great cultural importance, as it is has been gathered for subsistence food for thousands of years (Coville 1904). Maintaining sustainable populations of this species within the Klamath Marsh is very important culturally and spiritually for the Klamath Tribes.

Quantification of the overall acreage, location, and species of submergent aquatics has not been completed for the Refuge. General sampling and observations have identified several species, like common bladderwort and sago pondweed (also see Appendix J); however, sampling is necessary to properly assess the abundance, density, and diversity of submergents occurring in Refuge wetlands.

Sedge Meadows. Wet meadows at the Refuge are generally dominated either by beaked sedge or by a mixture of sedges and rushes that includes Nebraska sedge, Baltic rush, and beaked sedge. The least disturbed meadows are composed of 60–100 percent beaked sedge. These pure sedge meadows occur at the edges of the emergent wetlands. Baltic rush is often present and can represent up to 25 percent cover. Field mint and narrow-spiked reedgrass are also common. More disturbed wet meadows tend to be dominated by a mixture of Nebraska sedge, beaked sedge, and Baltic rush. The presence of Nebraska sedge seems to be closely correlated with some level of disturbance that could include haying, grazing, or greater fluctuations in water levels. Various herbs and grasses are often found in the mixed sedge/rush wet meadows, the most common of which are narrow-spiked reedgrass, field mint, silverweed, senecio, and willow herb. Soils in this vegetative community are usually composed of saturated peat or muck. Sedge meadows often grade into shallow marshes or wet prairies. Occasional fires will stimulate spring growth of the sedges, while setting back invading woody vegetation. Sedge meadows are most successful when the soil remains saturated most of the time.

Approximately 13,889 acres of sedge/wet meadows occur on the Refuge (Figure 3-3, Table 3-2). Sedge and wet meadows are relatively healthy and intact on Refuge lands and provide important shallow water habitat for Federal and state conservation targets such as spring migratory waterfowl, nesting sandhill cranes, and nesting yellow rails. Sedge meadows represent a native plant community that is underrepresented within the landscape of the Klamath Basin.

Extensive wet meadows that include sedge meadows are common in the Blue and Ochoco mountains of central and eastern Oregon and in the upper portions of the Deschutes and Klamath basins. Wet meadows in most areas of Oregon have been degraded by livestock grazing and development of road and irrigation systems—some to the point where they have converted to sagebrush and other drier habitats. (Eastern Oregon Working Group and Oregon Habitat Joint Venture 2005)

Freshwater Aquatic: Rivers and Springs

Freshwater aquatic habitats, including rivers, streams, springs, and ponds, on or near the Refuge

are both interconnected and highly diverse. Freshwater aquatic habitats typically contain water year round, while wetlands may dry out through the season. The Williamson River and Big Springs Creek provide the majority of the Refuge's freshwater aquatic habitat. Seasonal flows from small creeks like Three Creeks, Cow Creek, and Mosquito Creek provide additional water sources when precipitation is abundant.

Water is crucial for all fish and wildlife, and high quality freshwater aquatic systems provide essential habitat to many at-risk species, including important spawning and rearing habitat for fish, breeding habitat for amphibians, and habitat for freshwater mussels and other invertebrates. Many of the river and spring complexes within the Refuge marsh were altered as a result of agricultural practices in place since the early 1900s. In many locations, flow and hydrology have been affected by barriers (e.g., roads, dams and culverts) and irrigation diversions that can reduce water flow and interfere with fish and wildlife migration. Channelization has restricted the natural ability of the rivers, streams, and riparian habitats to meander over time, limiting the quality and availability of these habitats and affecting floodplain function. These alterations have affected native species like redband trout, Klamath largescale sucker, and Miller Lake lamprey. Furthermore, these impacts to surface and groundwaters within the basin likely altered the hydrology of the marsh, contributing to the conversion of open water to closed emergent marsh.

Forests

There are approximately 1,785 acres of forested habitat on Klamath Marsh National Wildlife Refuge (Figure 3-3, Table 3-2). Although forests constitute a small fraction of the Refuge acreage, they are important because of their proximity to the marsh and connection to larger landscape forest management units.

The Refuge is bordered along its north, south, and eastern boundaries by the Fremont-Winema National Forest (WNF). Administratively combined in 2002, the Fremont-Winema National Forest occupies 2.3 million acres in southern Oregon. Several WNF areas adjacent to the Refuge have been identified and managed as Bald Eagle Management areas. The Refuge provides the main food source for eagles nesting and roosting on these lands, and Refuge staff have worked closely with the U.S. Forest Service to help achieve these eagle management objectives. In addition to bald eagles, numerous other bird and mammal species take advantage of the forest/wetland interspersion.

Three major forest habitat types managed on Klamath Marsh Refuge are ponderosa pine, lodgepole pine, and aspen.

Ponderosa Pine Forest. The structure and composition of ponderosa pine forests varies across the state, depending on local climate, soil type, moisture, elevation, aspect, and fire history. In Blue Mountains, East Cascades, and Klamath Mountains ecoregions, ponderosa pine woodlands have open canopies, generally covering 10–40 percent of the sky. Their understories are variable combinations of shrubs, herbaceous plants, and grasses (ODFW 2006).

Approximately 998 acres of the Refuge is ponderosa pine forest. Ponderosa woodlands within the Refuge are dominated by ponderosa pine but often have inclusions of lodgepole or small patches of aspen, depending on site conditions. Primary understory species include antelope bitterbrush, golden currant, green manzanita, green rabbitbrush, wild strawberry, Western rye grass, Western needle grass, and squirrel tail.

Ponderosa pine is still widely distributed in eastern and southern Oregon, currently covering more than 5.1 million acres, primarily in the East Cascades and Blue Mountains ecoregions. However, similar to stands in the Refuge, the structure and species composition of these forests have changed dramatically. Historically, ponderosa pine habitats had frequent low-intensity ground fires that maintained an open understory. Due to past selective logging, livestock grazing, and fire suppression, dense patches of smaller conifers have grown in the understory of ponderosa pine forests. These dense stands are vulnerable to drought stress, insect outbreaks, and disease. The tree layers act as ladder fuels, increasing the chances that a ground fire will become a forest-destroying crown

fire. Of particular concern within the Refuge and state is the loss of large-structured pine habitats. Based on a comparison between historic (1850) and current vegetation maps, less than one percent of the historic large-structured ponderosa pine is estimated to remain in the Blue Mountains and East Cascades ecoregions, and approximately seven percent remains in the Klamath Mountains (Oregon Natural Heritage Information Center spatial data sets). Most of these large-structured ponderosa pine stands are greatly reduced in size and connectivity, occurring in a patchwork with much younger forests that are managed with shorter rotations to generate timber products (ODFW 2006).

Some 90 species of birds are regularly associated with the ponderosa pine forests of eastern Oregon and Washington, including two priority species, white-headed woodpecker and pygmy nuthatch, that are rarely found in other forest types (Eastern Oregon Working Group and Oregon Habitat Joint Venture 2005). Other species dependent on this forest include Lewis's woodpecker and several species of bats. Because of the extensive loss of ponderosa pine forest, restoration of this vegetation type is an important strategy for the future conservation of landbirds. The desired condition in ponderosa pine forest is a large tree, single-layered canopy with an open understory dominated by herbaceous cover with scattered shrubs and pine regeneration.

See Section 3.19.5 on page 117 (Forest Management) for a description of past and current management practices

Lodgepole Pine Forest. Approximately 787 acres of lodgepole pine forest occurs within Klamath Marsh Refuge. On pumice soils, like those on the Refuge, a sparsely developed shrub and grass undergrowth appears with open to closed tree canopies. The tree layer of this habitat is dominated by lodgepole pine, but it is usually associated with ponderosa pine. Understory shrubs often include manzanita, antelope bitterbrush, and wax currant. Common grasses within the understory include western needlegrass, Kentucky bluegrass, and bottlebrush squirreltail.

Lodgepole forests typically reflect early successional conditions that originated with fires. With time, lodgepole pine stands have increased in fuel loads. Woody fuels accumulate on the forest floor from insect (mountain pine beetle) and disease outbreaks and residual wood from past fires. High-severity crown fires are likely in young stands when the tree crowns are near deadwood on the ground. After the stand opens up, shade-tolerant trees increase in number. Fire suppression has left many single-canopy lodgepole pine habitats unburned to develop into more multilayered stands.

Lodgepole pine encroachment into wet and sedge meadows has been occurring for decades on Klamath Marsh Refuge. This encroachment is characterized as high densities of small lodgepoles extend their distribution from the older forest edges into sedge meadows. In Refuge areas such as Abraham Flat, survey maps from the 1890s indicate lodgepole encroachment of meadow habitat has completely cut off the connectivity to other sedge meadows located to the south on USFS lands. These encroachments have compromised the integrity of Refuge wet meadow and sedge habitats. The Refuge has conducted a couple of prescribed burns to limit this encroachment. Future management should focus on cutting and/or burning encroaching trees to reclaim former meadow habitats.

Very little of the lodgepole stands on the Refuge contain old-growth trees, which are desired by such species as black-backed woodpecker, mountain chickadee, yellow-rumped warbler, Cassin's finch, pine siskin, and dusky flycatcher. The Conservation Strategy for Landbirds of the East Slope of the Cascade Mountains in Oregon and Washington (Altman 2000) calls for the preservation of old-growth lodgepole stands that are greater than 1,000 acres in size. Although the Refuge does not contain large stands of lodgepole pine, it may be successful in linking small segments of this habitat with adjacent USFS tracts to create desired future conditions.

Aspen. Approximately 18 acres of aspen exist on the Refuge along the edge of meadows and within lodgepole and ponderosa pine habitats. The evaluation of Refuge aspen stands indicates there is little evidence of regeneration or new growth. The lack of regeneration is likely the result of fire suppression, encroachment by pine forests, and historic overgrazing.

Aspen forest communities on the Refuge are dominated by aspen trees with a forb, grass, or shrub understory. Aspen generally occurs in areas that have additional moisture but are well drained or located in moist microsites within drier landscapes. Characteristic understory grasses include Idaho fescue, pinegrass, Great Basin wildrye, or blue wildrye. Shrubs include sagebrush, snowberry, serviceberry, and roses.

Aspen habitats are dependent on disturbance, with fire and blowdown as the major disturbances. Aspen sprouts after fire and spreads vegetatively in large clones. With no disturbance, stands 50–100 years old are often replaced by other vegetation types (ODFW 2006).

Aspen is identified as a conservation focus habitat within the Partners in Flight East Slope Cascades Plan (Altman 2006). With the exception of some large stands on Steens Mountain and Hart Mountain, aspen habitats are limited to small pockets scattered across the higher and wetter areas of eastern Oregon. Grazing by livestock, and in some areas, wild ungulates, along with changes in fire regimes, have significantly reduced or degraded aspen habitats in most areas. Aspen forests and woodlands provide important habitat for a number of songbirds. Priority species include red-naped sapsucker and Williamson's sapsucker (Eastern Oregon Working Group and Oregon Habitat Joint Venture 2005).

Aspen stands provide unique structure among other habitats and is useful as nest sites and hiding cover for wildlife. Aspen is a deciduous tree, and stands generally have high invertebrate prey diversity and densities. A suite of associated species, particularly songbirds, is entirely dependent on aspen. Aspen is important for birds in both migration and breeding seasons. It also provides fawning and calving habitat, hiding cover, and forage for mule deer and elk. Other wildlife that use aspen include bats, black bear, beaver, rabbits, ruffed grouse, and blue grouse (ODFW 2006).

Throughout the west, and within the Refuge, there is concern about the loss of aspen habitat and the lack of aspen regeneration in remnant stands. Aspen stands often depend on natural fire to reduce competition from conifers and to stimulate the growth of suckers from roots. In addition to the changes from fire suppression, uncontrolled grazing can prevent regeneration, and invasive species degrade understories. Within a stand, the aspen trees are clones arising from an interconnected root system. While the root systems may last for thousands of years, individual trees may only live 100–150 years. Many existing stands are reaching the end of their natural life cycle, and—without young aspen trees to replace them—the stands will be lost completely (ODFW 2006). Management actions that may be used to improve aspen stands include use of prescribed fire, removal of encroaching pines, and disturbance to aspen root systems to stimulate clonal sprouting.

Grassland/shrub

The vegetation of Klamath Refuge can be seen as a series of concentric rings arranged around the deepest water. At the center are aquatic plants and emergent wetlands. The next rings consist of sedge/wet meadows, then grasslands, mixed herbs and grasses interspersed with willows, upland shrubs, and finally a ring of pine forests, as the topography rises abruptly at the edge of the basin. This section presents details on the grasslands, mixed herbaceous, and shrub areas that occur between the marsh and the forest, comprising approximately 10,959 acres of habitat.

Grasslands. The most common grass on the refuge is Kentucky bluegrass. In wetter areas, tufted hair grass or rough bent grass is dominant. Baltic rush is present (if very scattered) in practically all grasslands, along with various species of sedge. Numerous forbs occur in the grasslands, the most common of which are yarrow, rosy everlasting, western aster, tall willow herb, and slender cinquefoil. Exotic grasses other than Kentucky bluegrass are not common except in areas where there were previously cattle ranching activities (e.g., around corrals or gates).

Mixed Herbaceous. Mixed forb/grassland areas occur in the transition from grassland to upland shrubs or forest and are extremely variable. These are areas where grasses are still abundant but where all species of grasses combined make up less than 50 percent of the vegetation. Although one forb species often dominates at a particular site, many

forbs occur only in limited areas of the Refuge. Typical forbs include yarrow, rosy everlasting, western aster, tall willow herb, slender cinquefoil, field mint, and goldenrod.

Shrubs. The most common shrub community on the Refuge is dominated by green rabbitbrush. This community occurs along the transition between grasslands or wetlands and coniferous woodlands. Green rabbitbrush is generally very open with up to 50 percent bare ground. Grasses commonly found in rabbitbrush shrublands include giant rye grass, squirreltail, cheat grass, and Muhlenbergia. Sedges, often *Carex rossii*, and forbs such as naked buckwheat often accompany green rabbitbrush. An antelope bitterbrush shrub type also occurs at the edge of the woodlands, but it is much less common than green rabbitbrush. Several species of shrubs occur in forest clearings, most commonly squaw currant and green manzanita. Big sagebrush occurs at the Refuge but only in one area known as Sagebrush Point. Priority wildlife species that are highly associated with sagebrush habitats include sage sparrow, Brewer's sparrow, sage thrasher, loggerhead shrike, lark sparrow, and vesper sparrow (Eastern Oregon Working Group and Oregon Habitat Joint Venture 2005).

Riparian Willow

Refuge riparian shrublands are dominated by two species of willow and occur adjacent to rivers, diversion channels, springs, seeps, and intermittent streams; and in patches throughout the marsh wetland system. Approximately 195 acres of riparian willow habitat occurs on the Refuge. Spring flooding of Refuge wetlands from snowmelt, along with the annual recharging of groundwater and springs, are important hydrologic conditions for maintaining the riparian willow vegetation. Haying, grazing, and fire also play an important role in the overall health of willow riparian habitats. All three management practices may have negative impacts on willows if not properly controlled or applied.

The willow riparian habitat offers unique structural diversity in the Refuge wetlands and is important to species that prefer moist shrubby habitat. Riparian areas provide essential habitat and travel corridors for songbirds, elk, deer, and other wildlife. Priority species using riparian shrub habitats on the Refuge include willow flycatcher, MacGillivray's warbler, yellow warbler, and lazuli bunting (Eastern Oregon Working Group and Oregon Habitat Joint Venture 2005). In addition to providing habitat for birds and other wildlife, riparian habitats have important ecological functions. Healthy riparian vegetation protects banks from erosion, influences in-channel aquatic habitats, maintains favorable water temperature for fish through shading, filters runoff, and provides nutrients. Riparian vegetation creates meanders and increases habitat complexity in the Refuge wetlands and riverine systems.

Riparian shrub habitat is the most common type of riparian habitat in eastern Oregon. However, losses have been estimated at approximately 75 percent in the inland Pacific Northwest. Riparian willow habitats on or adjacent to the Refuge have been heavily affected by habitat conversion, unmanaged grazing, invasive species, road building, and alterations in hydrology (e.g., water withdrawals and channelization). Willow habitat on the Refuge appears to be slowly increasing as grazing and haying pressures have been reduced. Runoff containing fertilizers and other contaminants can further affect this habitat.

Historically, beavers played a key role in creating wetlands and riparian areas within the Klamath Marsh. Historic beaver populations within the region declined some as a result of early trapping operations. More recent declines in beaver populations (since 1900) are likely linked to changes in habitat, such as the channelization of the river and drainage of wetlands, by private landowners. With the establishment of Klamath Marsh Refuge, water management has shifted from draining wetlands to wetland creation. Over the years, a number of beaver have been translocated to the Refuge in cooperation with Oregon Department of Fish and Wildlife (ODFW). Today, a small population of beaver has re-established within the Refuge. Future increases in this species could significantly increase the diversity of wetland and riparian habitats.

3.3 Natural and Current Role of Fire

3.3.1 Pre-Refuge Fire History

Fire is one of the major disturbance factors that has shaped the vegetative communities found in south central Oregon. Fire has had a presence at the Klamath Marsh throughout historic times and was undoubtedly present for many millennia in prehistoric times. Early surveys of the area mention the evidence of past fires. While surveying the area in and around the Ashland and Cascade forest reserves in 1899, John Leiberg noted, "There is not a single forested township either on the west side or on the east side of the range in which the timber is not more or less fire marked" (Leiberg 1900). In the area of the Klamath Marsh, Leiberg noted that most of the timber stands surrounding the marsh showed indications of being fire scarred. He even surmised that some even-aged stands in the area were the result of ancient fires.

Prehistoric fires were certainly ignited by lightning. There is at least anecdotal support that Native Americans used fire for various purposes in south central Oregon (Boyd 1999; Williams 2005). Regardless of the ignition source, fires undoubtedly burned at frequent intervals prior to the arrival of the European-Americans.

As the American west was settled, European-Americans brought concepts on how to manage their natural surroundings with them. Early forest management practices were based on concepts learned in moist European forests. Early European foresters viewed fire as a totally destructive force that needed to be eliminated from the landscape. At times, pioneers were faced with destructive fires during the settlement period. Forest fires burned into towns, destroyed buildings and other improvements, and killed livestock and people. Destructive fires helped fuel the sentiment that all fires needed to be suppressed.

The first attempt to bring about organized fire control in Klamath County occurred in 1908 when the Klamath-Lake Counties Forest Fire Association was formed. This was the first such fire protection association in the state of Oregon. Members of this organization were representatives of private land interests. Jackson Kimball was the first secretary-treasurer for this organization. Kimball was involved with the legislation that created the State Board of Forestry, the State Forester, and the State Forestry Department. In 1922, the Klamath-Lake Counties Forest Fire Association became the Klamath Forest Protective Association (KFPA). The KFPA was responsible for fire suppression on state and private lands in the county until 1975, when they entered into a contract with the State Forestry Department (known now as Oregon Department of Forestry). The creation of the original association in 1908 placed emphasis on "systematic protective fire patrol" (Oregon Department of Forestry 2007). By 1927, KFPA was using a tractor and drag system to establish fire lines. KFPA advocated the building of road systems so that, "no timber will be more than one mile from a road" (Klamath Forest Protection Association 1927–1931).

Reservation Period

The Klamath Marsh was made a part of the Klamath Indian Reservation by the Treaty of 1864. Under the auspices of the Office of Indian Affairs, organized fire control began early in the twentieth century on the Klamath Reservation. The first fire control on the Klamath Reservation was accomplished by men on horses. Fire lines were frequently built by dragging a Manzanita bush behind a horse through the pumice soil (Weaver 1961). Reports list fire control efforts at least as early as 1911 (Klamath Agency 1911–1961). By 1913, the reservation had 12 guard stations, and telephone lines running on both the east and the west sides of the Klamath Marsh. One guard station was at Big Spring on the west side of the Marsh, and another was at Bloody Point on the east side of the Marsh (Klamath Agency 1913). In 1918, a series of fires burned throughout the Klamath Reservation. While little specific information is available on these fires, the area burned is estimated at 200,000–300,000 acres. The fires burned most of the central portion of the Klamath Reservation, where they did little damage except where they crowned in lodgepole pine stands, and in the vicinity of Skellock Draw and Military Crossing, where they crowned in patches of ponderosa pine (Weaver 1961). Fires obviously burned close to the Klamath Marsh in 1918, but it is unknown if they actually burned

on what is now the Refuge. The forestry officials at Klamath Agency were overwhelmed by the 1918 fires and were obliged to hire loggers and others to help control the fires. It took more than a year for the agency to pay the people who were recruited to fight fires in 1918. Many complaints were addressed to the local and national Office of Indian Affairs officials. In 1919, Jackson Kimball contacted Senator George Chamberlain and complained, "…no adequate forest fire protection has been provided for several years on the Klamath Indian reservation… Very extensive and disastrous fires occurred there during the season of 1918." Senator Chamberlain complained to the Commissioner of Indian Affairs, Cato Sells. Sells wrote to officials at the Klamath Agency, "You will immediately confer with Supervisor West in the formulation of such plans as may be necessary to improve the organization for forest fire control on the Klamath Reservation…." Sells also demanded "vigorous and effective action to be taken to prevent the spread of fires in any part of the reservation," stating that "Any man who is derelict in his duty in this regard should be immediately relieved," (Klamath Agency 1919).

In the 1920s, the Klamath Agency developed a fire control organization matching that of the KFPA's organization. A permanent lookout was established on Calimus Butte. Fire guards were assigned to work in road camps, and the primary job of fire guards when not fighting fires was to work on the establishment of new roads. A central fire dispatcher was located at Klamath Agency, and this person was responsible for the proper handling and suppression of all fires on the reservation. Automobiles were used to transport guards to fire locations. By 1932, Klamath Agency personnel bragged, "this agency will in a very short time be able within an hour or less to dispatch fires on any place on the reservation" (Klamath Agency 1911–1961).

During the 1920s, several fires were reported burning within the Klamath Marsh. A memo in the 1924 fire report by James A. Howarth, Supervisor of Forests, in 1924 states:

> "Marsh fires in the Big Klamath Marsh had not bothered us before 1923 when we had one such large fire in the fall. In 1924 the Marsh was very dry all summer and the number of fires starting therein is estimated at twenty-five. Up to the hunting season we controlled such fires as had been started, mostly in the shallow peat near the edges of the Marsh. However, about the beginning of hunting season occurred some Marsh fires that got beyond control. The first one, in a few hours, spread across this big Marsh and covered a number of sections. The peat was so deep that plowing failed to hold it and after the fire had repeatedly jumped our trails we abandoned all effort to hold it since it had proven that it would not come out of the Marsh into the timber. Some of the white ranchers lost hay in the stack and many more lost hay in the field. This fire burned both sides of the new military road and endangered our road at one time. Constant whirlwinds aided in the day time spreading of these fires so that our experience the past season convinced me that it is not possible in a very dry year to hold a marsh fire that gets under good headway in the tall grass and deep peat and I do not believe we are justified in great expense attempting to do so." (Klamath Agency 1911–1961)

A 1926 annual fire report mentions that in the fall of 1925, close to one-half of the Klamath Marsh burned over and that sod (peat) fires were a problem. "The only method we have at present of suppressing these fires is plowing several furrows around the burning area" (Klamath Agency 1911–1961). In the Report of Fire Situation in September, dated 1928, it is reported that "All…fires have been put out with the exception of the 3 small fires burning in the Marsh. These three fires will never do any damage to speak of this summer. They are burning very slow and have not progressed ten feet in the last two weeks" (Klamath Agency 1911–1961). In a budget justification dated November 15, 1929, the agency requested, "…the purchase of a "ditcher" to be used in fighting the marsh fires which present one of our big fire problems. The cost of the ditcher is approximately $100.00" (Klamath Agency 1911–1961). From these reports, it is clear that a number of fires burned within the Klamath Marsh in the 1920s. Very dry conditions during this decade may have contributed to the occurrence and tenacity of these fires. Peat fires occurred and were controlled using plows and ditchers when possible.

Despite an efficient fire control organization, large fires continued to occur on the reservation. Several other disturbance factors contributed to increased fire hazard. Coinciding with the start of fire control was the beginning of the commercial logging era on the reservation. Several small timber sales were sold starting in 1911 after passage of the Indian Omnibus Act, which established the legal sale of timber on reservations for industrial logging. Lumbermen were extremely interested in opening the timber on the reservation to commercial logging, and a great deal of lobbying was done by influential business men. The Southern Pacific Railroad had reached Klamath Falls in 1909 and was extended to Kirk in 1911. Logging and milling was fast becoming a major industry in Klamath County. By 1916, the Algoma Lumber Company had built a large mill just south of the southern reservation boundary, and Lamm Lumber Company had built a mill at Modoc Point within the reservation. Timber sales offered within the reservation started to be sold for higher then minimum bids in 1919. With industrial logging came an accumulation of logging slash. The Chiloquin sale in 1919 was the first reservation sale with provisions for slash disposal in the contract. For many years, staff at Klamath Agency spent a great deal of time and frustration trying to get compliance with slash disposal requirements. In 1926, a memo from the Oregon State Board of Forestry discouraged broadcast and pile burning of slash, and advocated spot burning or clearing of strips to deal with the increasing slash component (Klamath Agency 1911–1961). In 1929, Jackson Kimball offered the following observation on the logging slash issue. "…it is interesting to speculate on the reasons for the survival of the great pine stands in this locality which the early settlers found. The absence of undergrowth was likely due to the frequent ground fires which ran unchecked through the woods. It is apparent that occasionally such ground fires developed into destructive forest conflagrations, completely killing stands of mature timber. Such exhibitions caused timber owners and government agencies to inaugurate a protective system. It was comparatively easy here in the early years of patrol to suppress forest fires. Losses were light. But as the seasons passed the annual accumulations of forest debris increased in an appalling ratio. The logger also began to harvest parts of the great pine region. While he contributed largely to the liquid wealth of the community, he left behind horrible sore spots in the form of slashings to menace the remaining timber...Perhaps we will learn the wisdom of reducing hazards at the proper season." (KFPA 1927-1931).

Another disturbance factor that influenced the fire environment was a series of western pine beetle and mountain pine beetle infestations from 1915–1935. It is estimated that across the reservation, 20–30 percent of the large ponderosa pine were killed by beetle attacks during this epidemic (Klamath Tribes 2003). The agency initiated a systematic removal of infested trees. Trees were felled, the bark was peeled, and the tree and bark were burned. Despite the fact that beetle control operations were confined to the spring and fall season, several fires resulted from this activity. In 1924, a fire started by beetle control operations burned 300 acres. The 1930 annual fire report lists five fires started by beetle operations. It is probable that the large number of dead trees greatly added to the downed fuel component in both lodgepole and ponderosa pine stands as a result of this beetle epidemic.

Grazing occurred from the earliest periods on the reservation. The General Allotment Act of 1887 made it possible for individual Indians to lease allotments for haying and grazing. In 1927, one white rancher is reported to have acquired 7,000 acres of Indian grazing allotments (Stern 1965). Grazing of both sheep and cattle occurred both in the Klamath Marsh and in the timbered uplands surrounding the marsh.

Wind storms have caused localized concentrations of downed trees. In 1931, the Lamm Lumber Company was awarded a sale of timber blowdown on the Military Crossing Unit. There was also a sale of windthrown timber in Skellock Draw in the same year (Kinney 1950).

From the 1930s until 1960, the reservation fire control organization continued to aggressively suppress all wildland fires. Fire control became increasingly mechanized with the use of bulldozers, fire engines, and spotter aircraft. Although a number of small fires were reported in the Klamath Marsh during this period, there is little indication that extensive fires occurred within the current Refuge boundaries. In 1940, two large fires burned

to the southwest of the current Refuge boundary. The Wilson Point fire started on May 23 and burned 1,069 acres (including 4 acres in marsh); and the Wocus Bay fire started on August 17 and burned 2,774 acres (including 152 acres in marsh). These fires burned mostly in lodgepole pine stands, which were extensively killed (Klamath Agency 1911–1961). In 1959, a fire started at the Chiloquin dump and burned north across Solomon Butte, stopping short of the Klamath Marsh. This fire burned 15,000 acres and killed an estimated 85 percent of the overstory trees. Over 30 bulldozers were used on this fire, and one bulldozer was overrun and the operator killed (Weaver 1961).

3.3.2 Refuge Era Fire Management

With the establishment of the Klamath Marsh National Wildlife Refuge, fire control became a concern of the U.S. Fish and Wildlife Service (Service). As the Service had no fire program at that time, fire suppression on the Klamath Marsh shifted to the KFPA and the U.S. Forest Service. The only fires recorded during this period were a small fire in 1967 and a two-acre fire in 1979. It is possible that other fires occurred during the period that were not reported by either KFPA or the Forest Service.

In 1983, a Fire Management Officer (FMO) was stationed at the Klamath Basin Refuge Complex. This position was assigned to the regional office and had fire responsibilities for all of the national wildlife refuges on the west coast. The Klamath Basin Refuge Complex formalized its own fire program in 1983. A formal agreement with the Winema National Forest was secured to provide fire suppression at the Klamath Marsh. The Service assumed direct fire suppression responsibility in 1993, when a fire crew was placed at the Klamath Marsh Refuge. Since 1993, a fire engine with 3 crew members has been stationed at the Refuge during the critical fire season. Fire staff provide fire suppression, prevention, and educational duties. This crew responds to fires both on the Refuge and on cooperator-owned lands adjacent to the Refuge.

Twenty one wildfires have been recorded at the Klamath Marsh Refuge since 1983. The largest fire occurred in 1987, when lightning caused the 1,500-acre Wocus Fire in Wocus Bay. This fire was managed by the Forest Service with assistance from the U.S. Fish and Wildlife Service. The Wocus Fire was confined to the interior of the marsh, where it burned in a mosaic. Very little direct suppression action was possible due to the inaccessible location of the fire. A backfire was set when a finger of fire made a run toward the forested uplands. Fire crews monitored this fire until it quit burning. In 1993, a black lining project in preparation for a Service prescribed fire escaped after hours and burned 180 acres in the marsh north of the Silver Lake Highway. The burned area was all within the prescribed fire unit boundary, but the escape was declared a wildfire due to a large number of outside resources (including a helicopter) being assigned to it. Also in 1993, a fall thunderstorm started a 40-acre fire in the marsh north of the Silver Lake Highway. Due to the inaccessibility of this fire, crews monitored the fire until it was extinguished by rain that same day. In 2001, lightning ignited another fire within the marsh north of the Silver Lake Highway. A helicopter with a bucket and tracked vehicles were used to stop the perimeter spread of this 72-acre fire (North Marsh fire). In 2002, lightning started five fires on the Refuge in one day. The largest of these fires, on the northwest side of the marsh in ponderosa pine, was suppressed at less than two acres. Two loads of retardant were dropped on this fire during the initial attack stage.

During the Refuge era, a number of fires have been suppressed in the vicinity of the Refuge on both national forest and private lands. No large fires have occurred immediately adjacent to the Refuge, but a 300-acre fire was stopped on the western edge of the Klamath Marsh (on private land) in 1992 (Sand Creek fire). The Chiloquin Ranger District has had a number of large fires to the south of the marsh as well (e.g., Cowboy in 1987, Lone Pine in 1992, Quick in 1994, and Skunk in 2002).

In 1991, the Service conducted the first recorded prescribed burn projects at the Klamath Marsh Refuge. See Section 3.19.2 (Fire Management) for recent information on the use of prescribed fire on Refuge lands.

Numerous prescribed fires have occurred on lands adjacent to the Refuge. The Winema National

Forest has burned a number of piles and conducted several underburns within close proximity to the Refuge. Private landowners have also burned piles and conducted a small amount of underburning in recent years.

The Klamath Basin National Wildlife Refuge Complex has developed a Wildland Fire Management Plan (USDI USFWS. 2001) to address all aspects of fire management. This plan covers fire management activities at the Klamath Marsh.

3.4 Fisheries

Fish habitats on Klamath Marsh Refuge are comprised of river and stream habitats that include the Williamson River, Big Springs Creek, and year-round flooded marsh habitats located primarily in the area of Military Crossing and where Big Springs Creek enters Klamath Marsh. Although fisheries resources have not been extensively studied on Klamath Marsh Refuge, fish surveys were conducted in 1992 and 1993 by Oregon State University. Fish species documented during these surveys include redband trout, eastern brook trout, speckled dace, brown bullhead, tui chub, blue chub, Klamath largescale sucker, and fathead minnow. Eastern brook trout, fathead minnow, and brown bullhead are non-native species. Miller Lake lamprey, a recently rediscovered species in the Upper Klamath Basin, has been found in the Upper Williamson River (Doug Markle, Oregon State University, Pers. Comm.. 2008) and is believed to exist on Klamath Marsh Refuge. The Oregon Department of Fish and Wildlife has completed a conservation plan for this species (http://www.dfw.state.or.us/fish/docs/lamprey_plan.pdf). The Klamath largescale sucker that is located in the Upper Williamson River has been identified as genetically unique (Tranah and May 2006) and therefore may merit special conservation attention in the future.

Because Big Springs Creek is a spring fed creek system, habitat for fish in Big Springs is highly variable depending upon output from the several springs at its headwaters and along its length. Big Springs Creek output varies with wet and dry cycles, with output from wet and dry years delayed by two to three years due to subterranean transit times from water source to the respective spring heads. Flows in Big Spring Creek are also affected by irrigation on private lands upstream of the Refuge. Riparian vegetation along Big Springs Creek is sparse but recovering within the Refuge where it is protected from grazing.

The Williamson River through the Refuge has been highly altered from it original conditions. Prior to Refuge acquisition, the river was channelized in an east-west direction. This facilitated rapid drainage of the seasonally flooded sedge and grass meadows for cattle and hay operations. In addition, several water control structures were placed on the river to facilitate water diversion for irrigation.

The current configuration of the "river" through the Refuge provides relatively poor habitat for fish and other riparian and aquatic species. Water control structures on the river can block fish movement and are not modified to facilitate fish passage. In addition, the habitat provided by a simple straight channel does not provide the natural diversity of aquatic habitats that a more "natural" channel configuration would provide. Riparian vegetation is recovering along the remnant historic river channel but remains sparse along all diversion ditches and channels. The channeling and ditching of the Williamson River and lack of riparian vegetation allows for substantial river heating during the summer months. Future restoration of the Williamson River to more natural conditions would significantly improve conditions for fish and other aquatic organisms.

3.5 Migratory Birds

The U.S. Fish and Wildlife Service is responsible for the conservation and management of more than 800 species of migratory birds that occur in the country. In 2004, the Service released the Migratory Bird Program's 10-year strategic plan, A Blueprint for the Future of Migratory Birds (USFWS 2004). It calls for cooperation from all governments and partners to ensure the continued survival of migratory birds. The Blueprint identifies three priorities for the Service's Migratory Bird Program: 1) address the loss and degradation of migratory bird habitat,

2) improve scientific information on bird populations, and 3) increase partnerships to achieve bird conservation. Implementation of Refuge plans will compliment these priorities by addressing needs of some Birds of Management Concern listed in the Blueprint for the Future of Migratory Birds.

3.5.1 Waterfowl

Klamath Marsh National Wildlife Refuge is part of the Klamath Basin National Wildlife Refuge Complex located in the Upper Klamath Basin of northern California and southern Oregon. The region is noted for its waterfowl abundance in both fall and spring, with numbers generally ranging from one to two million birds during the peak of spring and fall migration. In terms of migratory waterfowl use, Klamath Marsh Refuge tends to support fewer waterfowl in migration than other refuges in the complex. The peak waterfowl numbers recorded for Klamath Marsh Refuge in fall were 98,000 (in 1968) and 145,000 in spring (in 1995) (Gilmer et al. 2004). There are several reasons for the relatively low numbers of waterfowl during migration at Klamath Marsh Refuge. First, the Refuge is at a relatively high elevation—freezing of marshes in fall occurs early, and ice often remains late in the spring. In addition, the natural hydrology of the Klamath Marsh results in very low marsh water levels in fall. In fact, most of the marshes on the Refuge are dry in autumn during dry years. In addition, large areas of dense emergent vegetation at the Klamath Marsh preclude use by fall and spring waterfowl.

Waterfowl use varies considerably from year to year (Figure 3-3) depending on fall and spring water conditions and Refuge habitat management practices. Fall burning of Refuge wetlands (particularly sedge meadows) can result in high use by spring migrant waterfowl. Predominant waterfowl species using Klamath Marsh Refuge during migration include (in order of abundance) northern pintail, mallard, American wigeon,

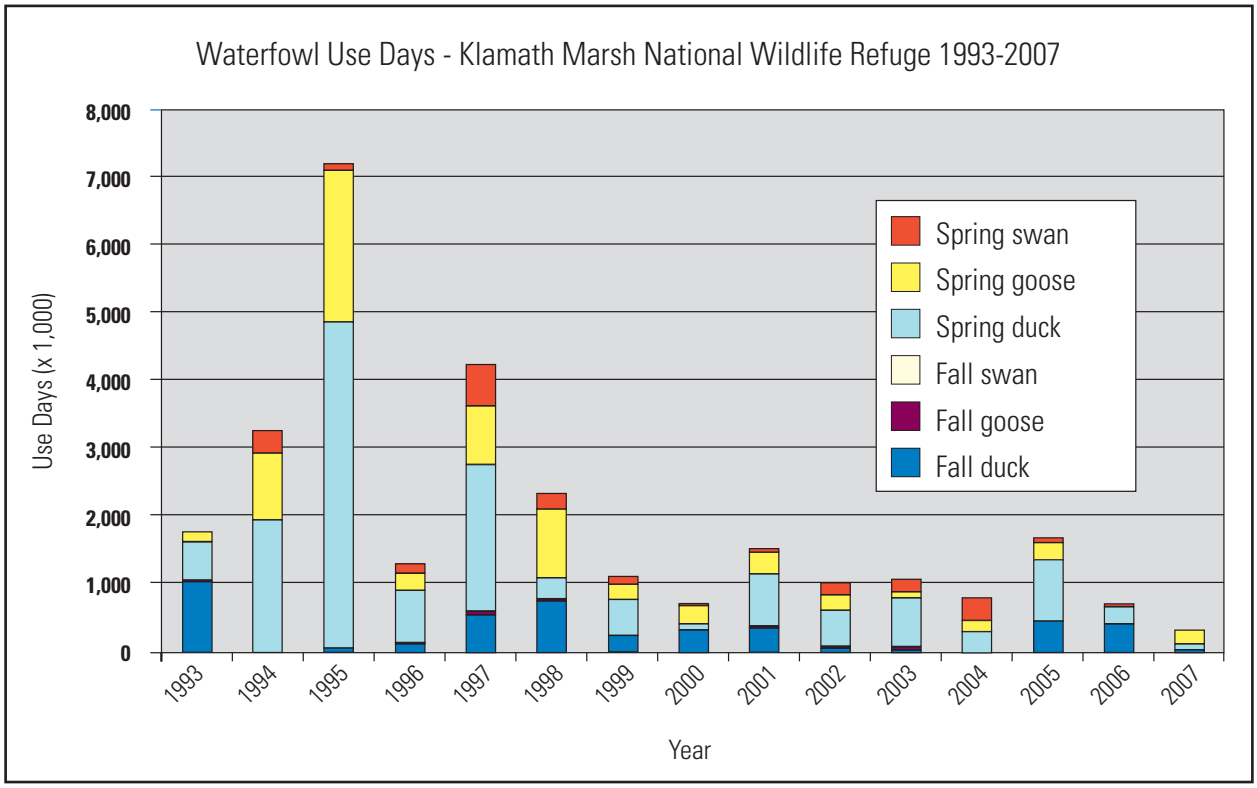


Figure 3-4. Waterfowl use days (x1,000) Klamath Marsh National Wildlife Refuge, 1993–2007

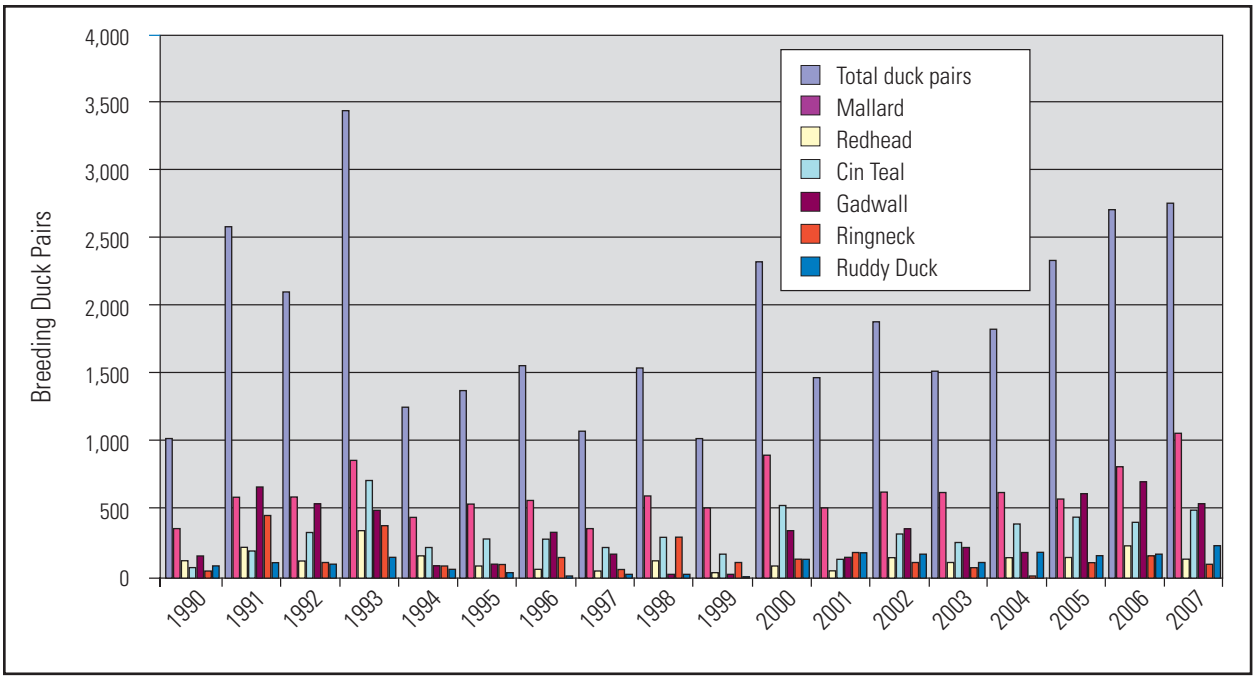


Figure 3-5. Estimated breeding duck pairs, Klamath Marsh National Wildlife Refuge, 1990–2007

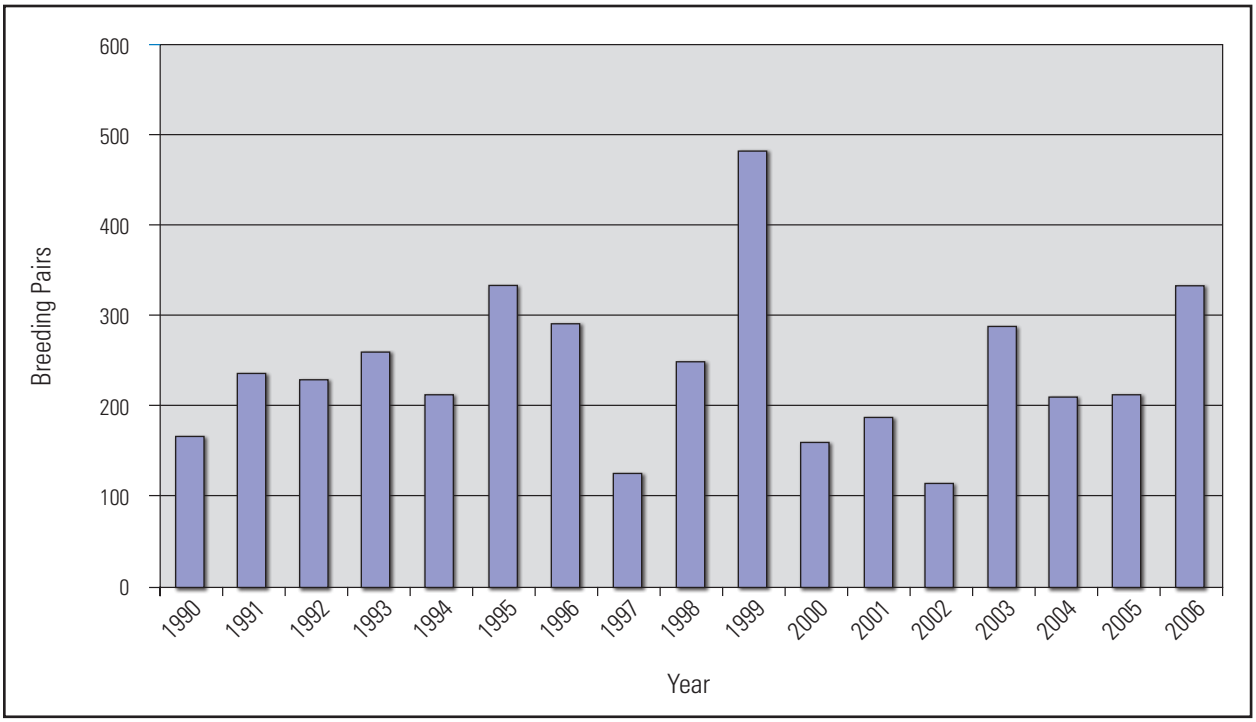


Figure 3-6. Estimated breeding pairs of Canada Geese at Klamath Marsh National Wildlife Refuge, 1990–2007

northern shoveler, green-wing teal, ruddy duck, gadwall, and canvasback (Gilmer et al. 2004).

Klamath Marsh Refuge is important to molting waterfowl, particularly mallards. Molting ducks lose all wing feathers during the late summer molting period. The large contiguous emergent marshes at Klamath Marsh Refuge provide secure habitat during the critical 30-day flightless period. Large emergent marshes are relatively rare in the Intermountain West. Mallards have been documented traveling over 300 miles to molt in these areas. In particular, large post-breeding populations of mallards travel from the central valley of California to molt in Klamath Marsh each year.

Klamath Marsh is also an important breeding area for waterfowl, with Canada geese, mallards, gadwall, cinnamon teal, and redheads being the predominant species (Figure 3-5 and Figure 3-6). Breeding numbers of waterfowl are highly variable. The cause of this variation is difficult to determine but likely results from year-to-year variation in total breeding populations, wetland habitat conditions on and off the Refuge, visibility conditions during surveys, etc.

3.5.2 Other Migratory Birds

This section highlights important Refuge information about non-waterfowl species like songbirds, raptors, secretive marsh birds, and shorebirds. One of the ranking systems we used to evaluate and prioritize the conservation needs of various species was developed by the American Bird Conservancy (see Appendix J). The American Bird Conservancy is a not-for-profit organization whose mission is to conserve wild birds and their habitats throughout the Americas and produce a "Green List" that contains all the highest priority birds for conservation in the continental United States and Canada (American Bird Conservancy 2004). This list builds on the Partners in Flight assessments and divides rankings into three broad categories.

Category one species are the "Highest Continental Concern" birds that suffer multiple problems and include federally listed threatened and endangered species. The yellow rail (which breeds on the Refuge) and the long-billed curlew (observed in migration) are the only two species in this category on the Refuge. The second American Bird conservancy category, "Moderately Abundant Species with Declines or High Threats," lists birds with relatively high numbers but that are declining at an alarming rate. Of this group, the Refuge has 18 species listed (Appendix J). An additional seven species that have been observed on the Refuge are included in American Bird Conservancy's third category, "Species with Restricted Distributions or Low Population Size," a group with populations stable and threats apparently limited but where populations are limited in number or range.

The American Bird Conservancy also designates "Important Bird Areas" that are exceptionally important and essential for bird conservation (American Bird Conservancy 2004). The goal of the Important Bird Areas program is not just to recognize the sites as important, but also to mobilize the resources needed to protect them. The ABC has recognized the Klamath Marsh National Wildlife Refuge as an Important Bird Area in the State of Oregon because the Klamath Marsh hosts approximately 50 percent of the western U.S. yellow rail breeding population (Lundsten and Popper 2002). The Refuge also has several records of least bitterns (Marshall et al. 2003), a naturally rare species in Oregon, and large concentrations of nesting greater sandhill cranes, roughly six percent of Oregon's breeding population (Ivey and Herziger 2000).

Songbirds

Songbirds include a wide array of landbirds such as hummingbirds and woodpeckers, as well as the large order of birds called passerines or "perching" birds. Passerines comprise more than half the world's species of birds, and all have a perching foot that includes three toes forward and one toe backward. They range in size from wrens to ravens. Many passerines eat insects and fruit; passerines include flycatchers, shrikes, vireos, crows, jays, chickadees, nuthatches, tanagers, cardinals, sparrows, and finches.

Prior to the twentieth century, songbirds were considered very abundant. However, during the last 75 years, scientists have documented declines in many songbird species (Terborgh 1989; Finch

1991), particularly the Neotropical migrants—those that breed in North America and overwinter in the Neotropics of Mexico, Central and South America, and the Caribbean. Habitat loss in North America and in the Neotropics is the main culprit. Nonetheless, the Refuge still provides migration habitat for songbirds, many of which fly thousands of miles each year between Central and South America and the United States and Canada. Eighteen songbird species (Appendix J) have been labeled as species of conservation concern by Partners in Flight (PIF) for physiographic region 67, which is located along the east slope of the Cascade Mountains of Oregon (Altman 2000).

Researchers, staff, and volunteers have documented over 115 species of songbirds using the Refuge, including 10 species of warblers. During 2003 and 2004, bird monitoring was conducted on the Refuge by the Klamath Bird Observatory to gather baseline data on bird use of areas targeted for future forest management practices (Stephens and Alexander 2004). Spring and fall surveys documented 114 species of passerines, raptors, and waterbirds using pine, aspen, and wet meadow areas. Eleven of the species detected were focal species identified by PIF (Altman 2000). The Refuge is using the habitat descriptions and focal species identified in the PIF Plan (Altman 2000) to identify desired habitat conditions. The rationale for using focal species is that by managing for a group of species representative of important components in a functioning ecosystem, many other species and elements of biodiversity also will be conserved. Long-term post monitoring of treated forest areas will be conducted to determine treatment effects and, if necessary, to modify future management actions.

Secretive Marsh Birds

Secretive marsh birds include bitterns and rails that utilize wet meadow and emergent wetland habitats, both of which are present on the Refuge. Surveys and observations indicate that American bittern, least bittern, sora rail, Virginia rail and yellow rail use the Refuge for either migration or breeding.

The status of bittern and rail use on Refuge lands, with the exception of the yellow rail, has not been fully evaluated. Virginia and sora rails are often heard calling in a variety of locations around the Refuge. The Klamath Bird Observatory initiated the Oregon Coordinated Aquatic Bird Monitoring program in 2008 and has included Klamath Marsh National Wildlife Refuge as one of its monitoring areas. This program will contribute to the Intermountain West Coordinated Bird Monitoring program, which has—along with land managers and regional avian experts—identified Important Aquatic Bird Sites throughout the west. Klamath Marsh Refuge is one of 40 such sites in eastern Oregon. The Refuge's participation in this program will help meet Refuge biological monitoring needs and help supply regional land managers and conservation organizations information about ecosystem conservation in Oregon. Monitoring in this program will specifically focus on wetlands and associated aquatic birds, identify existing monitoring efforts, identify knowledge gaps limiting wetland bird conservation, and measure the effectiveness of wetlands management programs.

Yellow Rail. The yellow rail ranks as one of North America's most elusive and mysterious birds, best known by the insect-like nocturnal ticking song of males. Although there is some sentiment that this species is more abundant than encounters would indicate, there are no data on the population size or trends of yellow rail, and the species' biology on its wintering grounds remains largely unknown. Because of its secretive nature, the yellow rail is infrequently encountered and difficult to study. The second-smallest rail in North America (5–7 inches), it breeds in wet meadows and shallow marshes and winters in marshes and hay fields.

The primary breeding range for the yellow rail in North America extends across a large area of eastern Canada and south into the United States, including northeast Montana, North Dakota, Minnesota, Wisconsin, Michigan, and Maine. In winter, these populations migrate to coastal marshes in the southeastern states ranging from south Texas to North Carolina (Bookhout 1995).

Outside this range, in the Western U.S., yellow rails were known to nest in Mono County, California, from 1922–1950 (McCaskie et al. 1988). After 1950, the breeding population of yellow rails was considered extirpated from California (American Ornithologists Union 1983). In June of 1982, two yellow rails were

heard in the Wood River Valley near Fort Klamath in Klamath County, Oregon (Rogers 1982). From 1982 to 1992, observations by various birders and extensive inventories conducted by the Oregon Natural Heritage Program (Morawski and Stern 1992, Stern et al. 1993) provided further information about the yellow rail in Oregon.

The yellow rail is classified as follows: threatened or endangered in some eastern and Midwestern states (Bookhout 1995); a Species of Management Concern by the U.S. Fish and Wildlife Service (USFWS 1995); Sensitive Critical under Oregon's Sensitive Species Rule, as developed by the Oregon Department of Fish and Wildlife; and a Sensitive Species by the Pacific Northwest Region of the Forest Service (Oregon Natural Heritage Program 2001).

The estimated total breeding population in 2000 at known sites in Oregon (and therefore the Western U.S.) was 220–270 pairs (Popper and Stern 1999; Popper et. al. 2000). The Wood River Valley, Klamath Marsh, Sycan Marsh, and Big Marsh were the only confirmed or probable breeding areas for yellow rails west of the Rocky Mountains in 2000 (Popper and Stern 2000). As of 2000, 251 males were banded in Oregon over a six-year period. These banded birds may provide an opportunity to learn more about species survivorship, life span, site fidelity, and changes in population in response to varying habitat conditions (Popper and Stern 2000).

The following describes the habitat of the yellow rail in Oregon based on information gathered in Oregon from 1994–2000. Yellow rails have been found in marshes or wet meadows that have an abundance of thin-leaved sedges, as well as a layer of senescent vegetation, which they use to conceal their nests (Popper and Stern 2000). Most important, the average water depth where male yellow rails are found calling has averaged 7 centimeters (n=638 SD=3.6). Because of this shallow depth of water, yellow rail habitat can change drastically between and within years (Popper and Stern 2000).

The two important habitat characteristics that can be controlled by land managers are water levels and cover of vegetation. The management of water levels through dikes, head gates, and check dams is a critical environmental factor affecting habitat of breeding yellow rails. Using dikes for flood irrigation can result in flooded nest sites, and cleaning of ditches can result in the lowering of water tables. This alteration of the natural water levels and hydroperiod may result in nest or brood failures even if conditions were ideal when nesting was initiated. Human induced changes in water levels should be closely monitored to ensure we are not flooding ground-nesting or over-water nesting birds (cranes, rails, marsh wrens, waterfowl, etc.) The amount and type of cover is the second important habitat consideration for yellow rails. Rails were found primarily in areas with 100 percent vegetative cover that was a mixture of senescent (30–50 percent) and live plants (Popper and Lundsten 2001). If grazing is applied to rail breeding habitats, it should not occur until after mid-August and should be relatively light to ensure that sufficient senescent and live vegetative cover is available for the next year (Popper and Lundsten 2001).

In all areas, loss of wetland habitat is a continuing threat for the yellow rail (Bookhout 1995). In the Klamath Basin, there have been extensive losses of wetlands, some estimating losses of 85–90 percent since the 1900s (Bottorff 1989). The impacts of haying, grazing, and prescribed burns are not fully understood, and further evaluation is needed to determine how these activities may benefit or negatively affect the species.

Klamath Marsh Refuge has been identified as having the largest, most extensive acreage of potential yellow rail habitat in Oregon and generally appears to be the center of distribution for this disjunct population of the Rocky Mountains. Little is known about the nesting ecology and breeding behavior of yellow rails, particularly western populations.

The first yellow rail surveys were conducted on the Refuge in 1991 by the Oregon Natural Heritage Program and the Nature Conservancy. The goal of the surveys was to follow up on previous work completed in 1988 and 1989 on the abundance and distribution of the yellow rail in south central Oregon. During 1988 and 1989, small populations of yellow rails were located around Upper Klamath Lake and the Sycan Marsh.

Varied surveys have been conducted on the Refuge in potential yellow rail habitat since 1991. Surveys

from 2000–2006 were the most standardized and have provided the most consistent information regarding general abundance and distribution. During 2006, 120 calling males were documented, which was lower than the 137, 146, and 171 heard during complete surveys conducted in 2000–2002 (only partial surveys were completed in 2003–2005). The drop in rails calling may be attributable to a continued drop in groundwater levels along the western edge of the marsh—possibly exacerbated by the effects of haying in the area south of Silver Lake Highway. The distribution of yellow rails found during 2006 and a recent summary of yellow rail monitoring on the Refuge can be found in Appendix N (Popper 2006). Future monitoring will begin to focus more on the effects of various management actions (haying, burning, and grazing) on yellow rail populations and habitat.

Other Waterbirds

The Refuge is used by numerous other waterbirds, such as shorebirds, grebes, gulls, terns, herons, etc. (Appendix J). Several species are identified as species of concern as determined by the Service, Partners in Flight, Oregon Department of Fish and Wildlife, and the American Bird Conservancy.

At least 20 species of shorebirds have been documented using the Refuge for migration or breeding. Shorebirds often migrate long distances from breeding grounds in Alaska and Canada to wintering grounds in Central and South America. Refuge habitats used by these shorebirds include all types of Refuge wetlands and wet/sedge meadow habitats. Black-necked stilts, Wilson's phalaropes, and willets are just a few of the shorebirds that have been observed nesting on the Refuge.

In 2003–2004, surveys were completed by Shuford et. al. (2006) to document the abundance and distribution of nongame waterbirds throughout the Klamath Basin. Though their importance varied seasonally, grebes, pelicans and cormorants, wading birds (bitterns, herons, egrets, ibis), shorebirds, and gulls and terns were the groups accounting for the bulk of all individuals on each survey. Species or species groups with basin-wide populations of more than 5000 individuals were the Eared Grebe (all seasons), Western Grebe (May and June), American White Pelican (May and August), White-faced Ibis (June and August), Black-necked Stilt (August), Western and Least sandpipers (May and August), Dunlin (May), Long-billed Dowitcher (May and August), and Ring-billed Gull (all seasons). All of these species have been known to utilize Klamath Marsh Refuge for either migration or breeding. Klamath Marsh was found to be particularly important to breeding yellow rails and black terns. It is known that black terns nest on the Refuge, often below Silver Lake Highway, in Big Wocus Bay, and to the north near the Lane Ranch area. In 1991, an estimated 120 nests were observed in the South Marsh Unit close to Silver Lake Highway. Pied-billed, western, Clark's and eared grebes have also been sighted as nesting on the Refuge. A total of 73 eared grebe nests were observed in Big Wocus Bay in 1991 (USDI, USFWS 1990-1994).

Shuford et. al. (2006) noted that all of the wetlands in the Klamath Basin are important both individually and collectively to waterbirds. However, certain wetlands or large water bodies stand out in supplying breeding or foraging habitat for large numbers of particular species or species groups, hosting species of very limited distribution within the Klamath Basin, or supporting populations that are of regional or continental importance. Among the region's wetlands that Shuford et. al. (2006) found particularly notable for one or more of these reasons are Clear Lake National Wildlife Refuge, Klamath Marsh National Wildlife Refuge and associated wetlands, Lower Klamath National Wildlife Refuge, Sycan Marsh, Tule Lake National Wildlife Refuge, and Upper Klamath Lake and associated wetlands.

Cranes

Cranes are those birds belonging to the family Gruidae. They are tall birds with long necks and legs and fairly long, heavy bills. In North America, there are only two species of cranes, the sandhill crane and endangered whooping crane.

There are six different subspecies of sandhill cranes in North America. The different subspecies of sandhill crane vary greatly in size and weight. Lesser sandhills, who breed at more northern latitudes (e.g., the Arctic) are the smallest, weighing

on average 6–7 pounds and standing 3.0–3.5 feet tall. At the other end of the extreme, temperate-nesting greater sandhills are the largest subspecies and average 4.5–5.0 feet tall and 10–14 pounds. Klamath Marsh Refuge is an important breeding and migration area for the greater sandhill crane.

Greater sandhill cranes are listed by Partners in Flight as focal species for the wet and dry montane meadow habitat type. This species is listed as Endangered in Washington (1981), a Sensitive Species (1982) by the U.S. Fish and Wildlife Service, Threatened in California (1983), and Sensitive in Oregon (1989) and British Columbia (1993).

Figure 3-7. Breeding distribution of Greater Sandhill Cranes in the United States

The greater sandhill cranes are divided into five distinct migratory populations that return to the same breeding and wintering sites every year (Littlefield and Ivey 2000). These five populations are the Eastern, Prairie, Rocky Mountain, Lower Colorado River Valley, and California Central Valley (Figure 3-6). (Littlefield and Ivey 2002). Birds utilizing Klamath Marsh Refuge are part of the California Central Valley population.

An estimated 62,600 greater sandhill cranes exist today, and approximately 8,500 belong to the California Central Valley population (Littlefield and Ivey 2000). The most recent breeding surveys recorded 1,151 breeding pairs in Oregon, 465 breeding pairs in California, 20 pairs in Washington, and 11 pairs in Nevada (Ivey and Herziger 2000; Ivey and Herziger 2001; Littlefield & Ivey 2002). Greater sandhill cranes have a long history of nesting on Klamath Marsh Refuge, with the Refuge being one of the most important breeding sites in eastern Oregon. Refuge biologists conduct coordinated surveys in April each year and attempt to cover all important breeding habitats on the Refuge. Counts have declined somewhat from the early to mid-1990s but have stabilized at 40–50 nesting pairs since 1999 (Figure 3-7).

The California Central Valley population of greater sandhill cranes is now the focus of recovery efforts. It consists of two groups, which breed in different areas. One group winters in the southern part of California's Central Valley and breeds in southeast Washington, southeast and south central Oregon, northwest Nevada, and in northeast California. The other group winters in the northern part of the Central Valley and breeds in British Columbia (Littlefield and Ivey 2002).

Sandhill cranes are primarily birds of open freshwater wetlands, but the different subspecies use habitats that range from bogs, sedge meadows, and fens to open grasslands, pine savannas, and cultivated lands. Sandhill cranes occur at their highest breeding density in habitats that contain open sedge meadows in wetlands adjacent to short vegetation in uplands. This preferred breeding habitat type is supplied within Klamath Marsh National Wildlife Refuge.

Breeding greater sandhill cranes use both semi-permanent marsh and seasonal marsh but tend to nest in wet meadows and make less use of tall emergent vegetation in deep water for nesting. The preferred habitat characteristics of sandhill cranes for breeding are wet meadow areas dominated by short emergents like sedges and grasses. Foraging habitat is usually dry and wet meadows. At Grays Lake National Wildlife Refuge in Idaho, vast portions of the marsh—dominated by bulrush and cattail in deeper water—were used little or not at all by nesting cranes; instead, most sandhill cranes nested in meadows, on islands, and on the interface

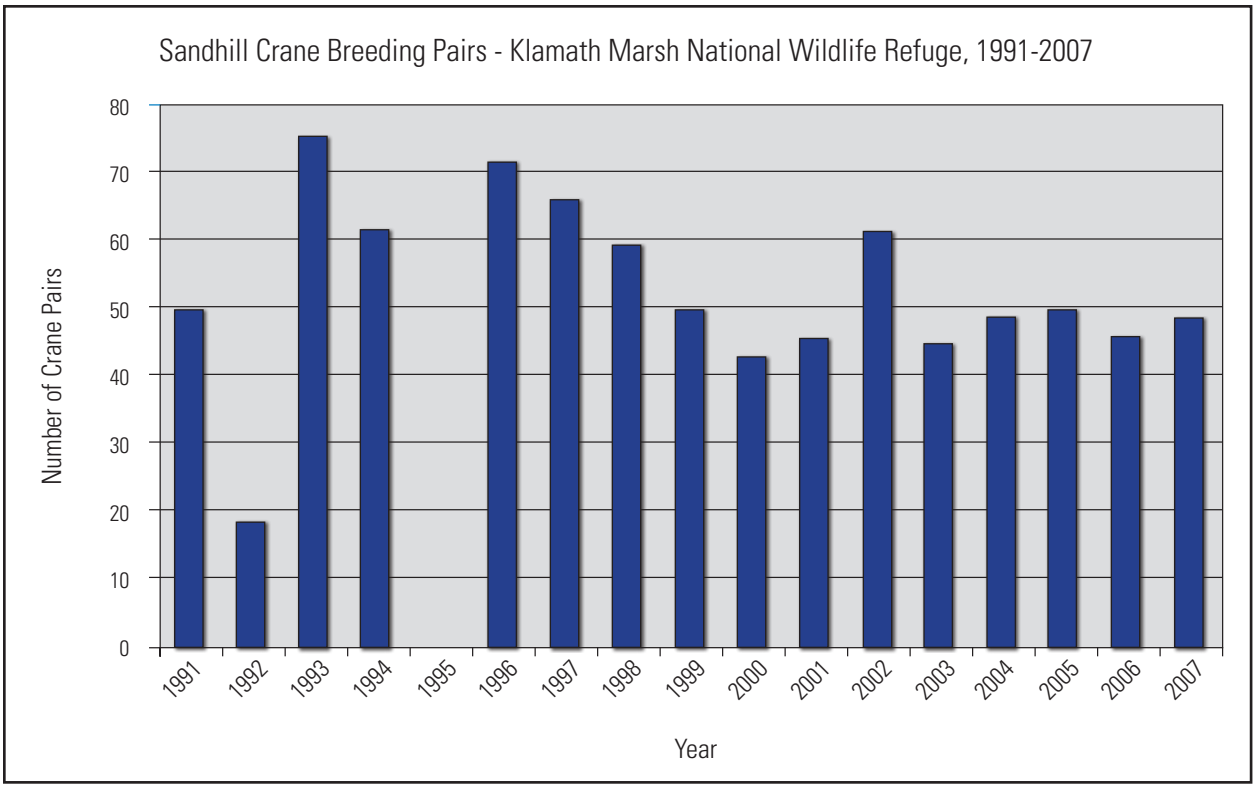


Figure 3-8. Estimated number of greater sandhill crane breeding pairs at Klamath Marsh National Wildlife Refuge 1991-2007

between wet meadow and permanent marsh (Drewien 1973).

On Klamath Marsh National Wildlife Refuge, cranes typically nest over shallow water in dense clumps of hardstem bulrush, avoiding the vast portions of the marsh that are monocultures of bulrush and cattails and lack any interspersion of open water. Nesting habitat varies from year to year based on vegetation changes and water levels. In very wet years, the center of the marsh is deep enough to force cranes to select nesting sites near the edges of the marsh. In these high water years, the lack of emergent cover often forces cranes to nest in relatively exposed sites.

Greater sandhill cranes are easily disturbed when they are nesting. They build their nests by heaping up vegetation in shallow water in wetlands or on the ground in wet meadows, making their eggs and newly hatched young extremely vulnerable to predators such as coyotes, the common raven, and raccoons (Littlefield 1989). On Klamath Marsh Refuge, breeding sandhills are especially secretive and will not readily flush unless the observer approaches very closely. They have been observed sneaking away from the nest with head lowered for quite some distance before flushing. This behavior reduces the chance of predators locating the nest.

Cranes often lay two eggs; however, it is rare for more than one chick to be successfully reared. Sibling rivalry, coupled with asynchronous hatch dates (results in one chick being larger than the other) and overall low survival rates to fledging, results in few breeding pairs successfully rearing two chicks. Cranes on Klamath Marsh Refuge are typically reared in seasonally flooded sedge meadows. Intensive monitoring of breeding sandhill cranes on the Refuge occurred in 1993 and 1994.

During 1993, 21 pre-fledgling crane chicks were counted in mid-summer, with 4 chicks counted in late summer just prior to fledging. In 1994, 29 chicks were counted in midsummer, with only 1 chick counted during the late summer period. However, accurate counts of cranes at Klamath Marsh Refuge are confounded by the lack of access and dense vegetation; thus, these counts likely represent minimum numbers. Annual survival of chicks to fledging in cranes is generally low compared to many other avian species, but high chick survival is not necessarily required to maintain populations, as adult crane survival is typically high and the birds are long lived.

Studies have indicated that the presence of grazing cattle can cause the birds to abandon their nests or avoid nesting in certain areas (CDFG 1994). By removing vegetative cover in the crane's nesting areas, grazing cattle can also expose nests to greater predation levels (Liebezeit and George 2002). Young birds may also be killed during mowing and haying operations (CDFG 1994). To reduce these potential effects on the Refuge, the use of fire, cattle grazing, and haying operations to enhance habitats for nesting waterbirds are usually restricted to late fall periods. Changes in water availability are also detrimental to the greater sandhill crane. In their wetland nesting habitat, the crane's nesting success is reduced by drought conditions and by wetland degradation—lowering of the water table eliminates suitable nesting areas altogether (CDFG 1994). The Service hopes to improve future water conditions on the Refuge via wetland and river restoration efforts and working with landowners to improve water conditions within the Williamson River Watershed.

Raptors

Raptors are birds adapted for living on prey. They typically have a strong decurved bill and sharp piercing talons used to capture prey. Refuge raptors include vultures, hawks, owls, and eagles. There are 26 species that have been sighted on the Refuge. Several species nest on the Refuge, and many others migrate through the Refuge during spring and fall (Appendix J). Some of the raptors known to be nesting on or immediately adjacent to the Refuge include red-tailed hawk, great horned owl, bald eagle, great gray owl, golden eagle, and Northern goshawk. Specific monitoring of raptors has not been completed on the Refuge with the exception of the bald eagle. The following summarizes some information on raptor species monitored primarily on adjacent U.S. Forest Service lands.

The bald eagle was declared an endangered species in 1973 due to low populations that existed following a century of persecution and habitat loss and several decades of poisoning from pesticides (e.g., DDT, dieldrin, endrin, etc.). The species began to recover after these pesticides were banned in 1972, and public awareness and management provided protection for the bird. Bald eagle populations have rebounded significantly during the past 35 years, and the species was de-listed in 2007 as a federally threatened and endangered species. The species remains protected under the Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act.

Monitoring of eagle nesting on or adjacent to the Refuge started in 1978. In 1978, one nest was located which produced two young (Figure 3-9). There has been a steady increase in the number of nests located on or adjacent to the Refuge, peaking at 12 nests in 2005. A pair of eagles may have several nests within their nesting territory, so the 12 nests do not reflect 12 separate nesting territories. The five-year average for the number of young produced per occupied nest site has ranged from 0.4 in 1983 to 1.34 in 1990 for data collected 1978–2003. Monitoring has been completed in coordination with Frank B. Isaacs and Robert G. Anthony of Oregon State University, Oregon Cooperative Wildlife Research Unit. Volunteers have been instrumental in gathering nesting data for the Refuge and are credited with achieving the collection of this long-term data for the Refuge.

Wintering bald eagle numbers on Klamath Marsh National Wildlife Refuge have been monitored from 1988–2009 as part of the National Midwinter Bald Eagle Survey that is coordinated by Karen Steenhof, Research Wildlife Biologist, Snake River Field Station, Biological Resources Division, U.S. Geological Survey. Surveys are coordinated by the Oregon Eagle Foundation, Inc., and are conducted in the first two weeks of January along standardized routes. Klamath Marsh Refuge data will be evaluated with data collected nationally to

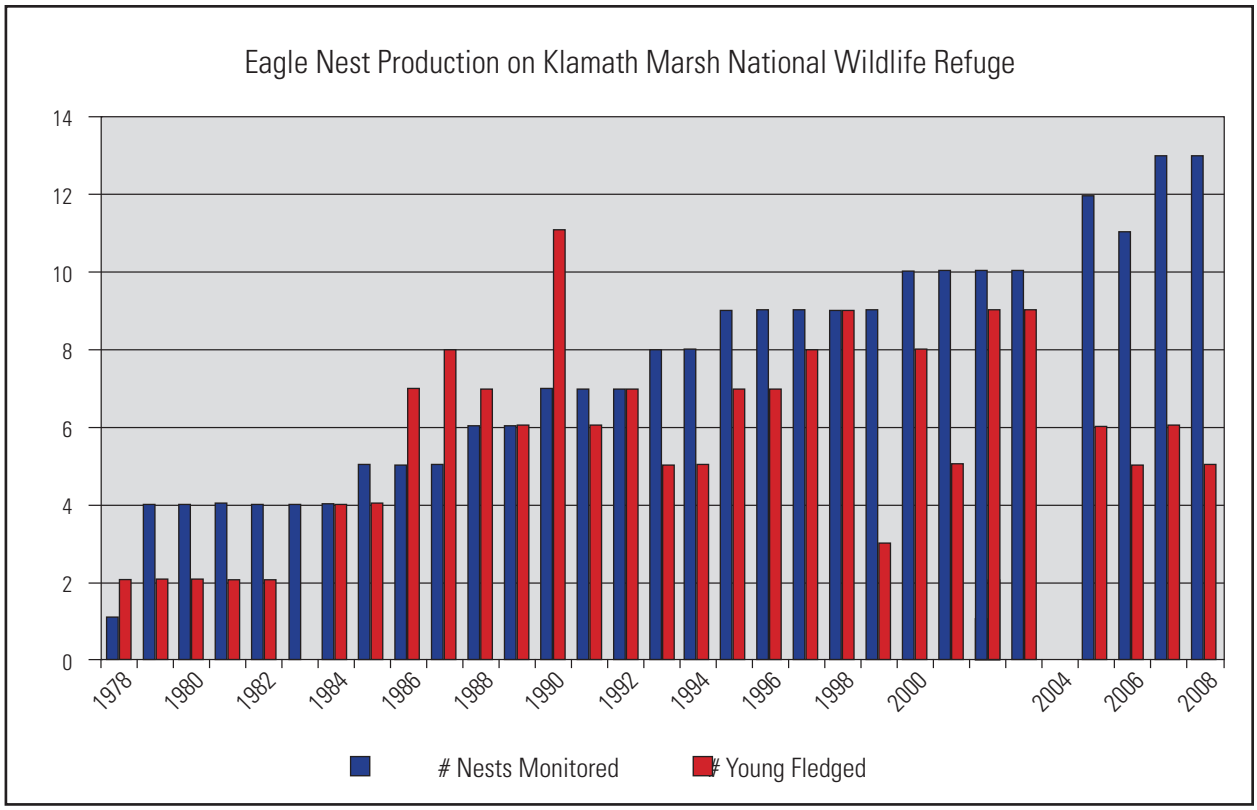


Figure 3-9. History of bald eagle nesting and production on Klamath Marsh National Wildlife Refuge, 1978-2008

determine trends in the number of bald and golden eagles wintering in the lower 48 states. Over the years, the number of wintering eagles has fluctuated from 0–13, with typically 0–4 birds observed. Due to deep snow, a comprehensive survey for wintering eagles is often not feasible unless conducted via plane. Most years, only partial surveys are completed along Silver Lake Highway and Military Crossing Road, as funding for aerial surveys is often not available. The lack of open water and presence of deep snow within and surrounding the Refuge often result in low numbers of wintering eagles. Hence, fluctuations in wintering eagles are likely a result of differences in annual weather patterns, local conditions, and observers.

Peregrine falcons are occasionally observed on the Refuge during migrations. Peregrines are known to nest 15 miles west of the Refuge at Crater Lake National Park. Frequent sightings of peregrines hunting on the Refuge during 1991 indicated that a nesting pair may have been located much closer (USDI, USFWS 1958-1998). U.S. Forest Service biologists spent time surveying likely nesting locations on and off the Refuge in 1991 but were unable to locate a nest. Peregrine falcons were recently taken off the endangered species list because their populations have rebounded.

The great gray owl is one of the largest of the North American owls. Great gray owl sightings are uncommon, yet five active nests were known to exist on U.S. Forest Service (USFS) lands adjacent to the Refuge in 1991. Recent surveys near the Refuge have not been completed by the USFS. Nine great gray owl platforms were installed on or adjacent to the Refuge boundary by a volunteer in 1991 to provide additional nesting habitat because a shortage of snags within the area were thought to be limiting owl populations. A survey of these platforms by volunteers in 2006 indicated they had not been used in 2006. Providing nesting materials

on these platforms in the future may encourage future use.

The northern goshawk is a Federal species of concern and a state-listed sensitive species. In the west, the goshawk typically nests in mature forests with large, tall trees and dense canopies. Its short wings and long tail allow it to maneuver through thick forests after birds and to catch small mammals on the ground—unlike most hawks that soar high above the ground in more open landscapes. Data from some studies report declining goshawk numbers and loss or modification of habitat, while other studies offer conflicting data. A range-wide assessment of the goshawk has not been conducted, however, so scientists do not know if reported decreases are local phenomena or reflect the range-wide condition of the bird. A 2007 conservation report on this species found that data from raptor migration counts (Breeding Bird Survey and Christmas Bird Count) indicate this species has declined in much of western North America since the early 1980s (Bildstein et. al. 2008). Two adults and one juvenile were sighted in 2006 by USFS staff within one-quarter mile of the Refuge's north boundary, but a nest could not be located. Surveys for nesting goshawks have not been completed for the Refuge. Future efforts should focus on monitoring this species in coordination with the USFS Chemult and Chiloquin district offices.

During the winter months, numerous raptors are observed perched on signs or road markers along Silver Lake Highway. Rough-legged hawks and red-tailed hawks are the most frequent species. Several raptors have been killed or injured by vehicles when perching on these artificial structures. In efforts to reduce raptor mortalities, Refuge volunteers have modified road posts with wires to discourage perching along the highway.

3.6 Mammals

Specific inventories of mammals have not been completed on the Refuge. The most common mammals observed are coyote, Rocky Mountain Elk, mule deer, and a variety of chipmunk and squirrel species (Appendix J). Other mammals known to occur and occasionally observed on the Refuge include muskrats, river otter, beaver, striped skunk, raccoon, bobcat, and black bear. Further surveying is needed to document the presence of various bats and rodent species.

Coniferous forest is the primary habitat for Rocky Mountain elk and mule deer on the Refuge. However, elk and deer also use the wetland habitats for cover and forage, particularly during the summer and early fall as the marsh water levels recede. For both mule deer and elk, Klamath Marsh Refuge, as well as surrounding U.S. Forest Service and private lands, are used as summer and fall habitat. During late fall, deer and elk move to lower elevation wintering areas near Silver Lake, Oregon. As spring weather and habitat conditions improve, deer and elk return to Klamath Marsh Refuge (generally March–May). In very mild winters, elk have been observed wintering along the edges of Klamath Marsh.

Klamath Marsh Refuge is bordered by three big-game management units (Oregon Department of Fish and Wildlife): Fort Rock, Silver Lake, and Sprague management units. Estimated deer populations for each unit are Fort Rock: 7,000 mule deer; Silver Lake: 6,500 mule deer; and Sprague: 3,000 mule deer (summer populations). Estimated elk populations are combined with other management units and include Fort Rock/Paulina: 1,000 elk; and Silver Lake/Sprague/Interstate/Klamath Falls units: 1,300 elk. In addition to mule deer and elk, approximately 300 pronghorn antelope utilize the Fort Rock Unit, some of which are occasionally sighted on Klamath Marsh Refuge, particularly in the summer and fall. Edges of Klamath Marsh provide excellent fawning and calving habitat due to adequate forage, cover, and security.

Presently, there is no active habitat management on or adjacent to Klamath Marsh Refuge that is targeted specifically for mule deer or elk. These species do benefit from Refuge burning, grazing, and haying programs that re-invigorate grasses and forbs, which are attractive forage species. Silvicultural activities on adjacent U.S. Forest Service lands have improved some areas by reducing densities of conifers and increasing grass, forbs, and browse species desired by deer and elk. The Klamath Tribes, which have subsistence rights to hunt deer and elk on Federal lands within their

former reservation, work with the U.S. Forest Service and the Refuge to create beneficial habitats for deer and elk as part of silvicultural and other land management activities. Mule deer in the vicinity of Klamath Marsh Refuge have experienced a long-term population decline, partly due to the increasing density of coniferous trees which has reduced the quality and quantity of understory vegetation. In contrast, the increase in coniferous tree densities has provided improved hiding cover for elk, which have gradually increased in number. In addition to tribal subsistence hunting, sport hunting adjacent to the Refuge is very popular with deer and elk hunters.

3.7 Reptiles and Amphibians

There are 15 species of reptiles and 7 species of amphibians suspected to occur on the Refuge (Appendix J). Very little survey work has been completed on the Refuge to document species occurrence, distribution, or abundance. Future monitoring should be completed to provide baseline information on these species.

3.7.1 Amphibians

Four species of frogs, two species of toads, and one salamander species are listed as potentially occurring on Klamath Marsh National Wildlife Refuge (Appendix J). Current Refuge knowledge of frog and toad distributions on the Refuge is limited to surveys conducted for the Oregon spotted frog, bullfrog (non-native), and chorus frog. (See Section 3.9.1 for information concerning the Oregon spotted frog) One bullfrog diet study was conducted in 1994. Twenty-two bullfrogs were collected from the northwest side of the Refuge in wetlands located just north of the Peninsula area and their stomach contents analyzed (Hayes and Drew 1994). The current distribution and abundance of bullfrogs has not been documented since 1994. There are also Refuge file records indicating that when chorus frogs were surveyed in 1995, various populations were found along the east boundary of the Refuge. Further monitoring and study is needed to determine the distribution and abundance of other species listed in Appendix J.

3.7.2 Reptiles

Fifteen species of reptiles are suspected to occur on the Refuge (Appendix J). No studies have been completed to document occurrence, distribution, or abundance of reptile species on the Refuge. Based on staff observations in annual narratives, the garter snake and western fence lizard have frequently been sighted on the Refuge. Further surveying is needed to provide baseline information on species occurrence and distribution.

3.8 Invertebrates

Invertebrates are animals that have no backbone or spinal column. Most animals are invertebrates. Corals, insects, worms, jellyfish, starfish, and snails are examples of invertebrates. Invertebrates play an important role in fish and wildlife ecology on the Refuge and are a useful indicator of environmental quality. Aquatic and terrestrial invertebrates comprise a critical food base for many species that utilize the Refuge.

An inventory of invertebrate species has not been completed on the Refuge. Future sampling would establish a quantitative baseline inventory for the Refuge that would assist in assessing the health of all habitat types, particularly wetlands and riparian areas, in the future.

3.8.1 Clearwinged Grasshopper

The clearwinged grasshopper (Scudder) is distributed widely throughout North America, including the entire state of Oregon (Figure 3-10). Clearwinged grasshoppers feed mainly on a variety of grasses but also feed on grains such as barley and wheat, making them a severe economic pest in some areas. Adult clearwinged grasshoppers lay eggs in beds that may contain 3,000–100,000 eggs per square foot. Egg hatching is dependent on specific soil and air temperatures and is generally completed within a 12-day period. After hatching, immature grasshoppers, or nymphs, move thru five instar stages, shedding their hard exoskeleton at the conclusion of each stage. The nymphs quickly deplete food resources in the vicinity of the beds and begin to disperse to other food sources. Adults

Figure 3-10. Geographic range of *Camnula pellucida* (Scudder) (University of Wyoming 1994)

may migrate long distances in huge flying swarms in search of food (University of Wyoming 1994).

In the Klamath Basin, the clearwinged grasshopper is a native species with a long history of periodic outbreaks on both public and private lands. Outbreaks in the area of Klamath Marsh Refuge generally coincide with periods of extended drought. Large outbreaks occur in 7-year to 12-year year cycles and generally exceed economic threshold levels of 14–24 per square yard. Outbreaks in excess of economic thresholds, necessitating treatment of Refuge and private lands, occurred in 1954, 1959, 1973, 1980–1981, 1993–1995, 2003–2005, and 2007. Figure 3-11 provides a general distribution of where eggbeds or adult populations of grasshoppers occur within and surrounding the Refuge. With the exception of treatments since 1995, past outbreaks were treated with aerial applications of insecticides covering 10,000–25,664 acres of public and private lands in the vicinity of Klamath Marsh Refuge. The U.S. Department of Agriculture's Animal Plant Health Inspection Service (APHIS) has traditionally treated these outbreaks at the request of landowners. Treatment on the Refuge has not and would not occur unless economic thresholds were exceeded (USFWS 2004). APHIS has consulted with the Service on effects of treatments on listed species (Appendix Q).

In 1993, malathion was aerially applied to 11,200 acres of private rangelands adjacent to the Refuge. The Refuge did not participate in this control effort and was blamed for a resurgence of grasshoppers in 1994. In 1994, 19,902 acres of private land were aerially sprayed with malathion, and 3,575 acres of Refuge lands were aerially treated with five percent carbaryl bran bait. The 1994 control program was controversial—with concerns about loss of livestock forage and impacts to biological resources from insecticides. As a result of the 1993 outbreak, the Service received tort claims for $60,998 from four local ranchers, which were ultimately denied because the Service acted within its legal discretion (USFWS 2004).

In response to a grasshopper outbreak in 2003, the Service—working in close cooperation with APHIS—approved a compatibility determination in July of 2004 that provided a framework for treatment of clearwinged grasshoppers in the event that populations exceed economic thresholds. Since 2005, the Refuge has cooperated with APHIS to implement a proactive approach of intensive surveying and treatment as needed at the first sign of economic population buildups. The Service's goal is to maintain the ecological role of grasshoppers yet reduce the economic impacts associated with outbreaks by implementing integrated pest management (IPM) strategies. Treatment of grasshoppers in early to mid-nymphal stages allows the Refuge and adjacent private landowners to use pesticides on fewer acres and in very specific locations—using the least toxic chemicals with minimal environmental impacts. Treatments completed by APHIS are done by all-terrain vehicles using a boomless nozzle and the Reduced Area Agent Treatment Strategy (RAATS). Using RAATS, chemical treatment only occurs on 50 percent of the total area requiring treatment. Furthermore, the Refuge now uses a more environmentally friendly chemical called Dimilin. Dimilin is designed to control immature grasshoppers without harming mammals, birds, fish, or non-target insects by specifically targeting the grasshopper nymph's ability to molt.

In 2005, APHIS ground-treated 244 Refuge acres of hatching egg beds with Dimilin with a 97 percent effective rate on treated areas. Using a 50 percent

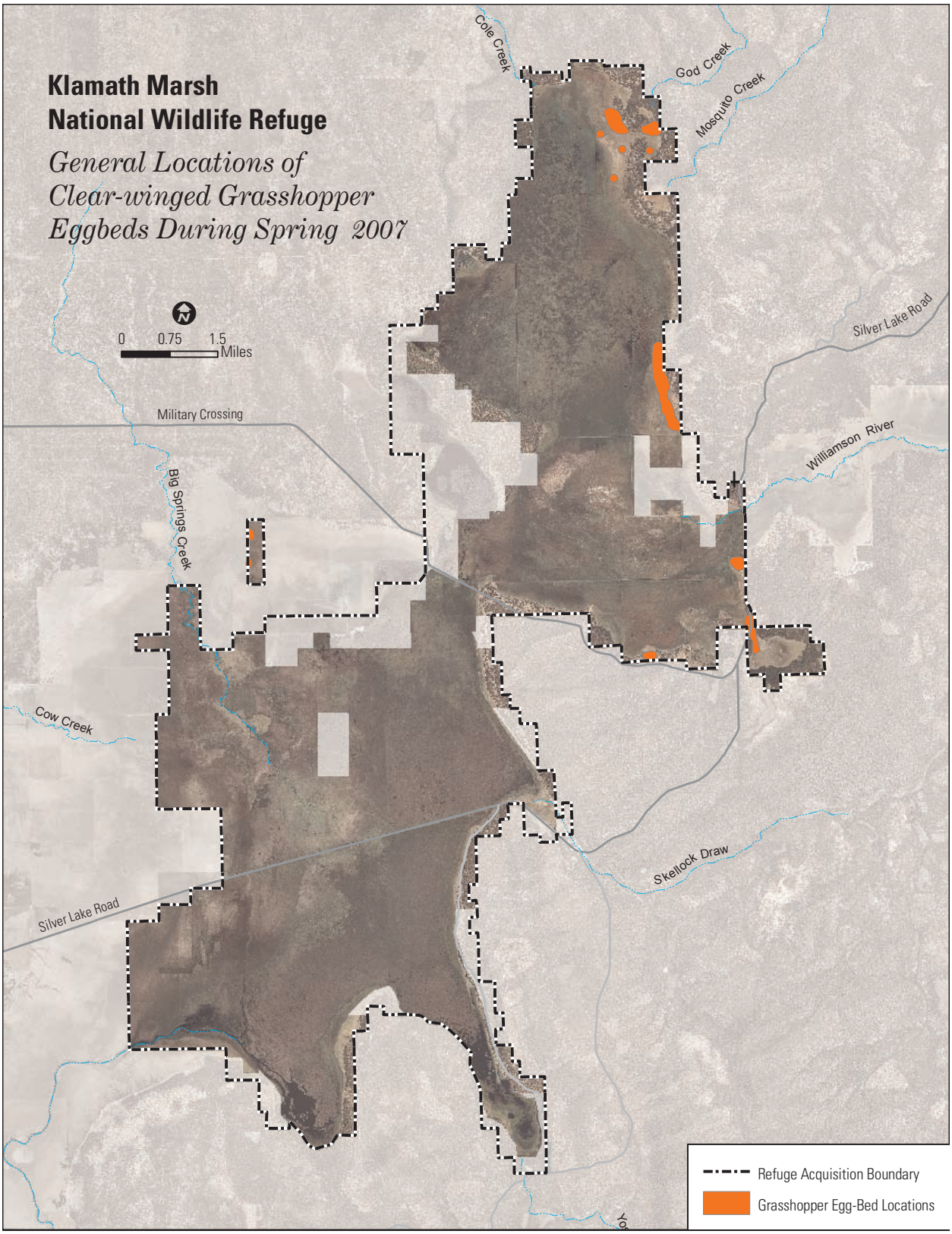


Figure 3-11. General locations of clear-winged grasshopper eggbeds during spring 2007

RAATS method means only 137 acres were actually sprayed on the Refuge. No treatment was necessary in 2006 due to a wet spring. Only 33 acres (12.5 acres sprayed) were treated on Refuge lands in 2007 using RAATS and Dimilin. No treatements were conducted in 2008.

Clearwinged grasshoppers are part of the Refuge's biological integrity and diversity, thus the control or elimination of natural outbreaks of this species is not necessary for the Refuge to achieve its habitat objectives. In addition to providing an important food source to many species of wildlife, grasshoppers provide a potentially long-term benefit to plant production by increasing nutrient cycling, similar to the impacts of fire. A better understanding of when grasshopper herbivory is beneficial or detrimental to plant production may provide the Refuge and neighboring ranchers clues about when grasshopper control is warranted. However, political pressure associated with economic impacts to private lands surrounding the Refuge will likely necessitate continued control to prevent significant outbreaks on Refuge lands.

3.8.2 Mosquitoes

Mosquitoes are an abundant invertebrate found throughout the Klamath Basin. Although they are a nuisance to humans and livestock, mosquitoes provide an important food base for many wildlife species. Although there are thousands of mosquito species worldwide, Oregon statewide surveillance in 2004 detected 17 mosquito species from 2,829 mosquito pools (Oregon Department of Human Services 2007).

The principle concern regarding mosquito populations remains transmission of West Nile Virus (WNV) to humans, livestock, and wildlife. West Nile Virus is caused by a virus carried by infected mosquitoes. Mosquitoes become infected when they feed on infected birds of the Corvid family, such as ravens, crows, jays, and magpies. The mosquito can then transmit the infection to humans and animals by biting them. There is no evidence that the disease can spread from other animals to humans or from person to person. Most infections are mild, causing fever and flu-like symptoms, but severe infections may result in encephalitis (inflammation of the brain) and rarely, death.

Oregon's surveillance program for WNV began in 2001, and WNV was first diagnosed in Oregon in August 2004. Klamath County is within the Klamath Vector Control District and has initiated a WNV Response Plan. While there have been 6, 8, and 70 human cases of WNV detected statewide in 2004, 2005, and 2006, respectively, there have been no reported human cases of WNV in Klamath County. Klamath County reported two bird cases of WNV in 2005 and two in 2006. There were three equine WNV cases reported in 2005 and one reported in 2006 in Klamath County (DeBess 2005). Current monitoring and results are available at http://www.oregon.gov/DHS/ph/acd/diseases/wnile/wnvnews.shtml.

Mosquito management on national wildlife refuges is conducted according to established policy of the National Wildlife Refuge System. Generally, national wildlife refuges will not conduct mosquito monitoring or control, but these activities may be allowed under special use permits in cooperation with Federal, state, or local public health authorities. When necessary to protect the health of a human, wildlife, or domestic animal population, management of mosquito populations on National Wildlife Refuge System lands is allowed using effective means that pose the lowest risk to wildlife and habitats.

3.9 Federal Candidate Threatened and Endangered Species and Species of Concern

A list of protected species for Klamath County Oregon is included in Appendix J, which includes federally listed threatened and endangered species, candidate species, and species of concern. Currently, no federally listed endangered or threatened species are known to occur on or near Klamath Marsh Refuge. However, two Federal candidate species are known to occur on or near the Refuge: the Oregon spotted frog and fisher.

A Federal candidate species is one for which there is sufficient information to support a proposal to list

the species as threatened or endangered, but the preparation of a proposal is precluded by higher priority listing actions. Candidate species do not receive the same Federal protection as listed species.

Species of concern are taxa whose conservation status is of concern to the U.S. Fish and Wildlife Service (many previously known as Category 2 candidates) but for which further information is still needed. Such species receive no Federal protection, and use of the term does not necessarily imply that a species will eventually be proposed for listing. There are 13 species of concern that may occur on or near the Refuge: long-legged myotis, silver-haired myotis, Pacific lamprey, Miller Lake lamprey, cascades frog, northwest pond turtle, northern goshawk, mountain quail, yellow rail, burrowing owl, Lewis woodpecker, white-headed woodpecker, and olive-sided flycatcher (Appendix J). These species will be considered when developing Comprehensive Conservation Plan alternatives and Refuge step-down management plans.

3.9.1 Oregon Spotted Frog

The Oregon spotted frog historically inhabited still water wetlands from southwestern British Columbia through western Washington and Oregon into north-eastern California (McAllister et al. 1993; Green et al. 1996; Hayes 1997). Recent surveys suggest that this species no longer occurs in 70–90 percent of its historic range (McAllister et al. 1993; Hayes 1997; Pearl and Hayes 2005). Data on many aspects of its ecology and habitat use remain sparse. As of 1999, only 31 populations were known to remain, of which 24 occurred in Oregon (Hayes 1997; McAllister and Leonard 1997; Pearl 1999). In Oregon, Oregon spotted frogs were historically found in Multnomah, Clackamas, Marion, Linn, Benton, Jackson, Lane, Wasco, and Klamath counties; currently this species is only known to occur in Deschutes, Klamath, and Lane counties. Sites where Oregon spotted frogs are known to occur include Federal lands managed by the U.S. Forest Service (Mt. Hood, Willamette and Winema National Forests), Bureau of Land Management (Wood River Wetlands), U.S. Fish and Wildlife Service (Klamath Marsh National Wildlife Refuge), and private land. This species is a candidate for Federal listing by the U.S. Fish and Wildlife Service

Oregon spotted frog

and is classified as a List 1 species in Oregon (taxa threatened with extinction or presumed to be extinct throughout their entire range) (Oregon Natural Heritage Program 2001).

The Oregon spotted frog is a medium-sized frog, ranging from 44–100 millimeters (1.74–4.0 inches) in body length (McAllister and Leonard 1997); it is olive, brown, or brick red with large, irregularly shaped spots on the back, sides, and legs. The dark spots have ragged edges and light centers, which are usually associated with tubercles or raised areas of skin. These spots become larger and darker, and the edges become more ragged with age. The belly and groin region display a mottled wash of red to orange in adults. Females are typically larger than males and can reach up to 100 millimeters (four inches) (Leonard et al. 1993).

This species is the most aquatic native frog in the Pacific Northwest. It is almost always found in or near a perennial body of water that includes zones of shallow water and abundant emergent or floating aquatic plants, which the frog uses for basking and escape cover (Leonard et al. 1993; Corkran and Thomas 1996; McAllister and Leonard 1997; Pearl 1997; Pearl 1999). Oregon spotted frogs seem to prefer fairly large, warm marshes (approximate minimum size of nine acres) that can support a large enough population to persist despite high predation rates (Hayes 1994) and sporadic reproductive failures. Overwintering and breeding sites are

related in that they provide year-round water. Post-breeding habitat is characterized by platforms of floating, submergent, or low trailing emergent vegetation adjacent to deep (greater than 0.5 meters deep) water refuge (Hayes 1998). Perennial springs, ponds, lakes, and slow moving streams dominated by grass, sedge, and rush communities appear preferred (Leonard et al. 1993). Breeding occurs in shallow pools at depths 10–60 centimeters that are often connected to larger or flowing water sources (McAllister and Leonard 1997; Pearl and Bury 2000). Wintering site components are mostly unknown but are suspected to provide low, continuous flows of water (Hayes 1998). Large concentrations of Oregon spotted frogs have been found in areas with the following characteristics: (1) the presence of good breeding and overwintering sites connected by year-round water, (2) reliable water levels that maintain depth throughout the period between oviposition and metamorphosis, and (3) the absence of introduced predators, especially warm water game fish and bullfrogs.

Oregon spotted frogs emerge from wintering sites immediately after ice and snow begin melting. Timing varies among years and is strongly influenced by local site conditions (e.g., elevation and weather). Licht (1969) reported a minimum sustained air temperature of 5 degrees Celsius (41 degrees Fahrenheit) to initiate spotted frog emergence from overwintering sites. This species begins to breed at three years of age. Breeding occurs in February or March at lower elevations and in late May or early June at higher elevations. Females may deposit egg masses at the same location in successive years in shallow, often temporary, pools no more than six inches deep. Egg deposition may occur at these sites when water temperatures reach 8–9 degrees Celsius (46–48 degrees Fahrenheit) (Hayes 1998). Eggs usually hatch within three weeks after oviposition. Tadpoles are grazers, having rough tooth rows for scraping plant surfaces and ingesting plant tissue and bacteria. They also consume algae, detritus, and probably carrion (Licht 1974; McAllister and Leonard 1997). Tadpoles then metamorphose into froglets during their first summer (Leonard et al. 1993). Post-metamorphic Oregon spotted frogs feed on live animals, primarily insects.

Many factors are believed to have caused Oregon spotted frogs to decline. Factors that continue to threaten this species include loss of habitat, non-native plant invasions, and the introduction of exotic predators such as bullfrogs. Over 95 percent of historic marsh habitat—and consequently, Oregon spotted frog habitat—has been lost in the Willamette and Klamath basins. Changes in hydrology (due to construction of ditches and dams) and water quality, pesticide use, development, and livestock overgrazing continue to result in habitat loss, alteration, and/or fragmentation. Non-native plant invasions by such aggressive species as reed canary grass and succession of plant communities from marsh to meadow also threaten this species' existence. Introductions of bullfrogs and non-native fish have affected this species both directly (by eating them) and indirectly (by out-competing or displacing them from their habitat). The majority of Oregon spotted frog populations are small and isolated. These factors make the Oregon spotted frog more vulnerable than large connected populations to random, naturally occurring events such as drought, disease, and predation.

The following actions have been offered for consideration toward maintaining or improving local habitat conditions likely to benefit Oregon spotted frogs.

- Restore or maintain intact hydrologic regimes where Oregon spotted frogs may be detrimentally affected.
- Protect and restore ephemeral and permanent wetlands near existing Oregon spotted frog sites.
- Restore or maintain open water and early seral vegetation communities.
- Re-evaluate or discontinue local fish stocking practices.
- Limit the spread and effects of American bullfrog in areas occupied or potentially suitable for reintroduction of Oregon spotted frogs.
- Develop comprehensive grazing strategies or adaptive management plans where livestock will occur in Oregon spotted frog habitat.
- Work locally and cooperatively to maintain or restore habitat conditions, and to monitor outcomes of management actions directed toward Oregon spotted frogs.

Refuge Monitoring: The Oregon spotted frog is the only frog species that has been monitored on the Refuge. A population of Oregon spotted frogs was first documented on the Refuge in 1994 (Drew 1996; Drew 1995). According to Drew, 116 spotted frogs were observed during June and July at 13 sites along Big Springs Creek and other nearby springs.

A visual encounter survey (Olson et al. 1997) designed to enumerate egg mass numbers (Heyer et al. 1994) of Oregon spotted frogs on the Refuge was completed on April 19, 2001. Surveys were conducted in the Big Springs Creek area, at Military Crossing, and in the Cholo area. A total of 170 egg masses and two adult frogs were counted (Ross 2001).

The Refuge annually monitored for Oregon spotted frog egg masses from 2000–2008 (Table 3-3). Frog egg mass surveys have been conducted as early as April 4 and as late as May 1. Unfortunately, survey effort has not been equal for each year (time invested, areas checked), and detailed annual reports summarizing what the surveys entailed and how surveys were completed have not been generated. In general, area searches are completed in April and May in areas with potential breeding habitat to look for the presence of egg masses. Since 2002, the locations of egg masses have been documented using global position system (GPS) units (Figure 3-12). During 2003 and 2004, only small portions of the Refuge were surveyed. In the future, it will be important to standardize surveys (Hayes 1998) and document negative locations (areas checked but no egg masses). In general, Refuge staff believe that overall numbers of frogs have declined over the years (Dave Mauser, USFWS Klamath Basin Refuge Complex, personal communication, 2008). The reason behind declines are not known but may be related to changes in water distribution and vegetation at breeding and overwintering areas. In addition, predation by bullfrogs and brook trout, both which occur on the Refuge, may also be contributing to their decline (Hayes 1994).

Twenty-two bullfrogs were collected on the Refuge in October 1994 (Section 9 and 10, T. 30 S., R. 9 E.). The raw data indicates that no frogs were found in the stomachs, but it confirms a population of bullfrogs on the Refuge as early as 1994 (Hayes and Drew 1994). No additional surveys for bullfrogs have been completed since 1994, but populations are likely still present.

Table 3-3. Oregon spotted frog egg mass survey data for Klamath Marsh 2000–2008 (source Klamath Refuge Complex data files, Tule Lake, CA, office). Note: Survey effort not consistent over the years.

Year	# Egg Masses Observed
2000	191
2001	170
2002	142
2003	4
2004	3
2005	30
2006	52
2007	109
2008	326

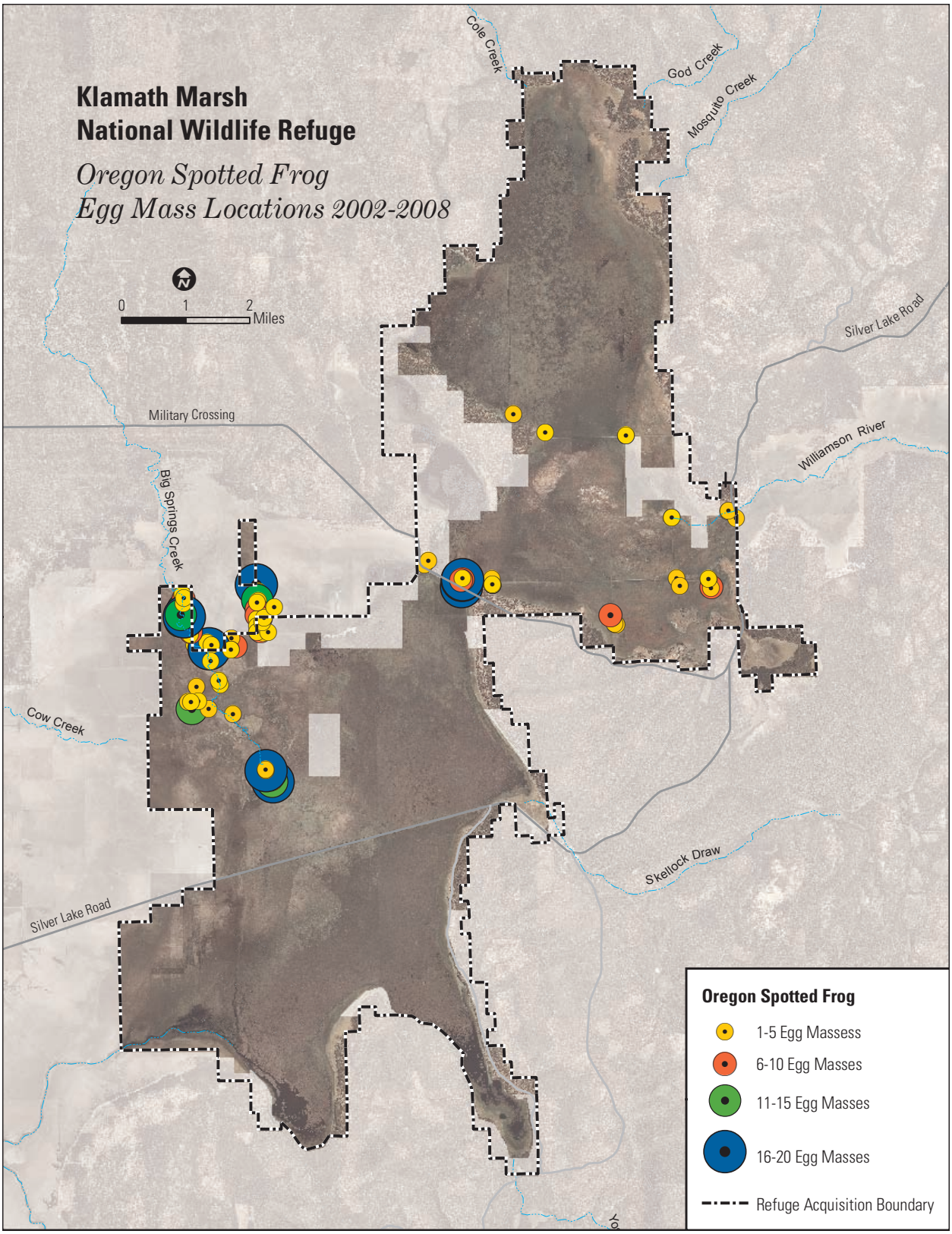


Figure 3-12. Distribution of Oregon spotted frog egg masses on Klamath Marsh Refuge

3.9.2 Fisher

The west coast population of the fisher was accorded Federal candidate status on April 8, 2004 (*Federal Register* 69:18769). This species has not been confirmed on Refuge lands but has been observed in Klamath County, Oregon. The state of Oregon lists the fisher as a sensitive species.

Fishers, found only in North America, occur in the northern coniferous and mixed forests of Canada and in the northern United States. Their range extends from the mountainous areas in the southern Yukon and Labrador provinces southward to central California and Wyoming, the Great Lakes, the Appalachian regions, and New England.

In Oregon, fishers occurred historically throughout the Coastal and Cascade mountains. Currently, the range of the fisher is severely reduced. Despite extensive surveys conducted in forested regions of Oregon, records dating from 1954 to 2001 show that the remaining populations of fishers are restricted to two separate and genetically isolated populations in southwestern Oregon—one in the northern Siskiyou Mountains and one in the southern Cascade range. The population in the southern Cascades descended from reintroduced fishers that were translocated to Oregon from British Columbia and Minnesota.

The fisher, a member of the weasel family, has a long body (three feet) with short legs and a long, bushy tail. The head is broad and flat with a sharp, pronounced muzzle. The ears are broad, rounded, and low. Fur color varies from light brown to dark blackish brown, although the face, neck, and shoulders may have a lighter grizzled gray appearance. It is estimated that fishers live up to 10 years. They are solitary animals except during the breeding season (late February through April). Fishers are opportunistic predators that hunt exclusively in forested habitats where prey is abundant and vulnerable to capture. Their diverse diet includes birds, porcupines, snowshoe hare, squirrels, mice, shrews, voles, reptiles, insects, carrion, vegetation, and fruit.

Fishers select forests with high canopy closure, large trees, and a high percentage of conifers. The physical structure of this type of forest provides the fisher with reduced vulnerability to predation and an abundance of prey. The distribution of the fisher is likely limited by elevation and snow depth.

American Fisher. Photo taken from internet. www.wildcarnivore.com/images/Fisher%20gif.gif

The west coast population of the fisher is endangered, mainly due to the loss and fragmentation of habitat due to timber harvest, roads, urban development, recreation, and wildfires. Other threats include small population sizes and isolation, predation, and human-caused mortality from vehicle collisions, poaching, and incidental capture and injury.

In December 2000, the U.S. Fish and Wildlife Service (Service) received a petition to list the west coast population of the fisher as an endangered species in Washington, Oregon, and California. The Service concluded that the west coast fisher population was a distinct population segment and was warranted for listing, but precluded from listing because of other higher priority listing actions, and subsequently placed the species on the Federal list of candidates. Now the Service will begin conducting an annual review of the species status and may propose to list the species at a later date.

3.10 State Listed Species

There is one Oregon state-listed threatened species, American bald eagle, known to occur on Klamath Refuge and several state-designated sensitive species discussed in previous sections. Six species of sensitive mammals are known to occur or potentially occur on the Refuge: long-legged myotis, silver-haired bat, fisher, pine (American) marten, white-tailed jackrabbit, and western gray squirrel. In addition, one fish, three amphibians, and two reptiles have been documented on the Refuge or are thought to occur there based on literature reviews. These are Miller Lake lamprey, Oregon spotted frog, western toad, Cascades frog, northwestern pond turtle, and western painted turtle. The Refuge is also home to 10 state-designated sensitive birds: bufflehead, northern goshawk, yellow rail, greater sandhill crane, flammulated owl, great grey owl, black-backed woodpecker, Lewis's woodpecker, white-headed woodpecker, and olive-sided flycatcher.

3.11 Invasive Species

Invasive and exotic species are one of Klamath County's greatest threats and are the "greatest threat to ecosystem integrity within the Refuge System" (USFWS 2004). Invasive species are those that dominate an ecosystem at the expense of other species, causing population crashes and ecological changes. These species invade or increase within the ecosystem as the result of a disturbance or degradation of the natural system. A healthy native system usually will not experience the infestations. Many invasive species are not indigenous (native) to North America but are imported intentionally or by accident from another continent. Newly arrived species often exhibit population explosions due to lack of competition or natural control.

3.11.1 Invasive Plants

Invasive plants reduce biological diversity, affect threatened and endangered species, reduce or eliminate native vegetation, destroy recreational environments, and cost tax payers millions of dollars each year.

Of the 365 plant species known to occur on Klamath Marsh National Wildlife Refuge, 49 are not indigenous to Oregon. Approximately 10 of these non-native species and aggressive native species are known to adversely affect Refuge native plants and habitat (Table 3-7). Native species, such as reed canary grass, can take on invasive qualities when natural process like fire, drought, and flooding are altered. Over the past 15 years, the Refuge has attempted to control several plant species using hand pulling and herbicides (see Section 3.19.3 Invasive Species Management).

3.11.2 Invasive Fish and Amphibians

Fish: The extent of invasive or non-native fish species in the Williamson River that runs through the Refuge is not fully understood. Fisheries resources have not been extensively studied on Klamath Marsh Refuge, but surveys were conducted in 1992 and 1993 by Oregon State University. Fish species collected during these surveys include three non-native species: eastern brook trout, fathead minnow, and brown bullhead. All three species are native to portions of the eastern U.S. and were likely moved by people to waters in Oregon. The impacts of these species may include competition with native fish species for food and shelter, and direct predation on fish, invertebrate, and amphibian populations. There has been no attempt to eliminate these species from Refuge waters, as their overall distribution and impacts are not fully understood at this time.

Bullfrogs: The bullfrog is the largest frog in North America and is native to eastern North America. Bullfrogs were first introduced to Oregon in the 1920s to provide frog legs for the West Coast market. The frog leg industry declined in the 1930s, but the bullfrogs remain. The bullfrog is highly adaptable to a number of aquatic habitats and is an opportunist that will eat anything it can catch and swallow. Because of the voracious appetite of the bullfrog, there is concern about the effect they are having on several rare or declining species in the Pacific Northwest, including the Oregon spotted frog.

In Oregon, areas with an abundance of bullfrogs have few or no turtle hatchlings or other frog

species. This same pattern occurs between bullfrogs and other amphibian and reptile species in several other western states where the bullfrog has been introduced.

The bullfrog has been documented on the Refuge (see Section 3.9.1). Its current distribution and abundance is unknown until additional surveying can be completed.

3.11.3 Invasive Invertebrates

There are no known populations of invasive invertebrates occurring on the Refuge at this time. Specific monitoring for these types of invasives has not been completed. Potential future invasives may include species like quagga mussel or zebra mussels. So far, neither of these species has been found in Oregon, but they have been detected in some adjacent states.

3.12 Wildlife Diseases

Transmission of wildlife diseases can severely affect both human and wildlife populations. Not only can some diseases travel from wildlife to humans, but they can also transfer from humans to wildlife and from one species of wildlife to another. Uncontrolled disease epidemics have the potential to wipe out entire populations of wildlife in short periods of time and cause significant health and economic loss to humans. The Service's national program initiatives help avert and respond to disease outbreaks through projects conducting disease research, wildlife population health monitoring, disease containment, and education campaigns for humans who come into contact with wildlife. The occurrence of wildlife diseases on or adjacent to the Klamath Marsh National Wildlife Refuge has been very low. The following text summarizes diseases that have occurred or are of concern in the region.

3.12.1 Avian Botulism

The only known record of avian botulism on the Refuge occurred in 1968 and resulted in the death of approximately 310 birds. Avian botulism is a paralytic disease caused by ingestion of a toxin produced by the bacteria *Clostridium botulinum*. This bacteria is widespread in soil and requires warm temperatures, a protein source, and an anaerobic (no oxygen) environment in order to become active and produce toxin. Decomposing vegetation and invertebrates combined with warm temperatures can provide ideal conditions for the botulism bacteria to activate and produce toxin. Several types of toxin are produced by strains of these bacteria, with birds being most commonly affected by type C and, to a lesser extent, type E strains.

Birds either ingest the toxin directly or may eat invertebrates (e.g., chironomids, fly larvae) containing the toxin. Invertebrates are not affected by the toxin and store it in their body. A cycle develops in a botulism outbreak when fly larvae (maggots), feed on animal carcasses and ingest toxin. Ducks that consume toxin-laden maggots can develop botulism after eating as few as three or four maggots.

Healthy birds, affected birds, and dead birds in various stages of decay are commonly found in the same area. The toxin affects the nervous system by preventing impulse transmission to muscles, which results in flaccid paralysis. Consequently, birds are unable to use their wings and legs normally or control the third eyelid, neck muscles, and other muscles. Birds with paralyzed neck muscles cannot hold their heads up and often drown. Death can also result from water deprivation, electrolyte imbalance, respiratory failure, or predation.

3.12.2 Avian Cholera

Avian cholera is the most important infectious disease among North American waterfowl, especially geese, and epizootics often kill thousands of birds (Samuel et al. 2006). The disease is caused by the bacterium *Pasteurella multocida*. Transmission typically occurs via ingestion of the bacterium from contaminated water or food, through inhalation of aerosolized wetland surface water, or by direct bird-to-bird contact. Wetlands are likely to become contaminated with bacteria when large numbers of birds die from the disease or when infected birds shed *P. multocida*. Avian cholera is typically a cold weather disease that occurs during the months of November–March. This disease

has not been detected on Klamath Marsh Refuge in recent times, but it occurrs almost annually at the Lower Klamath, Tule Lake or Upper Klamath Lake refuges. In recent years, losses at these other Klamath Basin refuges have approached more than 10,000 birds annually. Klamath Marsh Refuge is unique in that it does not overwinter waterbirds due to lack of water or frozen conditions, while the other refuges may harbor thousands of birds throughout the winter.

3.12.3 West Nile Virus

See Section 3.8.2 for information on this disease.

3.12.4 Avian Influenza

Avian influenza has not been detected in North America. However, the potential exists for wild migratory birds to carry the virus to North America or for the virus to be introduced through the legal wild bird pet trade, shipment of goods from overseas, smuggling, or other means. The Service and other agencies of the U.S. government are taking steps toward early detection of the disease and to minimize the potential impact of the occurrence of this disease should it reach the United States. Current monitoring efforts throughout the U.S. and detailed information about the disease are available at http://www.fws.gov/cno/hpai.html.

Bird flu, the popular name for avian influenza, is a disease primarily found in poultry and wild birds. Avian influenza can infect chickens, pheasants, quail, ducks, geese, and guinea fowl, as well as migratory waterfowl and shorebirds, and—less commonly—mammals (pigs, horses, cats, and marine mammals). The virus can be spread through contact with fecal droppings, saliva, and nasal discharges of infected animals. The highly pathogenic H5N1 strain of avian influenza has proved particularly dangerous to people who come in contact with infected birds. The World Health Organization provides statistics on the number of deaths caused by the disease since it first appeared in 1997 (www.who.int/csr/don/en).

3.13 Special Management Areas

3.13.1 Important Bird Area

Klamath Marsh National Wildlife Refuge has been identified by the Audubon Society as an Important Bird Area (IBA). The Audubon Society is working to identify a network of sites that provide critical habitat for birds. This effort, known as the Important Bird Areas Program, recognizes that habitat loss and fragmentation are the most serious threats facing populations of birds across America and around the world. IBAs are sites that provide essential habitat for one or more species of bird. IBAs include sites for breeding, wintering, and/or migrating birds. To qualify as an IBA, sites must satisfy a variety of criteria. In the U.S., the IBA program has become a key component of many bird conservation efforts, including Partners in Flight, North American Waterbird Conservation Plan, and the U.S. Shorebird Conservation Plan. The Oregon IBA program was initiated in 2002 to identify the sites in Oregon most important to bird conservation and to promote the continuation, restoration, or improvement of avian values at these sites (Audubon IBA 2008).

Klamath Marsh Refuge was selected and approved as an IBA for the following reasons (Audubon IBA 2008).

- It hosts approximately 50 percent of the western U.S. yellow rail breeding population.
- It is used by thousands of waterfowl during migration.
- There are records of least bittern.
- The Refuge supports about six percent of Oregon's nesting greater sandhill cranes.
- It supports a significant number of shorebirds, particularly during spring.
- It supports breeding Forster's and black terns.

3.13.2 Wilderness Status

There is no designated Wilderness within Klamath Marsh National Wildlife Refuge. However, a wilderness review was conducted in conjunction with the comprehensive conservation planning process as outlined in USFWS Manual Parts 602 FW 1 and 3. The purpose of a wilderness review is to identify and, if appropriate, recommend for congressional designation National Wildlife Refuge System (System) lands and waters that merit inclusion in the National Wilderness Preservation System.

The three phases to the wilderness review are 1) inventory, 2) study, and 3) recommendation. Lands and waters that meet the minimum criteria for wilderness are identified in the inventory phase. These areas are called wilderness study areas (WSAs). WSAs are evaluated through the comprehensive conservation planning process to determine their suitability for wilderness designation. In the study phase, a range of management alternatives are evaluated to determine if a WSA is suitable for wilderness designation or management under an alternate set of goals and objectives that do not involve wilderness designation. The recommendation phase consists of forwarding or reporting recommendations for wilderness designation from the director through the Secretary of the Interior and the President to Congress in a wilderness study report.

We inventoried Service lands and waters within Klamath Marsh Refuge and found three units that meet the minimum criteria for wilderness designation. Unit A consists of 9,843 acres north of the Peninsula Road on the northern portion of the Refuge. Unit B, located between the peninsula road and Military Crossing road, was not suitable due to the significant development present, including canals and numerous water control structures. Unit C is 11,052 acres located between Military Crossing Road and Silver Lake Road. Unit D includes 11,166 acres located south of Silver Lake Road. Appendix F contains the complete wilderness inventory for Klamath Marsh Refuge. It also includes a wilderness study report that addresses the quality of wilderness values; evaluates resource values, public uses, and associated management concerns; and evaluates the capability for management as wilderness.

3.13.3 Historical Significance trails/sites

There are no historical trails located on Klamath Marsh Refuge or any sites that qualify for inclusion into the National Historic Register. The area on and around the Klamath Marsh was used extensively by Native Americans and contains an abundance of cultural resource sites that require monitoring and protection.

3.13.4 Blue Jay Research Natural Area

The Blue Jay Research Natural Area (Area) is owned by the USFS and is located about one-quarter mile east of the Abraham Flat area of Klamath Marsh Refuge. The 210-acre tract is administered by the Chiloquin Ranger District, Winema National Forest. It was established in 1971 to exemplify ponderosa pine/bitterbrush/needlegrass and lodgepole pine/bitterbrush/needlegrass communities characteristic of the central portion of the pumicite deposits resulting from the eruption of Mount Mazama. The Area was estimated to have been covered by 1–10 feet of pumice by the eruption. The Area provides opportunities to evaluate soils and vegetation in relation to the Mount Mazama pumice deposits and to compare microsite relations and biomass productivity of ponderosa and lodgepole pine; it also serves as a reference stand for undisturbed vegetation in the center of aerially deposited Mount Mazama pumice (Federal Research Natural Areas in OR and WA 1972).

3.14 Visitor Services

Wildlife viewing is the most popular wildlife-dependent recreation activity among Oregonians, and this is also the case for the estimated 2,000–4,000 annual visitors to Klamath Marsh National Wildlife Refuge. Bird watching and nature/wildlife observation are second only to running and walking for exercise or pleasure in popularity as outdoor activities for Oregon residents. Nature and wildlife observation is also one of several outdoor recreation activities currently experiencing significant participation increases in Oregon. Opportunities for nature and wildlife viewing at

Klamath Marsh Refuge must be considered in the context of the many other opportunities available at Federal, state, county, and local forests, wildlife areas, and parks, which comprise approximately 80 percent of the Upper Klamath Basin watershed. Klamath Marsh Refuge is a short side trip from the Volcanic Legacy All American Road and is an identified stop on the recently designated Klamath Basin Birding Trail. The themes for the All American Road are geology (volcanism) and wildlife, while the Klamath Basin Birding Trail focuses on the diverse bird watching opportunities found in the Upper Klamath Basin. Tourism promotion within Klamath County has recently focused much of its advertising and outreach efforts on tourism specifically related to wildlife viewing, with particular emphasis on bird watching.

3.14.1 Public Access

Most visitors access the Refuge via Silver Lake Road from Highway 97. Silver Lake Road intersects with Highway 97 approximately 50 miles north of Klamath Falls. From the Highway 97 intersection, Silver Lake Road bisects a segment of the Refuge for a total of 4.5 miles. The other primary road through the Refuge is Military Crossing Road, which links Highway 97 to Silver Lake Road. This road is an all-weather gravel surfaced route. Forest Service Road 690, also known as the Wocus Bay Road, provides outstanding scenic and wildlife viewing opportunities but is not regularly maintained and is often closed in winter due to snow. It runs in a north-south direction between Silver Lake Road and Kirk Road. Many other U. S. Forest Service roads provide access to more remote areas of the Refuge. Figure 3-13 depicts the location of major access routes open to Refuge visitors.

A single highway sign at the Silver Lake Road and Highway 97 intersection notes the turnoff to the Refuge but uses the pre-1998 designation of "Klamath Forest Refuge." A new-style entrance sign is located on Silver Lake Road approximately four miles east of the Highway 97 intersection. A two-sided entrance sign with a large U.S. Fish and Wildlife Service logo is located at the Refuge Headquarters. In 1994, information panels were installed at the Refuge headquarters, at the junction of Silver Lake Road and Forest Service 690 (Wocus Bay Road), and at the Wocus Bay overlook. These panels provide basic information to visitors stopping at these sites. No Refuge locations currently offer public restrooms. The Refuge office is open intermittently due to limited staff.

To prevent disturbance to wildlife and possible damage to archaeological sites, most of the Refuge is closed to motorized traffic and foot access. Exceptions are outlined in the following text, including areas open seasonally for waterfowl hunting and for recreational canoe access.

3.14.2 Wildlife-Dependent Recreation

The 1997 National Wildlife Refuge System Improvement Act identified six priority public use activities on refuges: wildlife observation and photography, hunting, fishing, and interpretation and environmental education. The Klamath Marsh National Wildlife Refuge public use objective, which was written shortly after this act was passed by Congress, is "to provide high quality, wildlife-dependent visitor services which are compatible with refuge purposes and cultural resources." Refuge visitors are currently able to participate in all six of these recreational pursuits, with the vast majority of visits involving wildlife observation. Although wildlife observation and photography is most often conducted on foot or via cars, a small number of visitors ride bikes, snowshoe, or cross-country ski on USFS or Refuge roads. Figure 3-13 shows the visitor services and facilities on Klamath Marsh Refuge. Without a major effort to enhance facilities or promote Refuge visitor use, it is anticipated that public uses will increase only moderately in the future due primarily to the remoteness of Klamath Marsh Refuge.

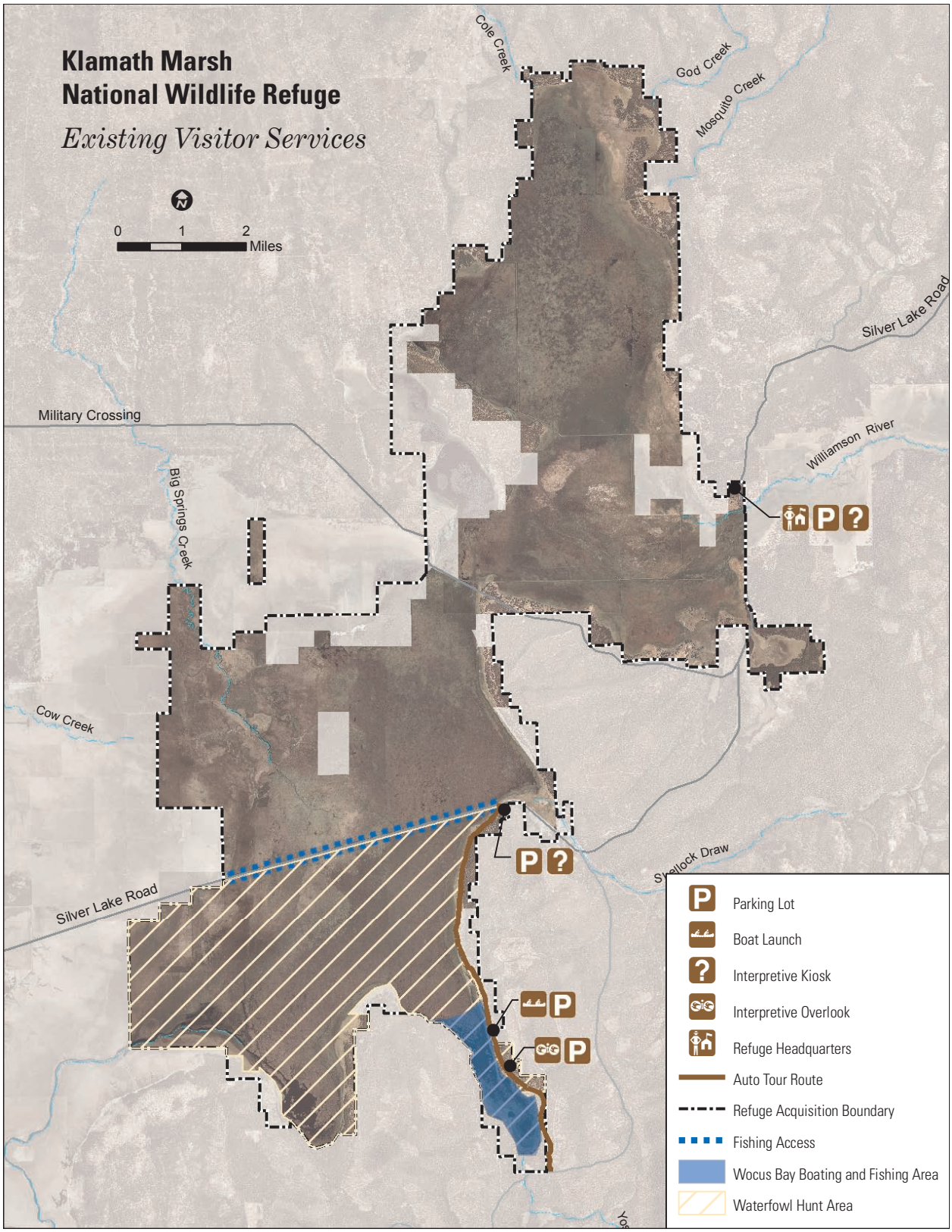


Figure 3-13. Klamath Marsh Refuge existing visitor services and facilities

Wildlife Observation and Photography

An estimated 85–90 percent of visitors to Klamath Marsh Refuge are involved primarily in wildlife and/or wildlands observation/photography. The Refuge provides outstanding scenic and wildlife viewing opportunities. Many of these opportunities are accessible from Silver Lake Road, Military Crossing Road, and Wocus Bay Road. No fees are currently charged (or anticipated in the future) due to the low level and dispersed nature of Refuge use. Wildlife viewing sites consist of several small gravel pull-offs along Silver Lake Road and a developed overlook site on Wocus Bay Road that contains three interpretative panels. A non-motorized boating area is available for visitor use within Wocus Bay. The boating area is open from July 1 through September 30 each year. A primitive boat launch area is located on Wocus Bay Road. Water levels in Wocus Bay vary greatly from year to year, making boating limited or unavailable some years. Information about wildlife viewing opportunities is available in the Refuge Complex leaflet, a Klamath Marsh National Wildlife Refuge canoe area tear sheet, and on the Klamath Basin Complex Web site at www.fws.gov/klamathbasinrefuges/index.html. These provide brief descriptions of recreation opportunities and maps of Klamath Marsh Refuge.

Hunting

The Refuge area south of Silver Lake Road is open to waterfowl, coot, and snipe hunting. Walk-in hunting and motorless boats are permitted in hunting areas, which include Big and Little Wocus bays. Waterfowl hunting varies greatly from year to year depending on the extent of water in the marshes during the fall. Water conditions in Little Wocus Bay are usually better in low water years than in Big Wocus Bay. Hunter use estimates of the Refuge range from non-existent in extreme drought years to over 100 hunter visits during wet years. A Refuge waterfowl hunting tear sheet is available that contains a map and a description of hunting areas and regulations.

Fishing

Portions of the Refuge, including the borrow ditches adjacent to Silver Lake Road and the shoreline of Wocus Bay, are open to fishing. Fishing from boats is prohibited. Based on observations by past Refuge managers, fishing on the Refuge is minimal to non-existent. The primary fish species harvested has historically been the non-native brown bullhead. Trout are likely non-existent in areas open to fishing due to warm water temperatures and lack of adequate water.

Environmental Education and Interpretation

The Refuge responds to requests for environmental education and interpretive programs on a case-by-case basis. There is no on-site public use specialist to address these requests, and thus the Refuge manager and public use staff from the complex office in Tulelake, California, provide activities and programs as time allows (usually 4–5 specific requests per year). Typical program requests are from groups who do volunteer projects on the Refuge, various non-governmental organizations (NGOs), and from local schools or universities. In the past, managers have also conducted programs at the Resources and People camps coordinated by Oregon State Extension and the Klamath County School District.

Interpretive resources on the Refuge consist of information panels at the headquarters, at the Forest Service Road 690 (Wocus Bay Road) turnoff, and the Wocus Bay overlook. These panels interpret key wildlife and cultural resource values of the Refuge. The Klamath Basin Refuge Complex brochure and Web site also provide information on Refuge resources and issues.

3.15 Cultural Resources

3.15.1 Cultural Resources Defined

Cultural resources are physical remains, sites, objects, records, oral testimony, and/or traditions that connect us to our nation's past. Cultural resources include archaeological and historical artifacts, sites, landscapes, plants, animals, sacred locations, and cultural properties that play an important role in the traditional and continuing life of a community. The cultural resources in and

within one mile of the congressionally authorized boundaries of the Refuge consist of 19 recorded prehistoric sites and three recorded historic sites.

Cultural resources, especially archaeological sites, are fragile and nonrenewable. Most consist of worked stone, fire altered rocks, and organically enriched soil on or close to the surface. When compared to the surrounding landscape and contemporary cultural features such as roads, ditches, and structures, archaeological sites are small and subtle.

3.15.2 Native American Cultural History and Landscape

Ethnographic and Archaeological Resources

Within the Klamath Basin, few archaeological sites that were formed prior to the eruption of Mount Mazama (approximately 7,000 years ago) have been investigated. Data from sites that post-date the Mazama eruption suggest they were created by people with a strong cultural affiliation to the modern Klamath Tribe.

When the first Anglo-Europeans reached the Klamath Basin in the 1820s, the Klamath Tribe occupied a region on the east side of the Cascade Mountains, from the head waters of the Deschutes River on the north to the upper reaches of the Klamath River on the south, west to the slopes of the Cascade Mountains, and eastward to Sycan Marsh and the headwaters of the Sprague River. The western portion of this traditional Klamath land contains forested mountains and ridges that rise above productive wetlands, including Klamath Marsh, Upper Klamath Lake, the Williamson River, and the Sprague River.

Ethnographic sources suggest that the largest sub-group of the Klamath Tribe, the A'ukckni Tribelet, lived at Klamath Marsh and along the Williamson River. Although A'ukckni settlements were more numerous on the lower Williamson River, the winter population at the marsh was greater.

The traditional Klamath year cycled through various resources as they became available. During the warm spring and summer, family groups dispersed throughout the area to fish, gather, and hunt. Although some summer camps were reoccupied each year, residence was often brief, and any housing consisted of temporary structures of poles covered with tule or grass. Occasionally, families returned to a permanent village site to process and store gathered resources. Winters were spent in a sturdy earth lodge partially dug into the ground with a timber frame covered in woven mats and soil for a roof. Each lodge housed a family or extended family. Clusters of these earth lodges formed permanent villages that were populated year round by seniors, the very young, and others unable to travel.

Of all Klamath Basin wetlands, Klamath Marsh provided the most abundant supply of the water lily: wocus. Seeds from the wocus formed a dietary staple of the Klamath. Wocus became such an important element of Klamath culture that over several centuries, unique tools and several curing methods were developed to process the seeds. Its popularity was such that other tribelets from throughout the territory converged to harvest wocus at the marsh for several weeks from July through September.

Spiritual Landscape

The religious and everyday lives of the Klamath and Modoc people were inextricably interwoven. Physical acts, such as fishing or gathering roots, have an aspect of spirituality. In addition, a geographic area (hills, lakes, rock piles, or caves) can be filled with meaning and significance and serve a symbolic cultural function. For example, the west side of Klamath Lake, where the sun sets, was considered the land of the dead. Another example is a pile of boulders at the southern end of Klamath Marsh, which people believed would cause a child to become insane should he or she climbed upon them.

Individual Klamath could seek spiritual guidance and power on mountains and in bodies of water. The rituals involved in achieving power include fasting and piling rocks into cairns over a period of several days.

Expected Prehistoric Archaeological Site Types

Remains of these cultural activities are clearly present in the archaeological record within the Klamath Marsh National Wildlife Refuge. Prehistoric site types include pithouse village sites, midden deposits, cremation piles, lithic scatters with and without associated ground stone, lithic procurement sites or quarries, rock cairns, rock art, and cambium barked trees. Isolated artifacts commonly found include groundstone, utilized flakes, and projectile points, all of which can still be found despite years of illegal artifact collecting.

3.15.3 European-American Cultural History

Fur Trade and Exploration

Arriving in the 1820s, fur trappers were the first non-Native Americans to reach the Klamath Basin. The era of inland exploration and trapping began and continued into the 1840s. In 1825, Thomas McKay led a small group of Hudson's Bay Company trappers south from Fort Vancouver as far as Klamath Marsh in search of a much-rumored large lake in that area. In 1826, Peter Skene Ogden took a trapping party toward Klamath Marsh. In late November, they camped in cold, windy, and snowy weather less than three miles west of the southern end of the marsh.

In 1843, Captain John C. Fremont of the Corps of Topographical Engineers led an American trapping party in search of beaver in the legendary Buenaventura River. The party traveled through the Klamath Basin and spent a few weeks during December at Klamath Marsh, interacting peacefully and profitably with the inhabitants.

In 1855, Lieutenant R.S. Williamson and Henry L. Abbot of the Corps of Topographical Engineers led a survey party through the marsh during explorations for a railroad route from the Sacramento Valley to the Columbia River. Abbot reported that along the marsh, "rancherias" were to be found "at nearly every turn" (Abbott 1855). The Williamson River is named after Lieutenant Williamson.

In 1864, Eugene residents organized the Oregon Central Military Wagon Road Company to construct a road over the Cascades to the Upper Klamath Basin, and east to mining districts in southeastern Oregon. To aid in the road's construction, Congress and the Oregon legislature approved a land grant in 1864 for the sale of land along the route to the road company. Military Road is still in use today, crossing the northern portion of the Klamath Marsh, although this is not entirely its original path around the marsh.

Reservation Era

In 1864, a treaty was signed between the U.S. Government and the Klamath and Modoc Tribes, and the Yahooskin band of Snake Indians. The terms of the treaty created the Klamath Indian Reservation, which included all of the Klamath Marsh. This brought major change to traditional Klamath life. Many villages were deserted as the population congregated around Fort Klamath and the Yainax agencies to become immersed in the European-American culture. Although the treaty led to many changes in traditional Klamath life, seasonal hunting, fishing, and gathering continued at many places, including a yearly harvest of wocus at Klamath Marsh. Although some wocus gathering continues today, its use declined during the Reservation Era (1864–1954). In the 1950s, wocus collection declined, along with environmental changes that greatly reduced the production of wocus in the marsh.

In 1954, the Klamath Indian Reservation was terminated by the U.S. Government, and the reservation lands were placed in trust. In 1960, the U.S. Fish and Wildlife Service used funds generated by the Migratory Waterfowl Stamp Act to purchase land that established the Klamath Forest National Wildlife Refuge. Federal recognition of the Klamath Tribes was restored in 1986.

Ranching and Logging

The General Allotment Act of 1887 (Dawes Act) allowed individual tribal members to own property within the reservation. The Federal government's goal was to convert the Klamath Basin into farms

and ranches. The natural summer grasslands made the marsh attractive and potentially profitable for cattle grazing. At least 34 allotments were issued within the current Refuge boundary. Initially, these allotments were used for both cattle and traditional uses such as plant gathering or hunting. As allowed in the original act and subsequent modifications, the allotments were converted to fee title. By the 1920s, most of the Klamath Marsh allotments had been converted and then sold to non-Indian ranchers. Over time, these small ranches were consolidated through purchase into large operations. A large portion of the Refuge was eventually comprised of two ranching operations.

Ora Summers, a Klamath Tribe member, began ranching in the early 1920s on his wife's allotment on the west side of the marsh. Summers purchased additional land from allottees and other private property owners. He continued to hold onto the ranch until 1978 and then sold the property. The subsequent landowner sold the property to the U.S. Fish and Wildlife Service in 1979 and 1989.

William Kittredge, a prominent cattleman with holdings in southern and eastern Oregon, began to settle in the marsh by leasing from allottees. By 1935, through purchase of allotments and land held by non-tribal members, he had the largest ranch in Klamath Marsh area. His grandson, Jack Nicol, sold his portion of the Kittredge holdings to the U.S. Fish and Wildlife Service in 1990. The Refuge headquarters is now located at the former Nicol Ranch homestead, and the Nicol house is used as a government residence.

Tribal land and allotments were opened for logging in 1910–1911, although subsistence harvest and illicit timber had been previously cut. Some logging did occur at Klamath Marsh and extensively elsewhere within the reservation. In 1929, the Lamm Lumber Company built a logging railroad grade across the marsh that was used until 1944. In the 1960s, the grade was paved by the county. Today this road is known as the Silver Lake Highway (County Road 676).

Historic Archaeological Site Types

Historic site types of the European-American period include sites associated with exploration and/or transportation routes, logging, ranching, and early recreational use. Isolated artifacts commonly found include cans, bottles, and miscellaneous personal items.

3.16 Tribal Subsistence Rights

The entire Klamath Marsh National Wildlife Refuge lies within lands that made up the former historic Klamath Reservation. This reservation, comprised of about 2.2 million acres, was established through an 1864 treaty between the United States and the Klamath and Modoc tribes, and the Yahooskin Band of Snake Indians. Termination of Federal supervision of the Klamath Tribes, per the Klamath Termination Act of 1954 and subsequent government actions, resulted in the conveyance of former reservation lands to Federal and private entities, including Klamath Marsh National Wildlife Refuge.

In Kimball (tribal members) v. Callahan (Oregon State Game Commission members), 493 F.2d 564 (9th Cir. 1974) (Kimball I) and Kimball v. Callahan, 590 F.2d 768 (9th Cir. 1979) (Kimball II), the Ninth Circuit found that the Klamath Tribe did retain treaty hunting, fishing, and trapping rights on national forest lands within the boundaries of the former Klamath Reservation as it existed at the time of termination and on privately held lands within these boundaries where hunting and fishing was permitted. The state could regulate hunting, trapping, and fishing on these lands by tribal members only where reasonable and necessary for conservation. In Kimball II, the court encouraged the tribe and the state to attempt to reach agreement on the scope of appropriate state regulations, holding that the district court should determine the scope of the state's authority if the parties were unable to agree. The United States never participated in these cases in any capacity other than as an amicus. The state, the tribe, and the United States participated in the settlement negotiations encouraged in Kimball II; and on May 13, 1981, the district court entered a consent decree negotiated by the parties (USDI OS 1982).

The consent decree states:

> "This Agreement shall not be construed as resolving the issue of Klamath tribal hunting, fish-

> ing and trapping rights within the Klamath Forest National Wildlife Refuge. The United States and the tribe agree to use their best efforts to resolve this issue within twelve (12) months after the effective date of this Agreement."

While specific regulations remain to be resolved, a 1985 memorandum of understanding (MOU) between the Klamath Tribe, Winema National Forest, and the U.S. Fish and Wildlife Service recognizes the Klamath Tribe's rights:

> "… the Klamath Tribe has retained hunting, fishing and gathering rights on former Reservation lands, and these rights have been reaffirmed in federal court…"

The Klamath Tribe did not claim exclusive hunting, fishing, and trapping rights, nor were those rights held to be exclusive for the tribe in Kimball v. Callahan and therefore are not considered exclusive on Klamath Marsh Refuge (USDI OS 1997).

The 1985 MOU reads:

> "The Klamath Tribe shall: 1. Regulate tribal hunting activities in accordance with terms and conditions of settlement agreement with the State of Oregon."

The purpose of the consent decree agreement is:

> "…to establish a cooperative management and regulatory system through defining: 1) the management and regulatory responsibilities of the parties; 2) the scope and nature of the tribal treaty rights; 3) the extent of the State's power to, and the conditions under which it may, regulate treaty hunting, fishing and trapping for conservation purposes; 4) the remedies of the parties, and; 5) the continuing jurisdiction of the Court."

Hunting, fishing and trapping rights of the Klamath Tribe are tribal rights that may be exercised by individual members of the tribe. To exercise these rights, tribal members must be on the current tribal roles and have in their possession a treaty permit card. The consent decree states:

> "The Klamath Indian Tribe and its agents are the sole authorities for the issuance and revocation of treaty permit cards and game tags."

The consent decree outlines principles on how to manage motor vehicle use, habitat protection, the sharing of biological data, and the prohibition on commercial use.

The consent decree reads:

"Tribal Regulation

1. The Klamath Indian Tribe shall issue comprehensive rules controlling the hunting, fishing and trapping activities of its members within the boundaries of the Reservation in accordance with this Agreement.
2. Members of the Tribe who violate tribal hunting, fishing or trapping regulations on the Reservation shall be subject to the jurisdiction of the Klamath Tribal court…
3. Members who violate tribal regulations when hunting, fishing or trapping on the Reservation shall be subject to prosecution in the Klamath tribal Court…
4. Members of the tribe who violate applicable federal laws or regulations when in exercise of treaty rights on the Reservation may be prosecuted in federal courts…
5. All Tribal hunting, fishing or trapping is prohibited except as expressly authorized by the Tribe.
6. The Tribe will consult with the State a reasonable time in advance of establishing or changing regulations governing tribal hunting, fishing or trapping."

The consent decree also outlines state regulations and dual responsibilities.

Per the consent decree, the Klamath Tribe regulates hunting seasons, methods of take, and bag limits on former reservation lands through the issuance of "The Klamath Tribes Wildlife Code Synopsis." Season dates and limits for all species are subject to change.

Species frequently hunted by tribal members on Klamath Marsh National Wildlife Refuge include elk and mule deer. The 2005–2006 synopsis reads as follows for these species:

> "Elk: Bull and Calf season open all year. Cow season opens October 1 thru February 28.

Limit Two (2) tags per month. Tags are valid until filled.

Mule Deer: May 1 thru November 30; Bucks Only. November 16 thru April 30; Yearlings and Spikes only. Limit two (2) tags per month. Additional tags for canning and jerky are available at the Klamath Tribes Fish and Wildlife Office in certain situations. Does not apply to bucks November 15 thru November 30."

Tribal members also occasionally hunt ducks, geese, and coots on Klamath Marsh National Wildlife Refuge. The 2007–2008 seasons and limits were published in the *Federal Register*; Volume 72, No.198, 10-15-2007. These season dates are October 1, 2007, through January 28, 2008. Daily bag and possession limits, respectively, are ducks 9/18; coots 25/25; and geese 6/12. Nontoxic shot is required, and shooting hours are one-half hour before sunrise to one-half hour after sunset.

3.17 Reserved Rights and Privately Owned Mineral Estates

Table 3-4 is a summary of specific reserved rights by land tract at Klamath Marsh National Wildlife Refuge. Public reservations and/or right-of-ways such as utility, road, and telephone were recorded for specific deeds but are not listed in Table 3-4.

Table 3-4. Summary of reserved rights and privately owned mineral estates

Tract acquired from	Year acquired	Acres	Reserved rights
Richard Gray	1958	158.13	1. "…all subsurface rights except water…" 2. Access right-of-way (ROW) for portion of Wocus Bay Road
Grace Gray	1958	150.99	1. "…all subsurface rights except water…" 2. Access ROW for portion of Wocus Bay Road
Fred Hood	1958	169.48	1. "…all subsurface rights except water…"
Modoc Lumber Co.	1959	106.08	1. "…all subsurface rights except water…" 2. Access ROW for portion of Little Wocus Bay Road
Klamath Indian Tribe	1960	14,641.02	
Edward Lampe et al.	1972	200.83	"Reservation of all subsurface rights except water…"
Nicol Land & Cattle Co.	1977	40 (land exchange for 40 acres)	
John Horton	1988	2491.50	1. "Reservation of subsurface rights except water…." for 2 sub-tracts
Nicol Land & Cattle Co.	1989	12,158.66	1. ROW on Peninsula Road and Levee Road 2. Cattle loading/unloading and use of facilities in specified location
Nicol Land & Cattle Co.	1990	6,584.37	1. "Reservation of subsurface rights except water…." for 7 sub-tracts 2. "Reservation of all oil and gas and mineral rights…" for 1 sub-tract 3. "Easement for irrigation and livestock purposes…" for 1 sub-tract
John Horton	1990	74.17	
Lane Ranch	1998	2,960.00	1. ROW for 100'-wide railroad (Forest Lumber Co.) 2. ROW for logging road (Weyerhauser Timber Co.)
Michael Horton	1999	181.41	

3.18 Socioeconomics

3.18.1 Socioeconomic Setting

Klamath Marsh National Wildlife Refuge is located approximately 55 miles north of Klamath Falls, Oregon, and 20 miles north of Chiloquin, Oregon, in north central Klamath County. Access to the Refuge is via Highway 97 north from Klamath Falls or south from Bend and then east on Silver Lake Road. The nearest point of the Refuge is 5 miles east of Highway 97, and the Refuge headquarters is 17 miles east of Highway 97 on Silver Lake Road. Activity sites on the Refuge are accessible primarily from Silver Lake Road (paved), Military Crossing Road (all weather gravel), and U.S. Forest Service Road 690 (Wocus Bay Road), which is not maintained.

Population and demographic trends cited in this section were taken primarily from the 2004 General Management Plan for Crater Lake National Park. Statistics and trends are for Klamath County, Oregon, unless otherwise noted. With the exception of the city of Klamath Falls, the character of Klamath County—and notably, the north central portion of the county—is distinctly rural in nature, with resource-based economic activities prevailing (forest products, farming, and cattle grazing). The majority of land ownership in Klamath County is Federal and state, with major landholdings managed by the U.S. Forest Service, National Park Service, and U. S. Fish and Wildlife Service (national wildlife refuges). State park and wildlife area managers also manage significant areas within Klamath County.

Census statistics document just under a 10 percent population increase in Klamath County between the census years 1990 and 2000. Recent anecdotal information for the city of Klamath Falls—and to a lesser extent, surrounding rural communities—indicates an accelerated growth rate, with increased population growth and real estate values in the past three to five years. The Klamath County population was 63,775 according to year 2000 census figures.

The top three industries in Klamath County, accounting for slightly over one-third of county residents' earned income, were manufacturing, local government, and health care and social assistance, according to a 2001 survey. In recent years (1990–2001), unemployment rates in Klamath County have ranged from three to five percent above Oregon and national unemployment rates. Over a similar period, poverty rates were two to four percent higher than the Oregon and national poverty percentages.

3.18.2 Environmental Justice

In February 1994, President Clinton issued Executive order 12898, requiring that all Federal agencies seek to achieve environmental justice by "identifying and addressing…disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low income populations." Environmental justice is defined as the "fair treatment for people of all races, cultures and incomes, regarding the development of environmental laws, regulations and policies."

The U.S. Department of Housing and Urban Development defines low income as 80 percent of the median family income for the area, subject to adjustment for areas with unusually high or low incomes or housing costs. The median household income as documented in 2004 for Oregon was $42,568, whereas the median family income for Klamath County was $33,765. Using the 80 percent criteria, Klamath County would be classified as "low income" when compared to Oregon as a whole.

The Klamath Tribe's former reservation lands included and surround Klamath Marsh National Wildlife Refuge in its entirety. Based on ethnicity data reported for 2006, Klamath County has a similar ethnic composition as the entire state of Oregon except that Klamath County has a higher percentage of American Indians (4.1 percent in the county compared to 1.4 percent statewide) and a lower percentage of Asians (1.0 percent compared to 3.6 percent statewide) (US Census Bureau Data www.quickfacts.census.gov).

3.18.3 Land Use

Surrounding Klamath Marsh Refuge are lands managed by the U. S. Forest Service (Chiloquin and Chemult Ranger Districts of the Fremont-Winema National Forest); corporate or private ranching or grazing; and widely scattered rural residential sites.

3.18.4 Refuge Management Economics

The report "Banking on Nature 2006: The Economic Benefits to local Communities of National Wildlife Refuge Visitation" (Carver and Caudill 2007) detailed the economic impacts to local communities from 80 national wildlife refuges. The study included money spent for food and refreshments; lodging at motels, cabins, lodges, or campgrounds; and transportation to calculate the total economic activity related to refuge recreational use.

According to the report, recreational visits to national wildlife refuges generate substantial economic activity. In 2006, 34.8 million people visited refuges in the lower 48 states for recreation. Their spending generated almost $1.7 billion of sales in regional economies. As this spending flowed through the economy, nearly 27,000 people were employed and $542.8 million in employment income was generated. In addition, refuge recreational spending generated about $185.3 million in tax revenue at the local, county, state and Federal level. About 82 percent of total expenditures were generated by non-consumptive activities on refuges. Fishing accounted for 12 percent, and hunting accounted for 6 percent. Local residents accounted for 13 percent of expenditures, while visitors coming from outside the local area accounted for 87 percent.

3.18.5 Area Recreation Sector

The 2003–2007 Oregon Statewide Comprehensive Outdoor Recreation Plan (SCORP) provides some insight into recreation and visitor use trends which have implications for the level of visitor services appropriate to Klamath Marsh Refuge. The Oregon SCORP found that bird watching and nature/wildlife observation are second only to running and walking for exercise or pleasure in popularity as outdoor activities. The plan also found that nature/wildlife observation was one of several outdoor recreational activities with significant participation increases in Oregon. However, this document also found that the highest demand for these activities is in the communities where people live and in nearby areas. While Klamath Marsh Refuge provides great potential for bird watching and nature/wildlife observation, the remote nature of the Refuge will appeal primarily to those willing to travel considerable distances to take advantage of the unique wildlife observation and scenic appeal of this large, natural marsh and the surrounding uplands.

The Oregon SCORP also recognizes the public's interest in and increased emphasis on the protection of streams, fish, wildlife habitat, and threatened and endangered species, which is consistent with the mission and goals identified for Klamath Marsh Refuge. Goals identified in this document that should be considered in planning for visitor services at Klamath Marsh Refuge include:

1. Providing additional benefits through increased motorized and non-motorized water-based recreation activities in appropriate settings
2. Providing quality outdoor recreation experiences in a sustainable manner to ensure the enjoyment and education of present and future generations

Nearly twice as many Oregonians would prefer to participate in activities such as nature study and hunting in a primitive setting than actually use primitive areas while participating in these activities (SCORP). This seems to indicate that the primitive nature of outdoor recreation that predominates at Klamath Marsh Refuge is appropriate to address current and future use.

3.18.6 Agricultural Sector

Although cereal grains, potatoes, alfalfa, and other agricultural commodities are widely harvested in the southern portion of the Klamath Basin, agricultural uses within and surrounding Klamath Marsh Refuge are almost entirely focused on livestock grazing and harvesting grass hay. Due to the scarcity of forage during the winter months, cattle are often trucked to grazing locations to the south during the winter months or fed hay in nearby winter feed grounds.

3.19 Historic and Current Management and Monitoring Practices

The primary management focuses of the Refuge are enhancing, restoring, and maintaining wetlands,

riparian, sedge meadows, and upland forests. Management tools and programs that are used to achieve habitat goals include water management, prescribed fire, invasive species management, commercial haying and grazing operations, and biological monitoring and surveys. From 1958–1990, lands were managed by staff located two hours south in the Klamath Basin Refuge Complex office at Tulelake, CA. With limited staff and only partial acquisition of Refuge lands, there was minimal on-site management during these earlier years. Generally, grazing and haying operations were continued at some level, and the management emphasis was more on fencing, acquiring additional lands, and protection of acquired lands primarily from trespass livestock. Focused and more intensive management of Refuge lands was initiated in 1990 when a full-time manager and maintenance position were stationed on site. It was also at this time that the Refuge doubled in size, and a majority of current refuge lands were acquired (Figure 1-3). The following outlines the basic management practices currently applied to Refuge habitats.

Management Units

The Refuge was originally divided into nine management units in 1991 (Figure 3-14) and later amended to include one additional unit, the Lane Ranch, in 1998. Another more detailed management unit map was created after 1991 (Figure 3-15). Boundaries identified in both management unit maps are based on historic water management units, haying operations, grazing operations, former ranch tract acquisitions, and habitat types (i.e., large wetland units). Both management unit maps are important in terms of interpreting historical and current management operations. The more detailed management unit map is currently the primary map used as a reference for haying, grazing, fire, and water management operations.

3.19.1 Water Management

The following text outlines the general water management strategy that has been used by the staff to irrigate the Refuge's marsh areas and wetland units located north of Military Crossing Road where irrigation infrastructure is currently in place. Much of the infrastructure was installed by ranchers for the purpose of draining marshes to improve grazing conditions for livestock. Some improvements, including adding new water control structures, were later added by the Refuge to improve water management for wildlife purposes.

The entire Klamath Marsh Water Strategy document is found in Appendix R, and a detailed analysis of the Klamath Marsh hydrology and Refuge water rights is provided in Appendix O.

Irrigation and Water Management Infrastructure

All of the active irrigation and water management on the Refuge occurs in the central portion of the upper marsh (Figure 3-16). The ditches that exist in this part of the Refuge are remnants of the former ranching operations that once operated in this area. There are three primary ditches in the upper marsh. Water from the Williamson River is diverted into Cholo ditch just upstream of the Refuge boundary and runs parallel to the Williamson River on the south side of the valley for about two miles. The Williamson River maintains its natural channel for about one mile into the Refuge, then becomes channelized at Rock Island, turns south, and merges with the Cholo ditch. Downstream of this point, the ditch, called Kittredge Canal or Kirk Ditch, runs all the way to Military Crossing Road. A third primary ditch in the upper marsh, Mitchell Ditch, carries water west of Rock Island. The Refuge uses this ditch to supply water to the north and west areas of the upper marsh.

Prior to U.S. Fish and Wildlife Service ownership, a number of small ditches and control structures were used to distribute water from Cholo Slough, Kirk, and Mitchell ditches to adjacent lands for haying and grazing. Most of these ditches still exist, but some have fallen into disrepair and no longer function. The highly permeable nature of the soils in the marsh means that there is good subsurface movement of water. Much of the irrigation on the Refuge in this area is now done by backing up water in the three main ditches and relying more on subsurface seepage and less on direct diversions through the smaller ditches.

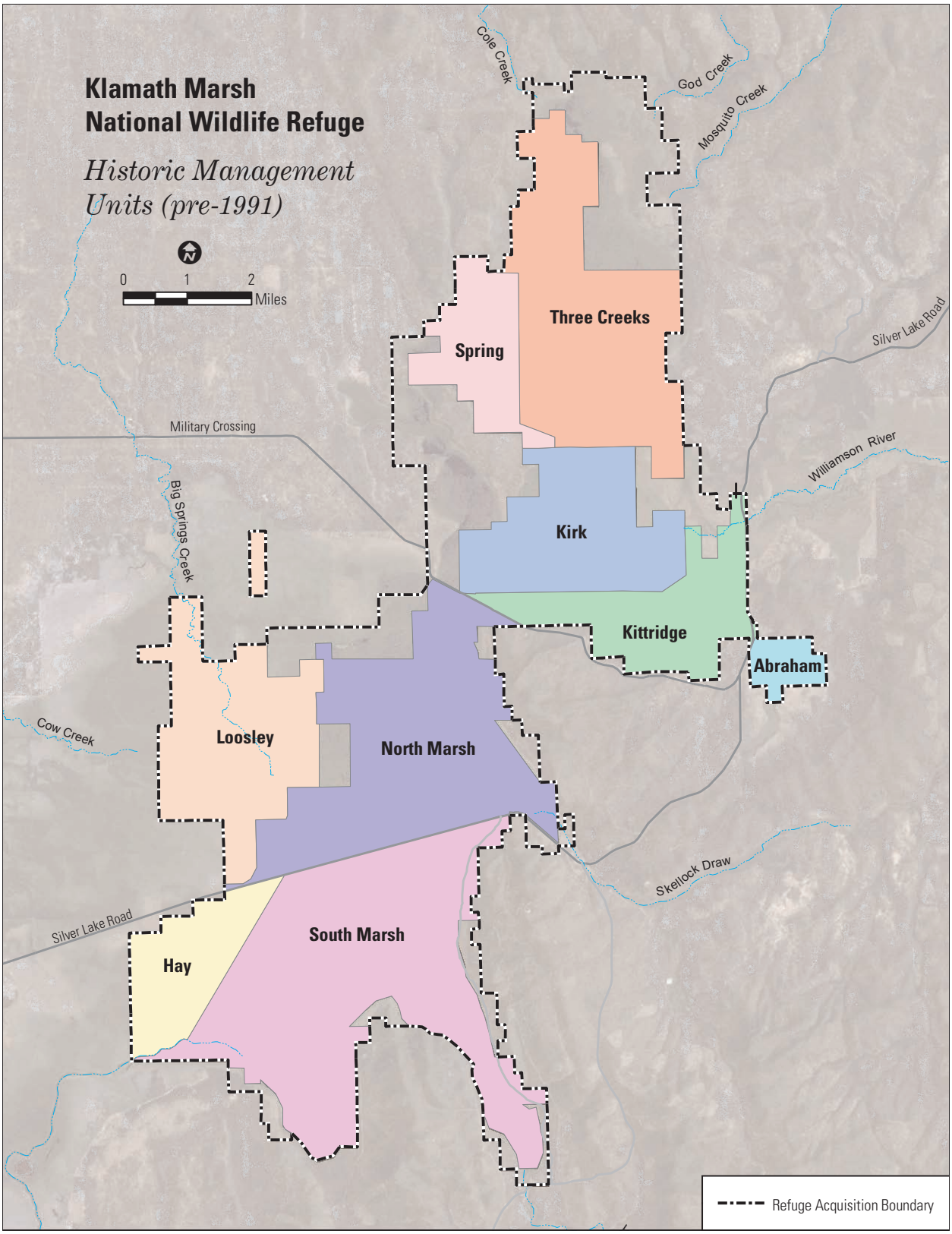


Figure 3-14. Historic management units

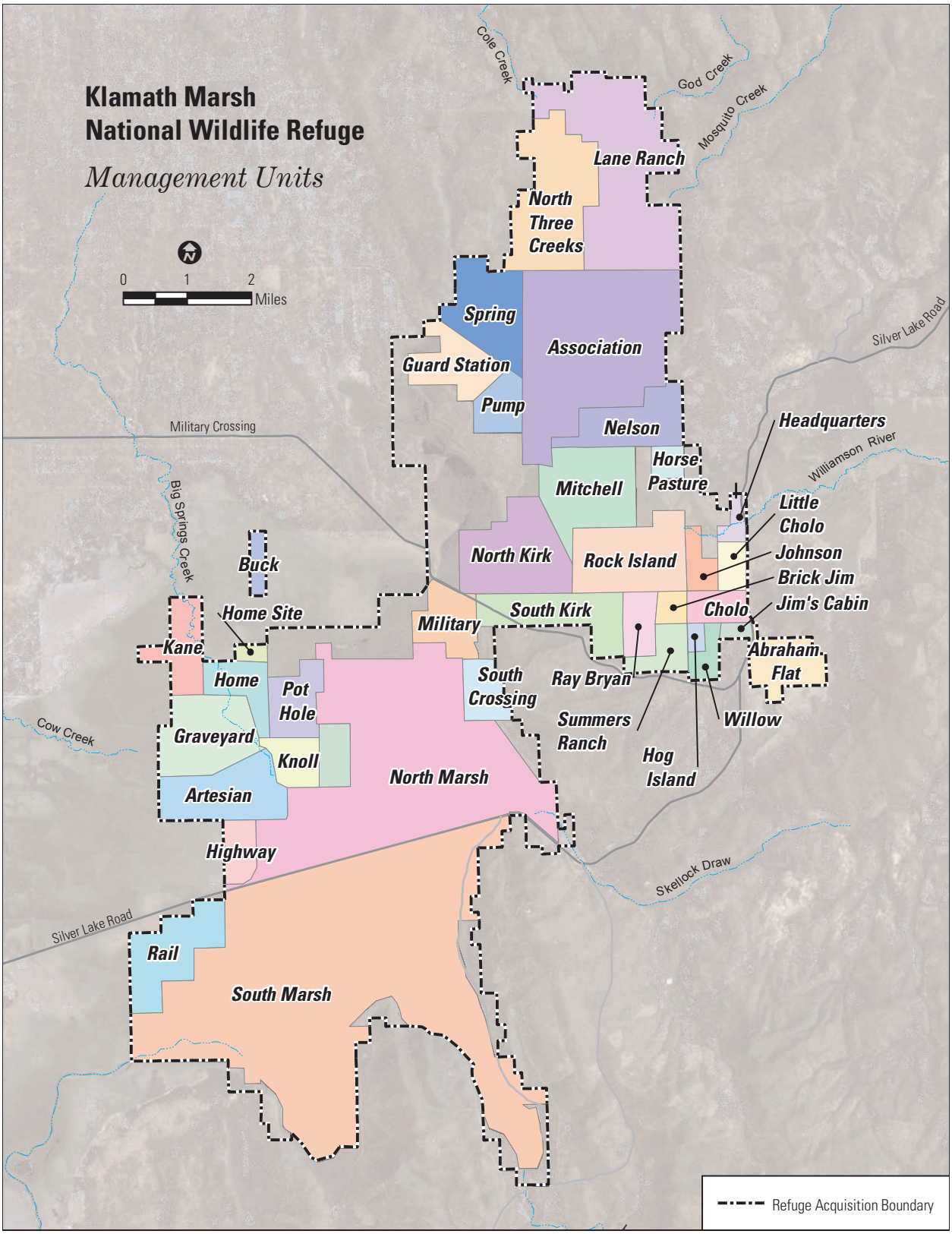


Figure 3-15. Klamath Marsh Refuge management units

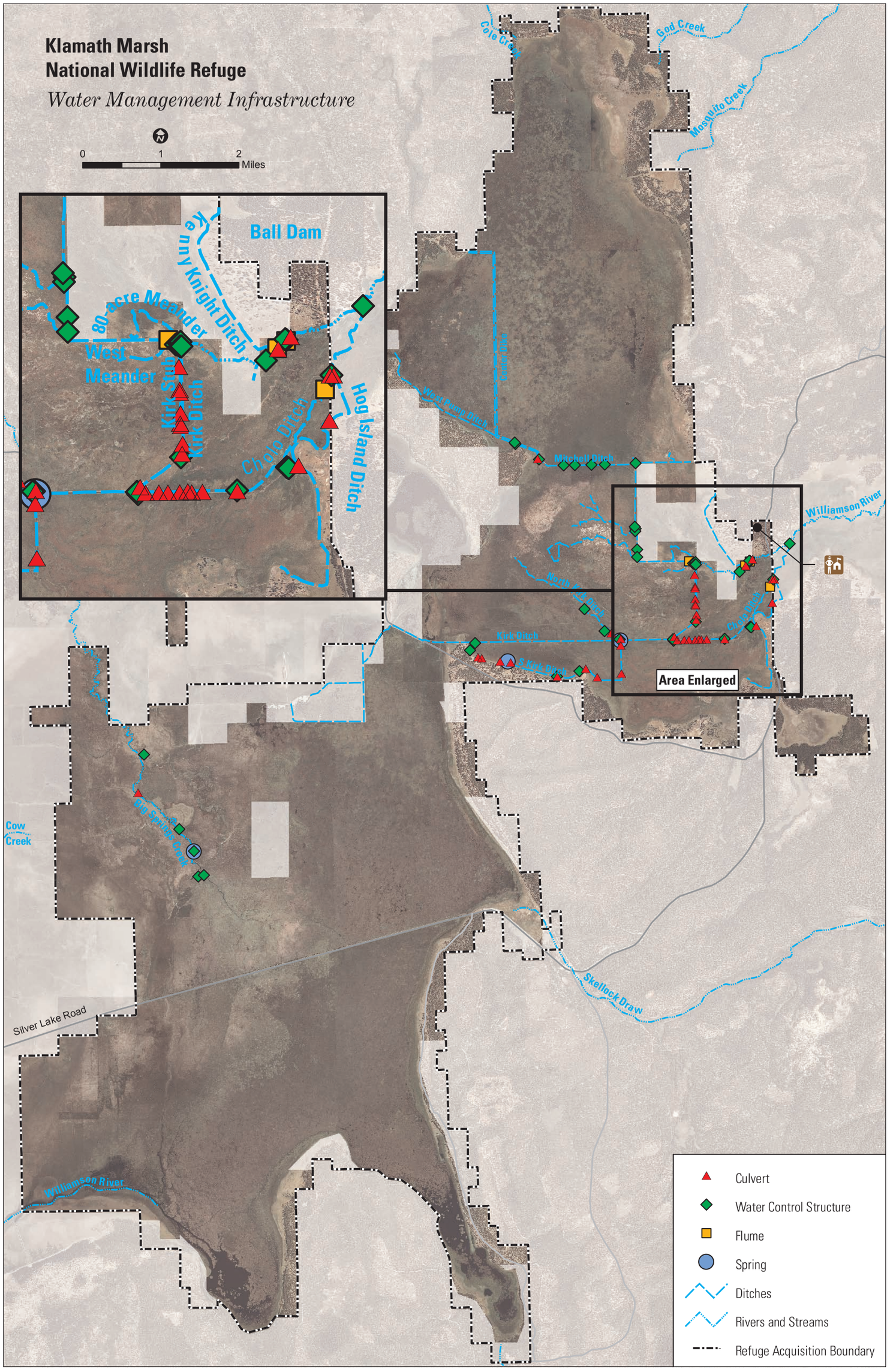


Figure 3-16. Klamath Marsh Refuge water management infrastructure

Historically, winter runoff from streams in the northern portion of the upper marsh was pumped out of and into the Williamson River in March and April to drain the upper marsh area and allow cattle access in the spring. This same area was irrigated later in the season. The Service no longer pumps water from these areas in the spring and instead uses the existing water control infrastructure to hold winter runoff later in the season.

Water Measurement and Monitoring

Inflows into the Refuge from the Williamson River can vary significantly throughout the year and also from year to year. Some of the factors that influence the volume of water delivery include snowpack, precipitation, temperature, evaporation rates, and upstream diversions for irrigation.

The Water Resources staff from the U.S. Fish and Wildlife Service's Portland, Oregon, regional office monitors Williamson River inflows into the Refuge using permanent data loggers. Because the Cholo Ditch diverts from the Williamson River upstream of the Refuge boundary, data is collected at three Refuge locations. The first is at a flume located in the Cholo Ditch, just downstream of Silver Lake Highway (Figure 3-16). The second is at a flume just downstream of Ball Dam. The third is at a flume in the Johnson ditch, which diverts just upstream of Ball Dam. The Johnson ditch flume is canted; therefore, the exact accuracy of the data collected there is in question. Historically, data was also collected at a flume in the private ditch to the north of Ball Dam, but that flume was removed. Because of these issues, data collected in the vicinity of Ball Dam does not always reflect the exact total volume of water in the Williamson River when the Johnson ditch and the private ditch diversions are operating. Margins of error in water measurement figures in this area when these ditches are running are estimated to be about 10 percent (F. Wurster, personal communication, May 2008).

Water flow data collected by continuous data loggers from October 1999 through September 2003 (see Table 3-5) helps provide a basic understanding of water volumes flowing into the Refuge throughout the year. While there is some measurement error, as outlined previously, the table still provides a general idea of the total flows and their seasonal distribution between the Williamson River and Cholo Ditch systems. Note, however, that water flows entering the Refuge do not always reflect the entire volume of the Williamson River. Upstream water inputs and deletions affect the total volume of water that is delivered to the Refuge boundary. Water volume measurements taken at Sheep Creek (about eight linear miles upstream, not taking into account the extensive meandering of the river channel) can vary significantly from those at the Refuge boundary. According to Mayer et. al 2007,

> "It is possible to compare the flow in the Williamson River below Sheep Creek to Williamson River measurements collected by the FWS at the refuge boundary, for four years of overlapping measurements (2000 to 2003). The flows at the two sites are about equal on an annual basis but there are diversions and tributary inflows between the two sites which result in seasonal differences. Generally, there is more flow in the Williamson at the refuge boundary in the winter and spring, during the runoff season, and less in the summer and fall, during the irrigation season. June to September totals at the refuge ranged from 75 to 116% of the June to September totals below Sheep Creek for the years 2000 to 2003. At times during the summer of 2003, refuge inflows were less than half the flow measured concurrently upstream below Sheep Creek, indicating upstream diversions and channel losses can significantly reduce the quantity of Williamson River flow reaching the refuge."

The following sections outline the general water management strategy using the Refuge's existing irrigation infrastructure. The water operations described are managed based on the institutional knowledge, experience, and expertise of Refuge staff members.

Seasonal Water Management Strategies

Spring Water Management. Water level management and irrigation is most active at Klamath Marsh Refuge during the spring and early summer months when snowmelt and subsequent runoff greatly increase water flows and availability for irrigation of

Table 3-5. Average monthly peak and low flow rates (cubic feet per second [cfs]) from October 1999 through September 2003. Data summarized by D. Damberg, U.S. Fish and Wildlife Service, Klamath Basin Refuge Complex, Tulelake, CA (2008).

	Ball Dam Flume (cfs)	Johnson Ditch Flume (cfs)	Cholo Ditch Flume (cfs)
January average peak	66	4	36
January average low	35	1	22
January peak range	53-88	0-8	18-50
January low range	20-43	0-1	16-36
February average peak	62	1	29
February average low	39	1	23
February peak range	56-67	0-2	17-52
February low range	36-41	0-1	16-39
March average peak	56	4	29
March average low	38	0	19
March peak range	42-72	4-7	17-49
March low range	34-44	0-0	13-27
April average peak	68	7	36
April average low	31	2	19
April peak range	45-98	5-8	18-60
April low range	13-43	0-3	7-27
May average peak	69	8	29
May average low	54	2	16
May peak range	34-73	4-11	23-39
May low range	13-54	0-2	6-34
June average peak	57	4	24
June average low	27	0	10
June peak range	31-73	1-7	19-36
June low range	12-45	0-0	6-14
July average peak	49	0	14
July average low	22	0	9
July peak range	36-62	0-1	10-21
July low range	14-33	0-0	6-11
August average peak	35	0	10
August average low	13	0	7
August peak range	19-48	0-0	8-14
August low range	4-24	0-0	5-10
September average peak	37	0	13
September average low	13	0	7
September peak range	29-46	0-1	10-16
September low range	3-24	0-0	5-7
October average peak	44	0	29
October average low	30	0	20
October peak range	39-52	0-0	18-57
October low range	24-36	0-0	9-43
November average peak	54	6	27
November average low	34	0	18
November peak range	33-71	1-11	21-36
November low range	27-39	0-0	11-30
December average peak	63	4	25
December average low	36	2	19
December peak range	39-82	0-7	18-38
December low range	29-42	0-3	14-29

wetland units. Spring water management activities on the Refuge are dictated by weather and road access. During the winter months, the Williamson River and all ditches are frozen and/or filled with snow, and roads can be impassible due to snow. As winter transitions to spring, the Williamson River eventually opens up and becomes ice free. Ice and snow in the ditch systems is slower to recede, but the melting process is accelerated by slowly adding to or increasing water in various ditches. Plowing of roads is sometimes necessary to provide vehicle access to ditches and water control structures.

In a normal snow year, water management activities begin in early March. In a higher than normal snow year such as 2008, management activities may be delayed until mid- or late March. As roads and water control structures become accessible, boards are placed in water control structures to elevate water levels in ditches and adjacent wetlands either via overflow or through upstream culverts. Each spring, boards are first placed into the East Cholo water control structure and then progressively into the further outlying structures, including the Kirk and Mitchell irrigation systems, as access improves. Generally, boards are placed in the east, center, and west Cholo water control structures at about the same time. In a normal year, Refuge staff can't access water control structures at the Rock Island Confluence area until about three weeks after starting irrigation in the Cholo due to snow and/or road conditions.

When air temperatures rise sufficiently to increase snow melt and runoff into the Williamson River and other peripheral creeks, water control structure boards are removed as needed to minimize overflow and potential damage to structures and roads. In normal water years, the elevated water levels during this period are sufficient to irrigate the wetland fields.

There is no in-stream gauge system in place to guide staff on how much water to divert into the Cholo ditch. Volumes can fluctuate significantly, sometimes on a daily basis, depending on inflows. Daily inflow volumes measured from October 1999–September 2003 (see Table 3-5) show that on average, roughly one-third of the Williamson River was diverted into the Cholo between September and April, while closer to one-quarter of the Williamson River was diverted into the Cholo ditch from May through August. Boards are added or removed at the main diversion structure to maintain a balance. From 1999 through 2003, the highest peak spring flows were in April ranging from 45–98 cubic feet per second at the Ball Dam flume and 18–60 cubic feet per second at the Cholo ditch flume.

Summer Water Management. The Williamson River inflows decline in the summer due to reduced snowmelt and/or runoff, increased evaporative losses, and increased irrigation upstream of the Refuge. As flows decline, boards in the Cholo, Kirk, and Mitchell ditches are gradually removed, lessening water flow into wetland units and insuring sufficient instream flow to maintain habitat for Oregon spotted frogs, redband trout, and other endemic species. Irrigation of wetlands is generally not possible in late summer. Many of the sedge wetlands dry up completely and can be grazed or hayed by August. From 1999 through 2003, water levels fell to their lowest in August and September, with low flows ranging from 3–24 cubic feet per second at the Ball Dam flume and 5–7 cubic feet per second at the Cholo ditch flume.

Fall Water Management. Fall can bring a slight increase in Williamson River inflows relative to the summer low flows as upstream irrigation diversions are shut down and evaporative losses decline with the cooler weather. Select fields within the Cholo, Kirk, and Mitchell ditch systems, often fields that were hayed in August, are irrigated for fall migratory waterfowl, crane, and other bird use. Sufficient water is maintained in the Cholo, Kirk, and Mitchell ditch systems to meet life cycle needs of wintering Oregon spotted frogs (overwinter habitat), redband trout, and other endemic species within the ditch systems. From 1999 through 2003, average low and average peak flows in October at the Ball Dam flume were 30 and 44 cubic feet per second, while average low and average peak flows at the Cholo ditch flume were 20 and 29 cubic feet per second, respectively.

Before winter freezes the water in the ditches and structures, Refuge staff remove most of the remaining boards in water control structures to avoid damage to structures that could be caused by winter ice.

Winter Water Management. Water is maintained in the Cholo, Kirk, and Mitchell ditch systems to meet life cycle needs of wintering Oregon spotted frogs (overwinter habitat), redband trout, and other endemic species. These areas will freeze over but continue to flow each winter. Boards in water control structures are left out to minimize damage from winter ice. Snow cover makes the entire irrigation area inaccessible in most years to vehicles. From 1999 through 2003, data loggers at the flumes show a continual recovery in water volume flowing into the Refuge as the winter progresses, with peak average winter flows occurring in January. January peak average flows were 66 cubic feet per second at the Ball Dam flume and 36 cubic feet per second at the Cholo ditch flume.

3.19.2 Fire Management

Wildfire Program

A detailed history of known wildfires on or near the Refuge is provided in Section 3.3. Since 1983, 21 wildfires ranging from 1–1,500 acres in size have been recorded for the Klamath Marsh National Wildlife Refuge. Most wildfires have been less than 10 acres. Wildfires are suppressed where accessible and feasible. Most wildfire starts are the result of lightning strikes in late summer. Since 1993, the Refuge has annually stationed a fire engine and three-person crew at the Klamath Marsh Refuge headquarters from July–October to cover wildfire suppression duties. The Klamath Basin National Wildlife Refuge Complex developed a Wildland Fire Management Plan (2001) to address all aspects of fire management. This plan covers fire management activities at the Klamath Marsh Refuge. The Service has also signed on as a member of the South Central Oregon Fire Management Partnership, which includes fire administrators from the Oregon Department of Forestry, Fremont-Winema National Forests, Sheldon-Hart National Wildlife Refuge Complex, Lakeview District Bureau of Land Management, Crater Lake National Park, and Klamath Basin National Wildlife Refuges. The area encompasses Federal, state, and private lands that are within an area from the California and Nevada border to the Cascade crest, east to the high desert, and north to the central Oregon desert. The purpose of this partnership is to operate a coordinated, interagency fire management program that provides comprehensive fire services to the area. The goal is to achieve a more efficient, effective, and integrated interagency fire management program for all participating agencies on the lands administered and protected by each agency. These programs include but are not limited to fuels management, preparedness, suppression, aviation, and training. In addition, the National Fire Plan established in 2000 provides guidance to all Federal firefighting agencies on fire management issues (National Fire Plan 2000).

Prescribed Burn Program

One of the most beneficial habitat management tools available to the Refuge is the use of fire to conduct prescribed burns. Prescribed burns are used to re-invigorate plant growth and health in all habitat types, reduce forest understory debris, reduce the potential for catastrophic forest burns, create areas of new vegetative growth for spring migrating and nesting waterbirds to forage and nest in, and increase the interspersion of open water to emergent vegetation in wetland areas. Prescribed fire was first used on the Refuge in 1991. Since 1991, over 28,000 acres have been treated with prescribed fire (Table 3-6). Aerial ignition, using a helicopter, has been the preferred ignition method for burns located within the actual marsh. Peat fires are sometimes a problem after prescribed burns. When peat soils sustain combustion, extensive mop-up and patrol is required.

The current goal is to annually conduct at least one fall or spring prescribed burn. The location, acreage, and vegetation type that burn each year depends on weather, staffing, funding, permit requirements, habitat goals, and the application of other management tools like haying and grazing. The major limiting factor for this program is the availability of fire staff and funding, which is spread among six refuges in two states.

The Klamath Marsh Refuge Fire Reduction and Wildlife Habitat Enhancement Project Environmental Assessment (USFWS 2003) was approved and provides direction for completing prescribed burns within forested stands and within grassland meadows encroached by pine stands.

Table 3-6. Prescribed burns conducted on Klamath Marsh Refuge 1991–2007. See figure 3-13 for management unit locations.

Year	Unit Burned	Acreage
1991	Mitchell Rock	650
1991	HQ LT-CHOL	200
1991	South Marsh	4,000
1992	Rock-George	300
1993	Brick Jim	100
1993	Summers	150
1993	Rock Island	400
1993	Marsh Complex	1,200
1994	South Kirk	140
1994	Mitchell	100
1994	North Kirk	450
1994	Rock Island	250
1995	South Marsh	7,040
1996	South Kirk	720
1998	Marsh Complex	4,090
2001	Abraham Flat	468
2002	North Marsh	1,510
2005–2006	Headquarters Piles	25
2007	South Marsh	6,500
2008	Lane Ranch	240 + 133 Wildfire
TOTAL		**28,666**

The future full implementation of this project is pending completion of the Comprehensive Conservation Plan.

3.19.3 Invasive Species Management

Invasive plant species have been treated and monitored annually since around 1990. Historical and current populations of invasive plants remain low in total acreage but broad in distribution. The primary species treated and locations of infestations are shown in Figure 3-17 for the years 2006–2008. Populations are treated primarily by chemical sprayers attached to ATVs, and localized individual plant populations are often hand pulled. Helicopter spraying was implemented to treat populations of reed canary grass during 2007 and 2008. The total acreage of actual invasive plant populations remains low and has been mapped as point locations rather than polygons. Based on chemical use and point data, there are approximately 100–300 total acres of invasive plants scattered throughout the Refuge. Chemical spraying has proven the most reliable control tool for invasive plants. Biological controls have not been used, as the overall acreages of invasives are too small to apply this technique.

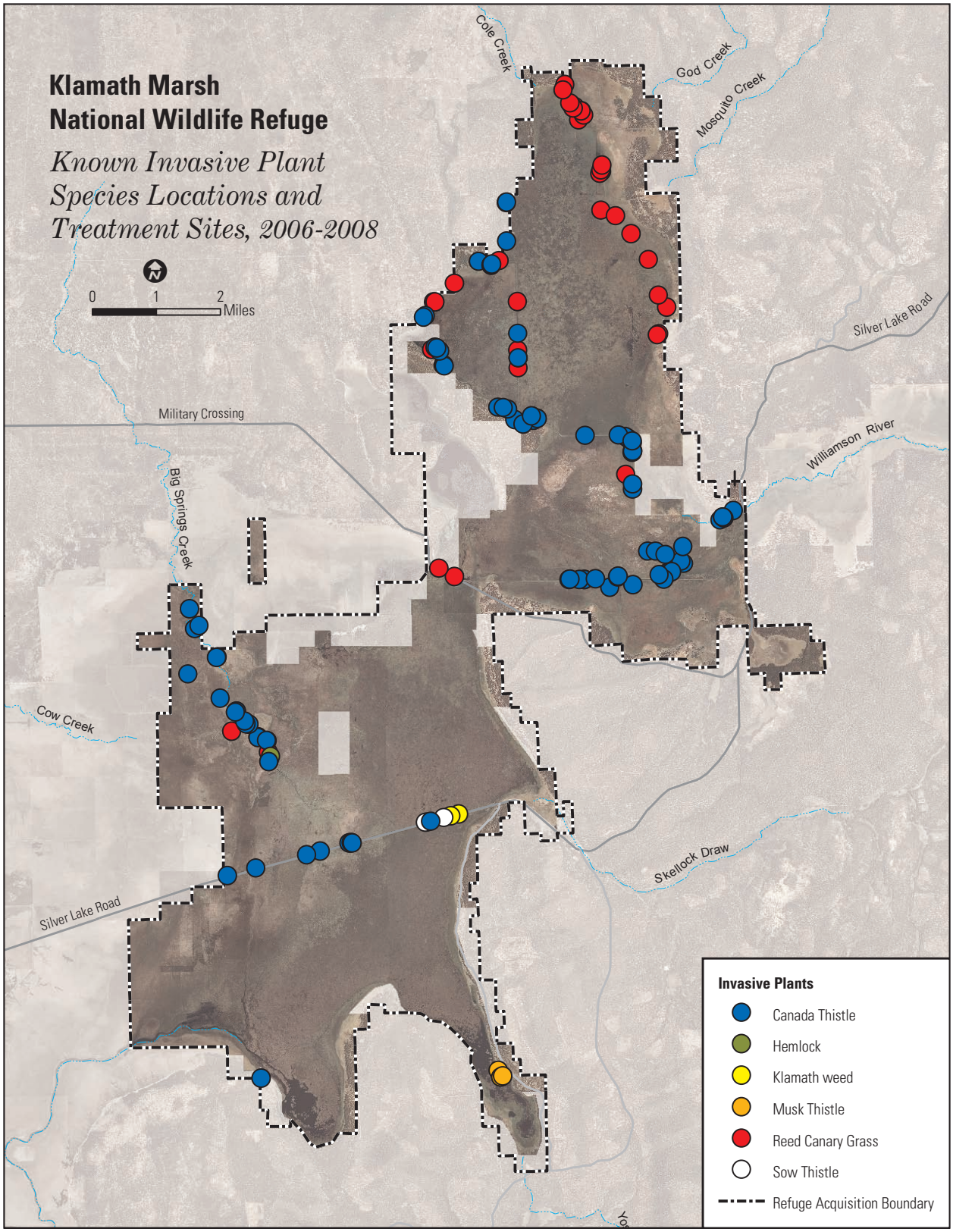


Figure 3-17. Known invasive plant species locations and areas of treatments, 2006-2008

Cheat grass is one invasive plant species that remains untreated on the Refuge due to limited staff and relatively ineffective control techniques. It occurs in scattered pockets within the upland areas and has not been mapped at this time.

Mapping of populations will continue annually to track treatment progress and potential spread of plants. Continued aggressive treatment of known populations and surveying of lands for new infestations is needed to keep invasive plant populations under control. Please see Section 3.11 (Invasive Species) for additional information regarding invasive species. Table 3-7 provides a list of chemicals and the plant species to which they are applied.

3.19.4 Biological Monitoring and Surveys

A variety of surveys and studies have been conducted by Service staff, volunteers, and students on the Refuge since its establishment. These studies are primarily intended to evaluate the effectiveness of management activities and monitor the status of biological resources. A summary of ongoing surveys and studies and their objectives follows.

Fall and Spring Aerial Waterfowl Surveys

Aerial waterfowl surveys are completed every two weeks from September through May to document numbers and species of waterfowl using the Refuge. This is a long-term survey that has been completed

Table 3-7. Invasive plants and control methods on Klamath Marsh National Wildlife Refuge, Chiloquin, OR (2008).

Plant Name (Native or non-native)	Scientific Name	Control Method	Comments
Canada Thistle (non-native)	*Cirsium arvense*	Herbicide – aminopyralid (Milestone)	Localized problem
Bull Thistle (non-native) Musk Thistle Sow Thistle	*Cirsium vulgare* *Carduus nutans* *Sonchus sp.*	Herbicide - Aminopyralid (Milestone)	Localized problem
Perennial Pepperweed (non-native)	*Lepidium latifolium*	Herbicide - Chlorsulfuron (Telar)	Localized problem
Dalmatian Toadflax (non-native)	*Linaria gentistifolia ssp. Dalmatica*	Herbicide - Chlorsulfuron (Telar)	Localized problem
Mayweed chamomile (non-native)	*Anthemis cotula*	Mowing	One known population discovered in 2008
Poison Hemlock (non-native)	*Conium maculatum*	Mowing Herbicide – 2,4-D amine (Weedar 64)	Localized problem
Cheat grass or Downy brome (non-native)	*Bromus tectorum*	Nothing so far	Widespread in some areas. Plant competes with native grasses and can alter natural fire patterns
Spotted Knapweed (non-native)	*Centaurea maculosa*	Herbicide – aminopyralid (Milestone)	Localized problem
Field Bindweed (non-native)	*Convolvulus arvensis*	Hand Pulling	Unknown distribution but has been documented in Refuge plant list (1991)
Reed Canary Grass (native and non-native eco-types)	*Phalaris arundinacea*	Hebicide – glyphosate (aquatic label such as AquaNeat, AquaMaster)	First treatment started in 2007
Klamath Weed (Common St. John's wort)	*Hypericum perforatum*	Hand Pulling	Localized problem

since 1953 to determine long-term trends. These numbers are also used to determine waterfowl use-days for the Refuge. In addition to USFWS surveys, ODFW initiated breeding population surveys for ducks, geese swans, and sandhill cranes in 1994. Three transects are surveyed from helicopter each spring across Klamath Marsh as part of a statewide survey effort.

Spring sandhill crane surveys. These surveys are completed each spring to determine the potential number of nesting sandhill cranes on the Refuge. Surveys have been completed from 1991–2008.

Bald eagle nesting and winter use surveys. Nest surveys are completed in spring and summer to determine the number of bald eagles nesting on or adjacent to the Refuge and the number of young fledged from each nest (1997–2008). Winter surveys are conducted, if feasible, to determine winter use of the Refuge (1988–2008). These surveys also contribute to the statewide survey for Oregon and Washington (Isaacs and Anthony 2008).

Yellow rail surveys. An attempt is made to complete surveys for yellow rails in available habitat to estimate densities and determine areas of use within the Refuge. This is a labor intensive survey that has not been completed each year. Most years, only portions of potential habitat are surveyed. Future monitoring will focus on completing surveys in areas receiving management treatments to determine potential negative and positive impacts to this species. Surveys have been sporadically conducted from 1991-2008.

Oregon spotted frogs. Surveys are completed in spring to count egg masses in available habitat and determine areas of use and relative importance. Surveys have been completed from 2000–2008 with variable survey effort. Comprehensive surveys of all habitats are completed only when staff is available. Attempts are made to annually survey all know sites where egg masses have been found in the past.

Secretive marsh bird surveys. This survey was started in 2008 and initiated by the Klamath Bird Observatory. There is one fixed survey route established on the Refuge that Refuge staff will survey annually in the spring (three times) to determine occurrence and relative abundance of secretive marsh birds (yellow, sora, and Virginia rails; American and least bitterns; pied bill grebe). This data will contribute to a larger statewide monitoring effort that will be coordinated by the Klamath Bird Observatory.

Duck and Canada goose breeding pair surveys. These surveys are conducted by plane in spring. Surveys have been conducted from 1990–2008 to document potential breeding pairs of Canada geese and waterfowl species.

Clearwinged Grasshopper Monitoring and Control

In the Klamath Basin, the clearwinged grasshopper is a native species with a long history of periodic outbreaks on public and private lands. Outbreaks in the area of Klamath Marsh Refuge generally coincide with periods of extended drought. Large outbreaks occur in cycles of 7–12 years and generally exceed economic threshold levels of 14–24 grasshoppers per square yard. Outbreaks in excess of economic thresholds, necessitating treatment of Refuge and private lands, have occurred in 1954, 1959, 1973, 1980–1981, 1993–1995, 2003–2005, and 2007.

Since 2005, the Refuge has cooperated with the Department of Agriculture's Animal Plant Health Inspection Service (APHIS) to implement a proactive approach of intensive surveying and treating as needed at the first sign of economic population buildups. The Service's goal is to maintain the ecological role of grasshoppers yet reduce the economic impacts associated with outbreaks by implementing integrated pest management (IPM) strategies. Treatment of grasshoppers in early to mid-nymphal stages allows the Refuge and adjacent private landowners to use pesticides on fewer acres and in very specific locations, using the least toxic chemicals with minimal environmental impacts. Treatments completed by APHIS are done by ATVs using a boomless nozzle and Reduced Area Agent Treatment Strategy (RAATS). The RAATS treatment strategy results in chemical treatment of only 50 percent of the total area requiring treatment.

In 2005, APHIS treated 244 refuge acres of hatching egg beds with Dimilin by ground at a 97 percent

effective rate on treated areas. Using a 50 percent RAATS method means only 137 acres were actually sprayed on the Refuge. No treatment was necessary in 2006 due to a wet spring. Only 33 acres (12.5 acres sprayed) were treated on Refuge lands in 2007 using RAATS and Dimilin, and no acres were treated in 2008. A detailed history of grasshopper biology and control can be found in Section 3.8.1.

3.19.5 Forest Management

Historic Forest Management around Klamath Marsh (Pre-refuge, 1800–1958) and Timber Harvest Era (Pre-refuge, before 1958)

Starting in 1911, the Office of Indian Affairs initiated a number of commercial timber sales throughout the Klamath Reservation. To maximize economic benefit to the tribe, these sales often targeted the removal of the largest and straightest trees within the stands. The ponderosa pine stands found on the reservation were considered some of the finest stands in the country. Ponderosa pine lumber products were in high demand, and the newly built Southern Pacific Railroad made the extraction of pine timber economically viable. Many of the initial timber sales on the reservation were accessed via branch logging railroads built off of the Southern Pacific mainline. In 1929, the Lamm Lumber Company built a railroad across the Klamath Marsh to access the privately owned Long-Bell Tract in the eastern part of the reservation. This railroad grade is now the Silver Lake Highway.

In 1920, the Calimus-Marsh Unit was sold. This unit stretched from Calimus Butte to the south end of the Klamath Marsh. Logging occurred from 1922 to1937. The perimeter of Wocus Bay was logged in 1934, and the perimeter of Little Wocus Bay was logged in 1937. Approximately 375,225,225 board feet were cut in this extensive sale that covered 67,000 acres (Kinney 1950; Klamath Agency, n.d).

In 1924, the North Marsh Timber Unit was sold. This unit stretched around the north end of the Klamath Marsh. Logging on this unit occurred from 1937–1944. The west side of the Klamath Marsh (including the Peninsula region) was logged for a mixture of ponderosa and lodgepole pine from 1937–1939. A buffer of mostly lodgepole pine existed on the eastern edge of the Klamath Marsh. An estimated 300,000,000 board feet were logged in this sale (Kinney 1950, Klamath Agency, n.d.).

The Military Crossing unit was sold in 1931. This sale was to salvage an area of windthrown timber on the west side of the Klamath Marsh. Logging occurred in 1943 and 1944, but the unit probably did not include any of the current Refuge.

When the reservation went to the allotment system, increased reports of trespass logging occurred. Several trespass loggers were caught and charged (Klamath Agency, 1911–1961). While there is no direct evidence, it is possible that trespass logging occurred in the stands surrounding the Klamath Marsh.

An epidemic of western and mountain pine beetle attacks occurred from 1915 through 1935, killing an estimated 20–30 percent of the large ponderosa pines trees. While the most severe damage occurred in the far eastern portion of the former Klamath Reservation, timber stands currently located on the Refuge were probably affected. During this period, the Klamath Agency initiated a systematic method of identifying beetle infested trees, whereby survey crews would locate and mark infested trees. Felling crews would follow and fell the trees, peel the bark, and burn them.

Cattle and sheep grazing occurred in the forested uplands surrounding the marsh since the very early days (early 1800s) of the Klamath Tribe reservation. These grazing activities continue at various levels in forested areas around the Klamath Marsh.

Forest Management and Changes since Refuge Establishment (1958–Present)

The acquisition boundary for Klamath Marsh National Wildlife Refuge includes a 5,100-acre forest buffer surrounding marsh wetlands. Since Refuge establishment in 1958, the Service has been successful in acquiring about 2,000 acres of forest covered lands within the Refuge acquisition boundary. These lands have been acquired gradually (see Section 1.4.3 on land acquisition), so that many of the forested lands now owned by the

Refuge have been under private management until recently. The following text provides a description of changes to forest lands within and surrounding the Refuge since its establishment in 1958.

The forest stands within the Klamath Marsh Refuge have been extensively altered by past logging activities. Beetle infestations, grazing, windstorms, and fire exclusion have also affected the current forest condition.

In 1962, the Columbus Day storm of October 12 felled approximately 20 trees on the refuge. These windthrown trees were sold to a local logger, who salvaged them in 1963. Thousands of other trees on adjoining properties were felled by the Columbus Day Storm. Areas that are now included within the Refuge—but were at the time under private ownership—were affected by the Columbus Day Storm. An area still covered with downed lodgepole pine trees is still visible just north of the headquarters at Bloody Point and is evidence of the ferocity of this storm (Walt Ford, personal communication 2004).

The wetlands and surrounding forest lands around Wocus Bay were owned by tribal members for many years and eventually sold to a private rancher in 1976. In 1979, a complicated deal was reached by the U.S. Fish and Wildlife Service to purchase the Wocus Bay tract. The Service acquired Wocus Bay, but the east side of the bay was logged in 1983 by a logging company that purchased timber harvest rights from the private landowner prior to the Service acquiring the lands. Fortunately, the Service was able to designate 100,000 board feet of the sale area as save trees (trees that would not be harvested). The logging at Wocus Bay was, at the time, the only means by which the Service was able to obtain the land in Wocus Bay. In 1984, more than 200 lodgepole and ponderosa pine seedlings per acre were planted in the area that had been logged in 1983. Another 100 trees were planted by volunteers in 1985.

In the 1980s and early 1990s, pine beetle infestations were noted to the east of the Refuge, but no outbreaks occurred in the Refuge timber stands. Today, there is significant evidence of pine beetle infestations flanking the areas south of Silver Lake Highway.

The majority of the north end of the current refuge (from Military Crossing Road to the north boundary) was not acquired until 1989–1990, and some of this area was not acquired until 1998. This land had been under private ownership prior to acquisition. All of this land was used for decades for private cattle ranching and showed signs of extensive grazing pressure (USFWS 1959–1998). This land also shows evidence of extensive timber extraction by previous landowners.

In 2001, approximately 30 acres of small diameter lodgepole pines were removed by chainsaw from the edge of the Abraham Flat meadow system. Several larger lodgepole pines within the interior of the meadow were also removed. All of these trees showed evidence of having encroached into the Abraham Flat Meadow as a result of fire exclusion. Small diameter trees have also been removed from the understory in a 30-acre parcel immediately surrounding the Refuge headquarters compound. This removal was conducted by Service fire crews and a contractor. Most of the removed trees were piled and burned; however, a portion were cut into firewood lengths and burned as firewood by Service personnel at the Refuge headquarters.

Adjacent national forest and private lands have been managed to varying degrees, and information on historic logging surrounding the Refuge can be obtained from the Chemult and Chiloquin USFS District offices. Much of the land directly west of the marsh and north of Military Crossing has been managed as an industrial tree farm. Crown Pacific formerly owned this land, but they filed bankruptcy in 2004, and the land is now owned by Cascade Timberlands, LLC. This company has hired Olympic Resource Management, LLC, to manage the land.

Management of the forested habitat (approximately 2,000 acres) within the Refuge has been minimal and essentially limited to removing small numbers of young pine trees from former grass or sedge meadows. The lack of management of this habitat is the result of several factors: (1) a majority of the forested lands were not acquired until after 1990; (2) historic harvest levels on lands prior to Refuge acquisition often precluded immediate effective management of some stands; (3) Refuge

management focused available staff resources on other priorities, such as protection and restoration of riparian and wetland habitats; and (4) procedural administrative planning required to implement active forest management practices had not been completed.

Efforts to initiate active management of forested lands was started in 2001 and resulted in the development and final approval of the 2003 Klamath Marsh National Wildlife Refuge Fire Hazard Reduction and Wildlife Habitat Enhancement Project Environmental Assessment.

Fire plays an important role in maintaining healthy ponderosa pine and lodgepole pine forest communities in the northwest. Wildfires in ponderosa pine communities historically consumed grassy and other herbaceous vegetation on the forest floor, along with the dead branches, needles, fallen trees, and seedlings, while leaving the mature trees largely unharmed. The result was a forest community that was rather open and park-like, with very few young trees or seedlings growing in the forest floor understory. Lodgepole pine forest communities are characterized by infrequent but high severity fires, often resulting in stand replacement where a majority of the forest stand is killed. While specific research on the fire regime of the Refuge has not been conducted, fire regimes of the Williamson River Watershed have been established and are applicable to the forested lands on the Refuge. The fire regime of ponderosa pine is characterized by frequent, low-severity fires with a fire return interval of 5–15 years. The fire regimes of lodgepole pine are characterized by variable frequency, mixed-severity fires and infrequent, high-severity fires, depending on the location of the pine stands. Those stands located in riparian areas or in savannas have the former fire regime with a fire return interval of 15–50 years. The remainder of the lodgepole pine stands in the watershed have the latter fire regime with a fire return interval of 50–150 years.

Beginning around 1920, wildfires were actively suppressed in and around the Refuge. The result is ponderosa pine stands that have grown up in the absence of natural, low-severity, frequent fires for many decades. Without frequent fires to kill seedlings, many seedlings have survived to form dense stands of trees that crowd and interfere with the growth of other trees and understory shrubs, forbes and grasses. Tree densities within ponderosa pine stands of the Refuge range from 200–800 stems per acre (average 500 stems per acre), with an average basal area of 150 square feet per acre (Kilbury 2002). High fuel loads in these overly dense stands can also be attributed to the dead woody material on the forest floor, along with masses of often intertwined dead branches still on the tree trunks. These "ladder fuels" can help flames climb from the forest floor up to the crowns of the trees. Although still alive and somewhat naturally moist, conifer crowns can ignite and burn intensely under the right conditions. When trees are close together, as they are in many parts of the Refuge, fire in the tree crowns can spread rapidly from tree to tree. In forest communities where the historic role of fire has been altered, and where high fire hazard exists, high-severity wildfires can occur that often result in stand replacement. The Refuge proposed in the 2003 EA to reduce surface fuels in ponderosa pine stands to approximately 6–10 tons per acre. The lodgepole pine stands in the Refuge have excessive woody debris on the ground in the wake of fire suppression efforts. As with the ponderosa pine, these surface fuels contribute to the high fire hazard in the lodgepole pine stands. Average estimates of surface fuels in the stands are 22 tons per acre (Goheen 2002).

Future Management

The Service completed an environmental assessment (EA) for a fire hazard and forest wildlife enhancement project within the forested portions of the Refuge in 2003 that essentially represents the Refuge's management plan for forested habitats. The proposed project and associated EA was developed in cooperation with the Klamath Tribes, U.S. Forest Service, Oregon Department of Fish and Wildlife, and the Klamath Bird Observatory. This combination of project partners provided expertise in forest wildlife and their habitats, silvicultural expertise, forest health, tribal subsistence needs, and archeology.

Previous logging of Refuge lands (while in private ownership) and the proliferation of small diameter trees because of natural fire regime alterations

resulted in both degradation of important wildlife habitats and an accumulation of forest fuels that threatened neighboring private lands and the forest itself. The 2003 EA used the Partners in Flight East Slope Cascade Mountains Bird Conservation Plan (Altman 2000) and the wildlife expertise of other partners to identify key wildlife species and habitats that occurred on the Refuge. Key habitats were identified as those that could contribute to wildlife conservation in the larger landscape and were assessed in terms of management actions required to bring them to the desired future condition. Habitats identified included old-growth ponderosa pine, old-growth lodgepole pine, meadow and forest meadow complexes, and large aspen trees and snags. A more detailed description of key habitats and objectives, focal bird species, desired future conditions, and restoration and enhancement options can be found in Appendix M.

3.19.6 Refuge Management Economic Activities

Klamath Marsh National Wildlife Refuge engages in two Refuge management economic activities: grazing and haying. In selected circumstances and when properly managed, livestock grazing and haying can be valuable and cost-effective tools to help a Refuge achieve its wildlife and habitat goals and objectives. Examples include short-term, high-intensity grazing at a particular time of year to help control invasive plants and thereby give native species a more competitive advantage; or using grazing or haying to remove tall or decadent grasses, sedges, and/or bulrush and provide short, vigorous wetland/upland fields for migrating or nesting geese, sandhill cranes, and other migratory birds. These management practices help refuges achieve refuge purpose(s), goals, and objectives; and provide permittees with a financial return (in the form of forage). Grazing and haying in these cases are considered "refuge management economic activities."

For a variety of reasons, grazing and haying are often managed differently on national wildlife refuges than on other public lands. Service policy favors, "…management that restores or mimics natural ecosystem processes or functions to achieve refuge purpose(s)" (601 FW 3.7 E). In selected circumstances, grazing and haying may serve in that role by simulating grazing by large, native herbivores or by the removal of vegetation caused by fire. By their nature, however, mechanized haying and grazing by domestic livestock are not natural processes, and these practices can also cause environmental harm. Examples include reducing habitat quantity (e.g., through grazing desirable, non-target plant species); degrading habitat quality (e.g., through deposition of feces in or adjacent to waterways); facilitating introduction of alien, including invasive species (e.g., through seeds carried in hair, on vehicles and farm machinery, and in feces); and disturbing or competing with wildlife (e.g., through presence of permittees and vehicles and/or farm machinery, and grazing plants that also provide forage for wildlife).

Grazing and haying programs may be implemented only when they benefit or are not harmful to wildlife and wildlife habitat, and the frequency of these programs will vary according to productivity and condition of the site and should be held to the minimum necessary to achieve the desired results. The primary objective of grazing or haying on refuge lands is to manage vegetation to maintain or increase its value to wildlife at minimum cost to the government. Except in unusual circumstances, grazing and haying on national wildlife refuges are privileges granted by the Service, not legal rights which can be bought, sold, or otherwise transferred among private parties.

The amount of grazing and haying occurring on Klamath Marsh Refuge to meet habitat objectives has varied over the years relative to weather, moisture, staffing, regulatory and policy changes, prescribed fire practices, grasshopper outbreaks, and funding. The use of prescribed fires, another primary vegetation management tool, was first completed on the Refuge in 1991 and was conducted almost annually in different units until 1998. Since 1998, prescribed fires have been used sporadically. The reduced use of prescribed fire is likely the result of changes in fire staffing, funding, weather or moisture patterns, and administrative and/or policy requirements for conducting burns (Figure 3-18).

The following sections provide a summary of the haying and grazing programs

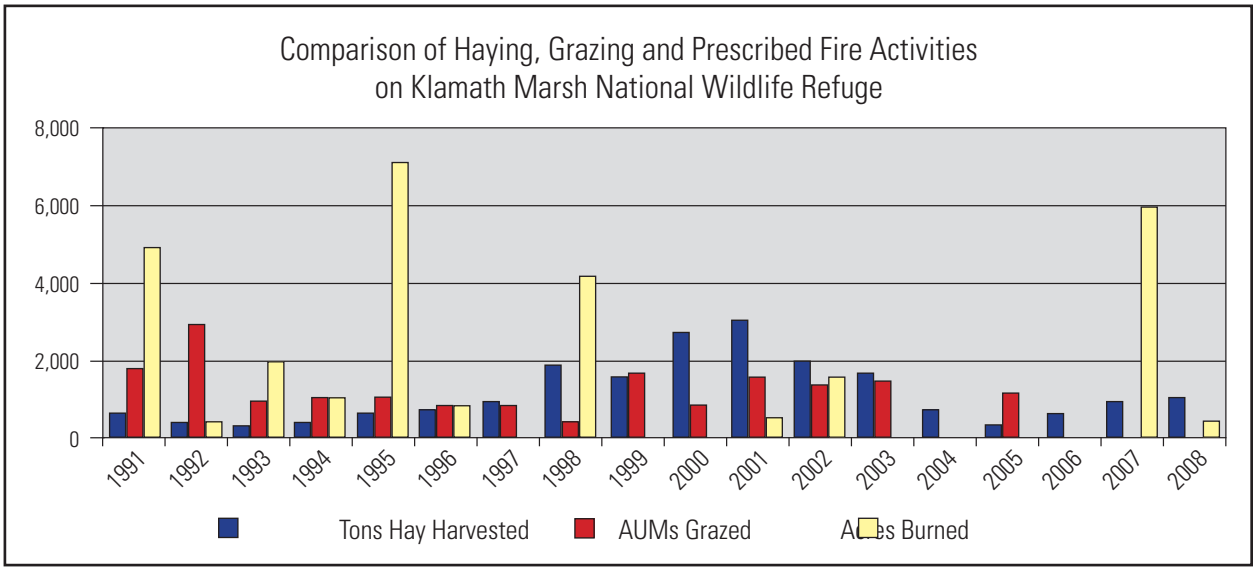


Figure 3-18. Amounts hayed, prescribed burned, or grazed on Klamath Marsh National Wildlife Refuge, Chloquin, OR (1991-2008)

on Klamath Marsh Refuge.

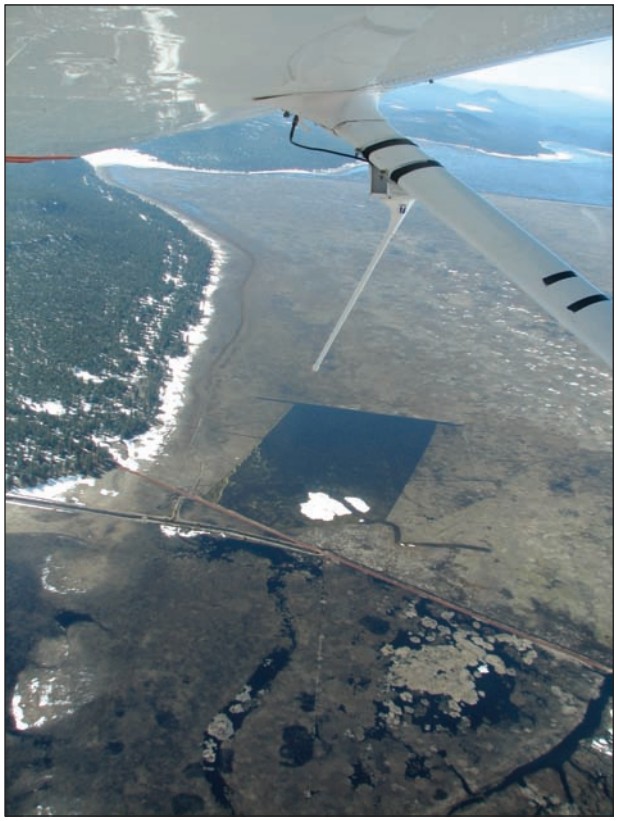
Haying

Since the Refuge was established in 1958, and many years prior to its establishment, haying has been conducted at various locations within the Refuge's acquisition boundary. Under private ownership, and prior to Refuge ownership, lands were hayed annually by ranchers for the purpose of acquiring hay to use as feed for livestock. Under Refuge ownership and management, lands are now hayed as needed for the express purpose of improving habitat for wildlife—most specifically, for migratory birds. Haying is one of several important tools that a land manager can use to manipulate vegetation to meet specific vegetative and habitat goals.

Haying supports the purposes of Klamath Marsh National Wildlife Refuge and the National Wildlife Refuge System by maintaining and/or improving sedge wetlands and grass communities for the benefit of migratory bird species and other wildlife. Only certain regions of the Refuge are suitable for haying operations based on vegetation, moisture, access, and terrain. Figure 3-19 shows Refuge management units where haying has occurred since 1990. These areas are dominated by grasses or sedge/grass type habitats, are often dry enough in fall to hay, and are level enough to accommodate haying equipment. Haying is conducted periodically in these units with the goal of meeting Refuge habitat objectives for focal species like greater sandhill crane, yellow rail, and a variety of migrating waterbirds (geese, waterfowl, shore birds, etc.).

The anticipated biological benefits to haying are as follows.

- Haying native grass/sedge species reduces above-ground litter, which promotes soil warming and the creation of a more favorable substrate for early invertebrate production and thus improves foraging habitat for invertebrate hungry species like migrating waterfowl, shorebirds, rails, and greater sandhill cranes.
- Haying removes decadent/dead vegetation, thus revitalizing plant growth and reducing potential encroachment of invasive species.
- Areas that are hayed are often flooded in spring or fall, providing open shallow water foraging areas that are adjacent to or interspersed with emergent vegetation. The mix of open water and emergent vegetation also creates excellent breeding habitat for waterbirds.



Spring aerial photo showing open water habitat created by haying operations (square block). Klamath Marsh Refuge 2008 Military Crossing Road area.

Typical vegetation conditions prior to haying. Areas are often choked with dense stands of sedges and grasses, offering no open water habitat throughout the year. Proper selection and rotation of haying areas on the Refuge allows managers to improve the availability of short emergent open water habitat for migratory birds and maintain healthy vegetation stands.

- Hayed areas provide younger and more palatable vegetative growth for spring migrants to feed on, such as white-fronted geese, pintails, mallards, Canada geese, cranes, etc. Big game also benefit from haying/grazing practices.

Hayed or mowed sites that provide short grass/sedge vegetation adjacent to permanent water can enhance potential breeding sites for the Oregon spotted frog (a Federal candidate species) by improving travel corridors (creating shorter vegetation) and facilitating warmer water temperatures in breeding areas (decreasing shading by vegetation). In contrast, haying may also affect residual nesting cover for some species, such as the yellow rail and greater sandhill crane. For example, yellow rail nests are often associated with sedge/grass areas that have a certain percentage of decadent vegetation. Care must be taken when selecting haying sites and acreages to balance the long- and short-term benefits and impacts to these species. Without the periodic disturbance caused by haying, grazing, or fire, the health and acreage of sedge and grassland areas would likely decline due to encroachment of these areas by willows, invasive plants, or pines.

In some instances, haying is implemented to create fire breaks for prescribed fire projects. Utilizing a haying permittee to complete this type of work can greatly reduce Refuge expenses, staff time, and equipment required to prepare for burns.

The compatibility determination for haying (Appendix H) provides a more in-depth description of the positive and negative impacts affiliated with this management activity and outlines the stipulations required to make this use compatible with Refuge purposes.

The following narrative summarizes the history of

A variety of water birds utilizing the mosaic of open water and sedge/grass habitat created by haying operations. Klamath Marsh Refuge 2008 Wocus Bay Road.

haying on Refuge lands based on annual narrative reports and Refuge special use permit files.

General Overall History. Haying permits have been issued on the Refuge almost annually since the Refuge's establishment for the purpose of improving habitat for migratory birds (Figure 3-19, Figure 3-20). Figure 1-3 shows the history of Refuge land acquisition and is important to reference when reviewing the history of haying on Refuge lands. To evaluate the history of haying on the Refuge, the information was divided into two general time periods: pre-1990 and post-1990. The data was evaluated this way because the Refuge acquired a significant amount of land in 1990 (approximately 24,000 acres), which subsequently increased the management responsibilities and capabilities of the Refuge.

In reviewing historic data, it was discovered that much of the information was missing or unclear relative to how many acres were hayed and exactly where haying was completed. For example, special use permits may have listed four different hay management units that were available for haying by a permittee, but the actual acreage hayed within each unit was not determined in the field. Although a permit may have listed a unit as hayed, portions of the unit may not have been hayed due to issues with moisture, vegetation, or terrain. Furthermore, the names of hay units changed over time, and maps were not always created showing the locations of units over time. Records improved post-1991 but remained unclear relative to the actual acreage hayed for any given year. Since 2005, hayed areas have been (and continue to be) determined using GPS technology to provide exact location and acreage estimates. Variability in the amount hayed in a given year were related to meeting desired habitat objectives, weather, moisture, implementation of other management activities (burning programs, grazing programs), and administrative burdens.

The tons of hay harvested by year proved the most reliable index to the amount of hay harvested over time and thus was graphed to show general trends. The tons of hay harvested each year are based on average bale weights for a specific year. There is not a direct correlation between acres hayed and tons harvested, as vegetation density, type, and water content can greatly influence the weight of hay bales and the ultimate tonnage harvested per acre. As indicated in Figure 3-19, the Refuge management units where haying can occur are limited due to topography, accessibility, moisture, and vegetation types.

1958–1990. The history of haying during this period is shown in Figure 3-20. In 1989, only 16,400 acres of land had been acquired and were managed by the Refuge (Figure 1-3). The initiation date for the haying season on the Refuge during this time period was unspecified within narrative reports. Likely, haying was started in late July to early August when vegetation was dry enough for harvest. The acres hayed in any one year are estimated to

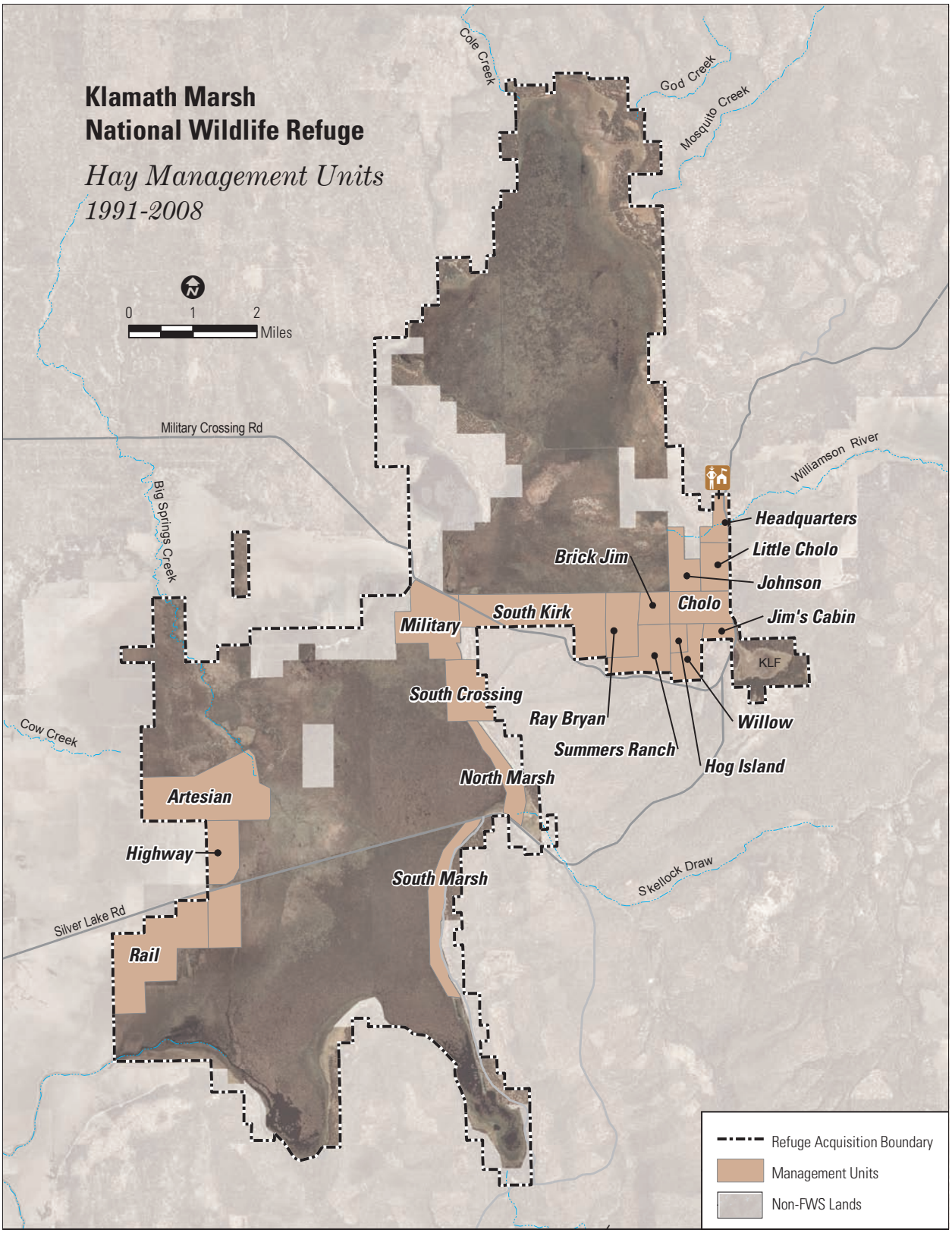


Figure 3-19. Klamath Marsh Refuge management units where haying has occurred, 1991-2008

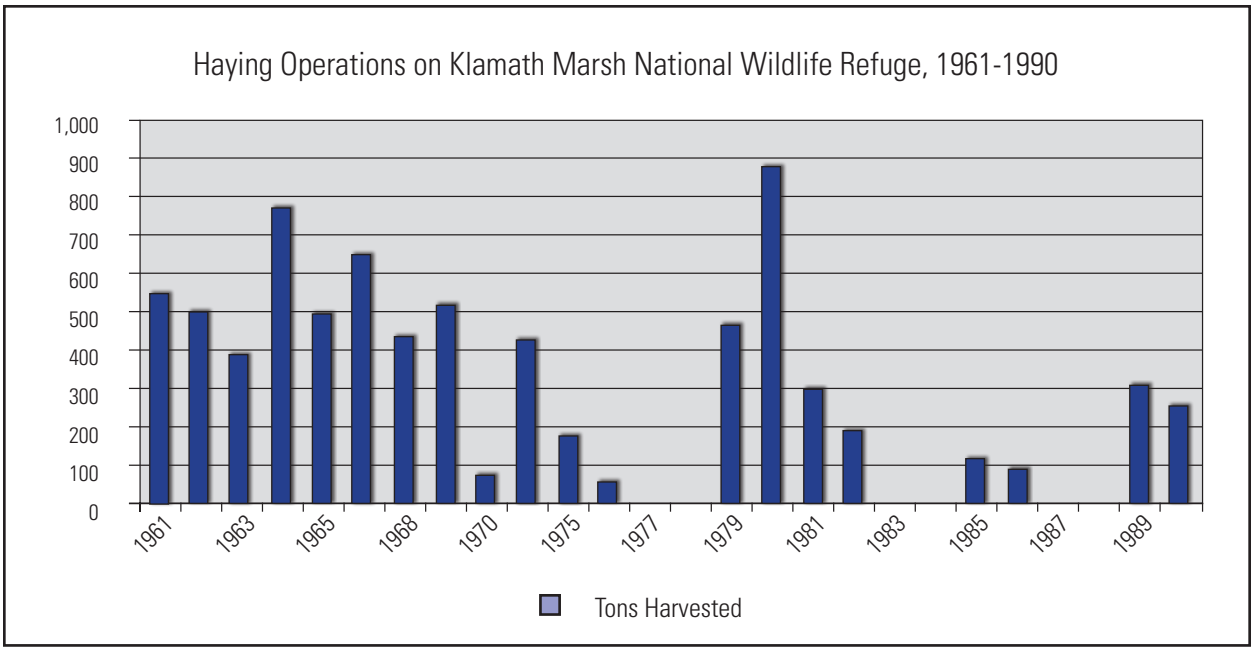


Figure 3-20. Amount of hay harvested annually on Klamath Marsh Refuge, Chiloquin, OR (1961-1990)

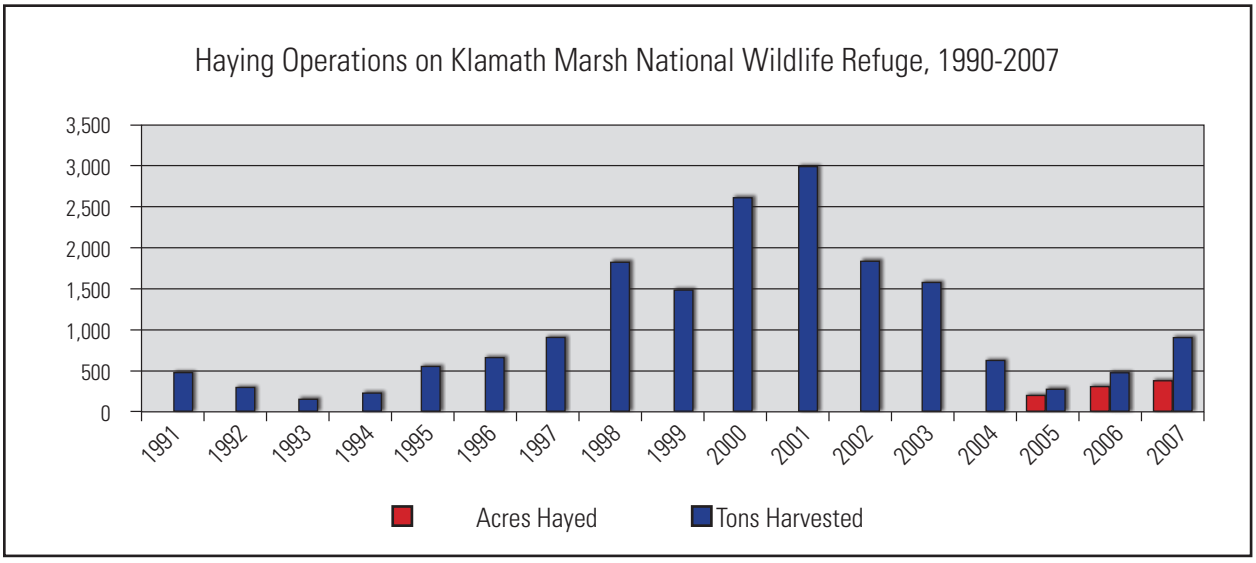


Figure 3-21. Amount of hay harvested annually on Klamath Marsh Refuge, 1991-2007

range from 0–700 acres (maximum of four percent of Refuge lands), while the total tons of hay harvested ranged from 0–880 (Figure 3-20).

1990–2007. The tons of hay harvested per year from 1990–2007 are shown in Figure 3-21. In 1989–1990, a significant portion of Refuge land was acquired (21,364 acres), with a total of 40,885 acres acquired within the acquisition boundary by 2000. Detailed documentation about haying permits improved after 1990, when a Refuge manager was stationed on site. Starting in 2005, GPS units were used to document total acreage hayed and actual haying locations (Figure 3-21 and Figure 3-22). Based on permit and narrative information, estimates of acreage hayed from 1991–1997 ranged from 300–700 acres per year. From 1989–2003, the acreage hayed may have ranged from 1,000–3,000 acres per year (maximum of seven percent of Refuge land hayed).

The initiation of haying operations during this time ranged from mid-July to September 10. Permits issued since 2002 required permittees to start after August 1 to reduce disturbances to wildlife. Permittees are generally done harvesting hay by late September to early October. Since 2005, the total acreage hayed per year has been restricted to 500 acres or less, and haying may not be initiated until after August 10.

Grazing

Grazing, like haying, has been conducted on Refuge lands for many years prior to and after Refuge establishment. Similar to haying, grazing can be used as an effective management tool under the right conditions to achieve Refuge objectives. The rationale for grazing is as a treatment to open up dense stands of vegetation, set back marsh plant succession (convert from a late successional to an early successional plant community), remove or reduce invasive plants, and provide improved foraging conditions for spring and fall migrating waterfowl, shorebirds, and wading birds. With the right timing and amount of grazing pressure, plants such as reed canary grass, river bulrush, and cattails can be significantly reduced in density. Surveys have indicated that foraging sandhill cranes, along with numerous other waterbirds, use treated areas extensively during the spring and summer (USFWS 1958-1994). Rocky Mountain elk also prefer to utilize areas opened up by grazing or haying operations for foraging. A more in-depth description of the positive and negative impacts of this activity are presented in the grazing compatibility determination (Appendix H), along with the stipulations necessary for this activity to be compatible with Refuge purposes.

The determination to graze and where to graze for a given year is related to meeting desired habitat objectives, wetland moisture conditions, implementation of other management activities (burning and haying programs), and administrative burdens. Permits for grazing are issued for one season, are based on a bid system per animal unit month (AUM), and consider the ability of a permittee to meet Refuge stipulations for grazing. Historically, many grazed areas were surrounded by permanent fences that were remnants of the former landowners. Most interior fencing has been removed on the Refuge to reduce maintenance requirements, remove travel obstructions to wildlife, and improve the overall view shed for visitors. Grazing permittees are now required to install and remove electric fence on an annual basis at desired grazing locations. The number of permits issued per year, the timing and duration of grazing, and the locations of grazing units are determined on a year-by-year basis and are directly linked to habitat objectives for the Refuge.

General History. Grazing special use permits have been issued on the Refuge most years since Refuge establishment (Figure 3-23, Figure 3-24). Figure 1-3 shows the history of Refuge land acquisition and is important to reference when reviewing the history of grazing on Refuge lands. A major portion of lands currently owned by the Refuge were not under Refuge management until 1990 (see Section 1.4.3). Based on historical Refuge files and annual narratives, the evaluation of grazing pressure on the Refuge is best represented by the number of AUMs permitted. The locations of grazing areas and actual acreages grazed were

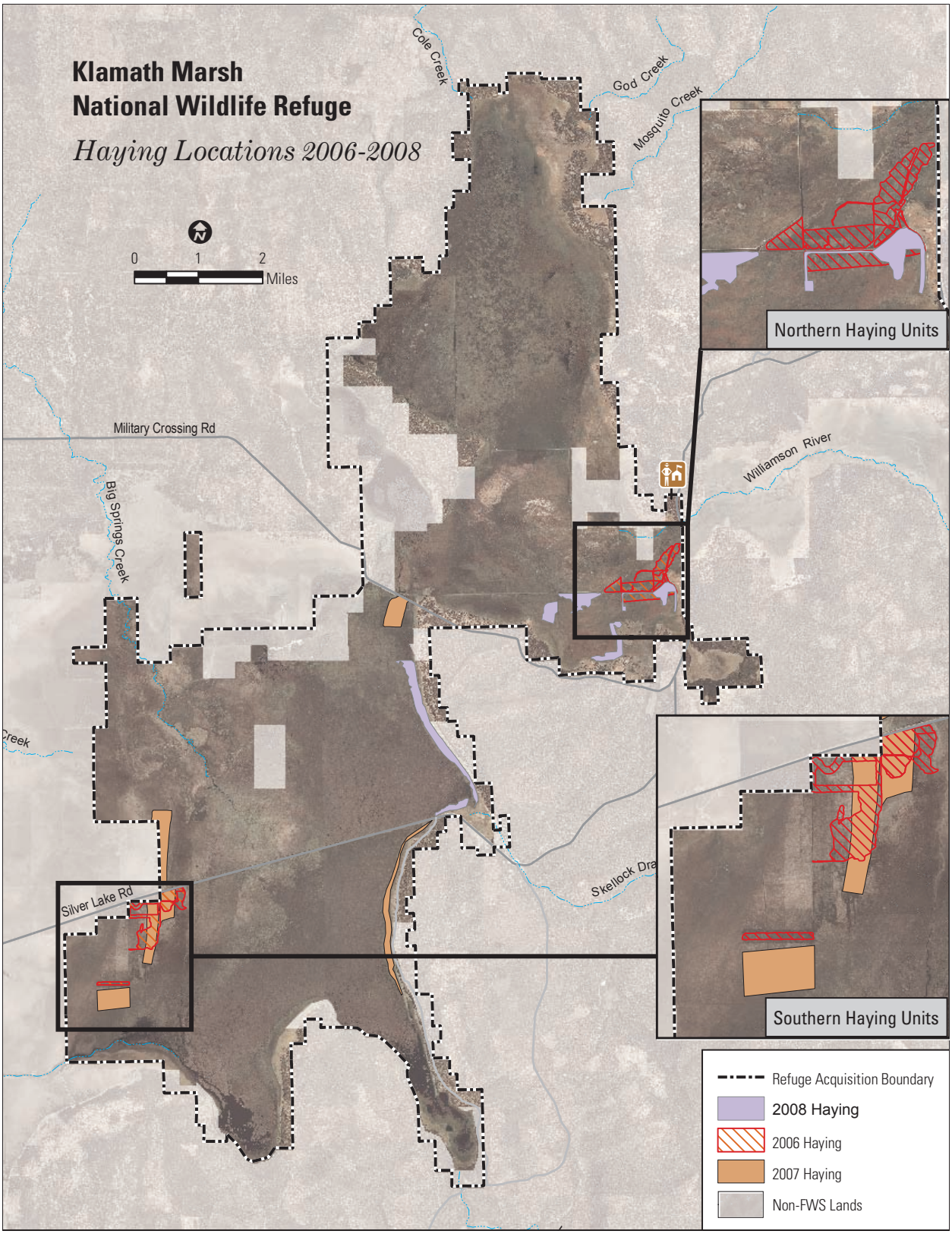


Figure 3-22. Klamath Marsh Refuge haying locations, 2006-2008

Typical pre-grazing vegetation conditions, showing dense stands of sedge and bulrush. There is no open water habitat available for migratory birds to use for resting, foraging, or nesting.

Typical post-grazing vegetation conditions. Proper timing and duration of grazing practices enable managers to create more diverse and healthy habitats that contain a mosaic of open water and vegetation. These habitat areas are highly desirable to a variety of migratory birds and other wildlife species.

not consistently documented over time. The evaluation of grazing was evaluated as pre-1990 and post-1990 because of the substantial changes in Refuge land ownership that occurred in 1990.

1958–1990. From 1958–1964, grazing of Refuge owned lands was basically unregulated due to the absence of fences and a lack of Refuge staff to enforce permits or Refuge boundaries. Hundreds of cows trespassed onto Refuge lands because few fences existed to exclude cattle. After 1964, additional fencing was slowly installed and other fences repaired. These fencing improvements helped regulate trespass cattle, and by 1966, habitat conditions for wildlife started to improve. Fluctuations in the number of AUMs grazed likely reflected changes in marsh productivity and moisture conditions. The period when no grazing occurred (1983–1987) was related primarily to major fence construction projects to control livestock trespass between Refuge and adjacent private lands.

Post-1990. In 1989–1990, two major land acquisitions increased the Refuge from 16,374 acres to 37,738 acres. Approximately 21,364 acres were added to the Refuge in 1989–1990. With the acquisition came an agreement to maintain the existing grazing allotments on these lands through 1990. Over 20,000 acres of the lands added in 1989 had a history of intensive cattle grazing, with a grazing season that often began on May 1 and ended December 1. Cattle normally started grazing in the better drained sites first, with intensive grazing pressure, and then were moved to more poorly drained areas later in the summer. The carrying capacity of the acquired pastures was relatively high and could be increased with flood irrigation.

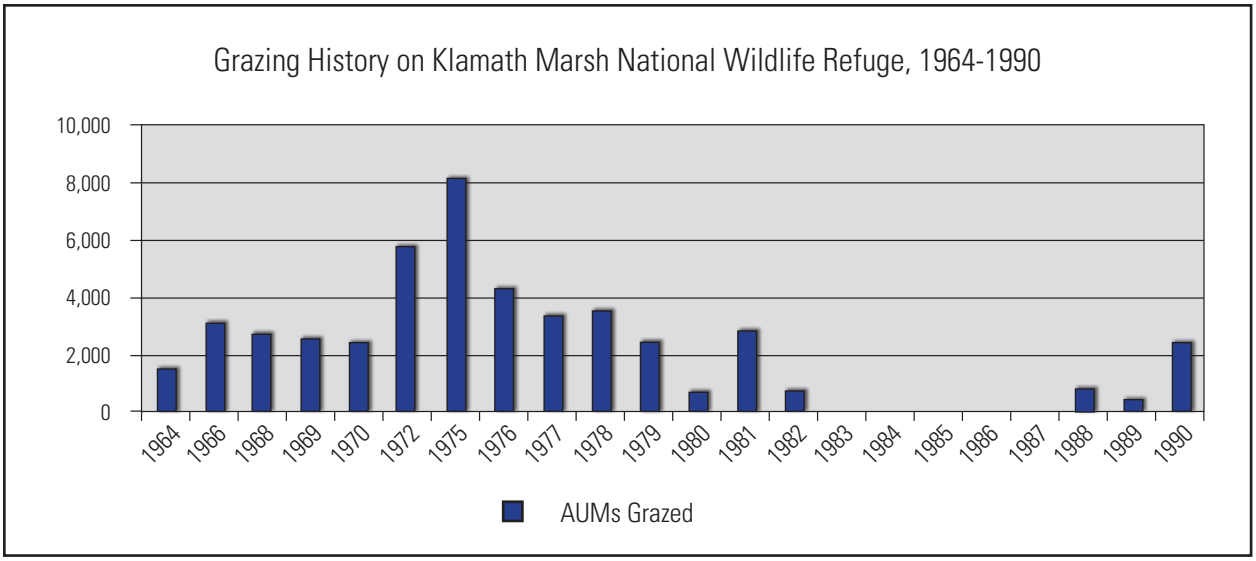


Figure 3-23. Grazing amounts on Klamath Marsh National Wildlife Refuge, Chiloquin, OR 1964-1990. The 1990 data does not reflect grazing AUMs that occurred by a private landowner on 16,000 acres of Refuge land as allowed by the U.S. Fish and Wildlife Service purchase contract.

Table 3-8. Vegetation occurring in grazed pastures within newly acquired lands on Klamath Marsh Refuge, 1989 (USFWS 1958-1998).

Common Name	Scientific Name
Nebraska Sedge	*Carex nebraskenis*
Meadow Sedge	*Carex praegracilis*
Beaked Sedge	*Carex rostrada*
Common Spikrush	*Elocharis machrostachya*
Meadow Rush	*Juncus nevadensis*
Hardstem Bulrush	*Scirpus acutus*
Reed Grass	*Calamagostis inexpansa*
Swamp Bluegrass	*Poa* Sp.
Tufted Hairgrass	*Deschampsia caespitosa*
Squirrel Tail	*Sitanion hystrix*
Cheat grass	*Bromus tectorum*

Stocking rates were historically one cow per three acres. Vegetation species documented in the 1989 land acquisition are listed in Table 3-8.

In 1991, Refuge management could finally take control of grazing on the lands acquired in 1989. Subsequently, grazing was removed from all timber and riparian habitat acquired in 1989 to provide the lands a much-needed rest. Overall, grazing was reduced on the 1989 acquired lands by 97 percent compared with 1990 (Table 3-9). "Resting" the lands enabled the Refuge to use the existing water management capabilities to start restoration of wetlands within the area.

Since 1991, grazing has continued via special use permits within certain Refuge management units containing bulrush, cattail, sedge, and grass habitats (Figure 3-25). The initiation of the grazing season post-1990 has primarily occurred after August 1 to reduce impacts to nesting birds and to allow grazing of seasonal wetlands that are often dry by late summer. During most years, cattle were removed from the Refuge by October 30. Grazing was not conducted in 2003–2004

Table 3-9. Comparison of grazing pressure, 1990–1991, Klamath Marsh National Wildlife Refuge, Chiloquin, OR.

Unit	Acres	AUMS 1990	AUMS 1991
Three Creeks	5,700	15,000	0
Spring	1,900	5,000	0
Kirk	3,600	6,500	0
Kittredge	2,200	5,000	0
Abraham	600	500	0
Loosely	4,500	13,500	0
North Marsh	7,800	2,200	908
Hay	2,900	1,500	837
South Marsh	8,600	0	0
TOTAL	**37,800**	**49,200**	**1,745**

1989 Photo showing the lands within the north portion of the Refuge (Three Creeks Unit). These areas were grazed every summer for many years. This type of overgrazing creates undesirable habitat conditions for wildlife.

because of an outbreak of clearwinged grasshoppers that seriously reduced much of the vegetation in the proposed grazing units. Grazing has not been completed since 2005 because the Refuge compatibility determination for this use expired after 2005. Refuge management decided to postpone future grazing until a revised grazing compatibility determination was completed as part of the final Comprehensive Conservation Plan.

Monitoring Programs for Haying and Grazing Operations

Monitoring of impacts or benefits to wildlife as the result of haying and grazing have been observational in nature. In general, areas that have been grazed or hayed have provided good to excellent spring migration habitat and summer nesting areas (general observations by Refuge Complex biologists, Refuge staff and from Refuge annual narrative documents USDI, USFWS 1958–1998). The removal of dead or decadent grass material and the creation of short stubble vegetation can be beneficial to some plant species and certain wildlife species. Grazed and hayed areas, if flooded in spring or fall, also provide valuable open water habitat in which a diversity of waterbirds feed and rest. Areas of open water have significantly declined within the Refuge during the past 150 years due to changes in hydrology, land use practices, and plant successional patterns. Grazing, along with burning, mowing, and haying, remain the primary tools for attempting to achieve emergent wetland objectives of maintaining a 50:50 ratio of emergent and open water wetlands. Future wildlife and plant responses need to be qualitatively and quantitatively documented to effectively evaluate if we are meeting Refuge objectives and to allow for implementation of an effective adaptive management program.

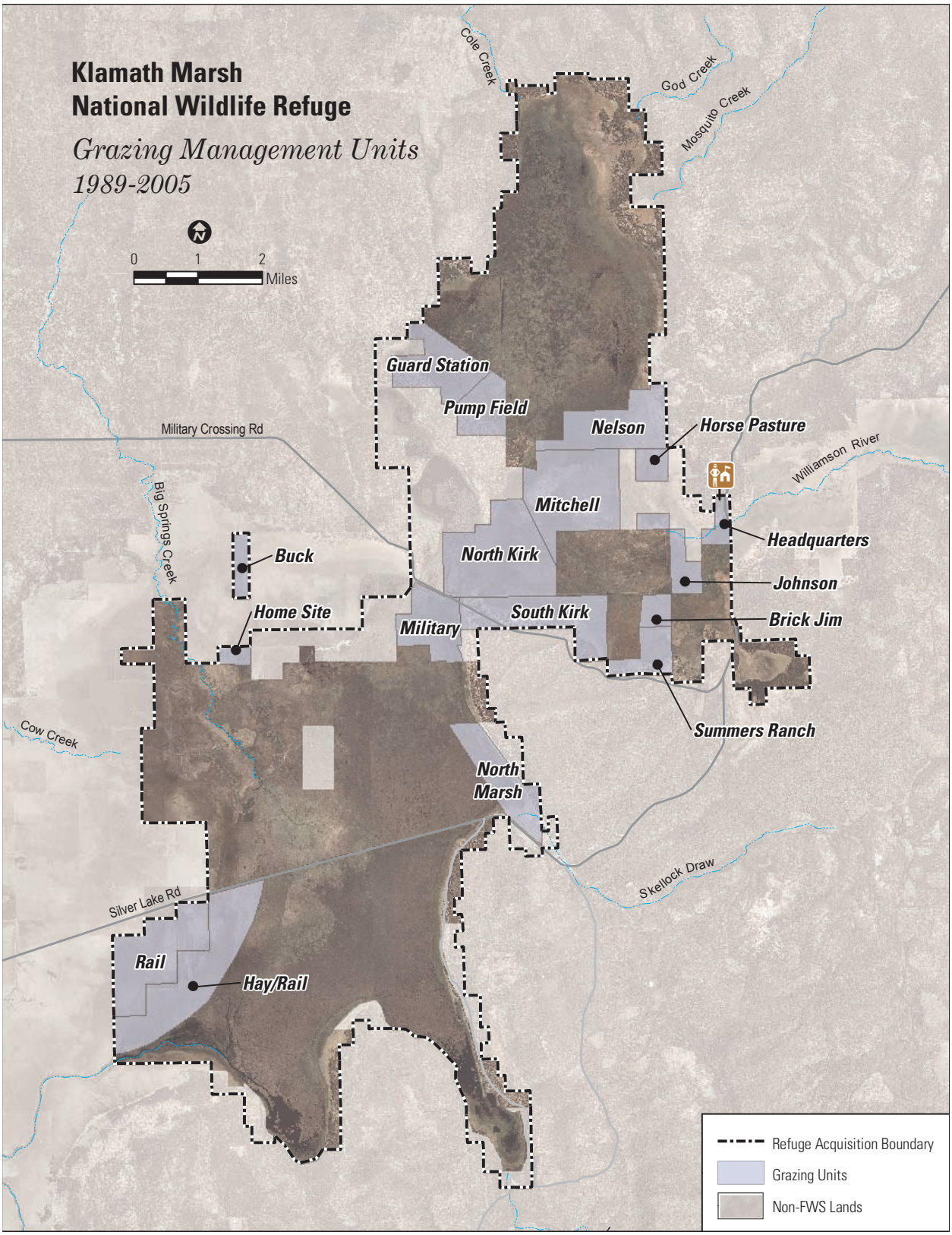


Figure 3-24. Klamath Marsh Refuge management units that have been grazed between 1989-2005

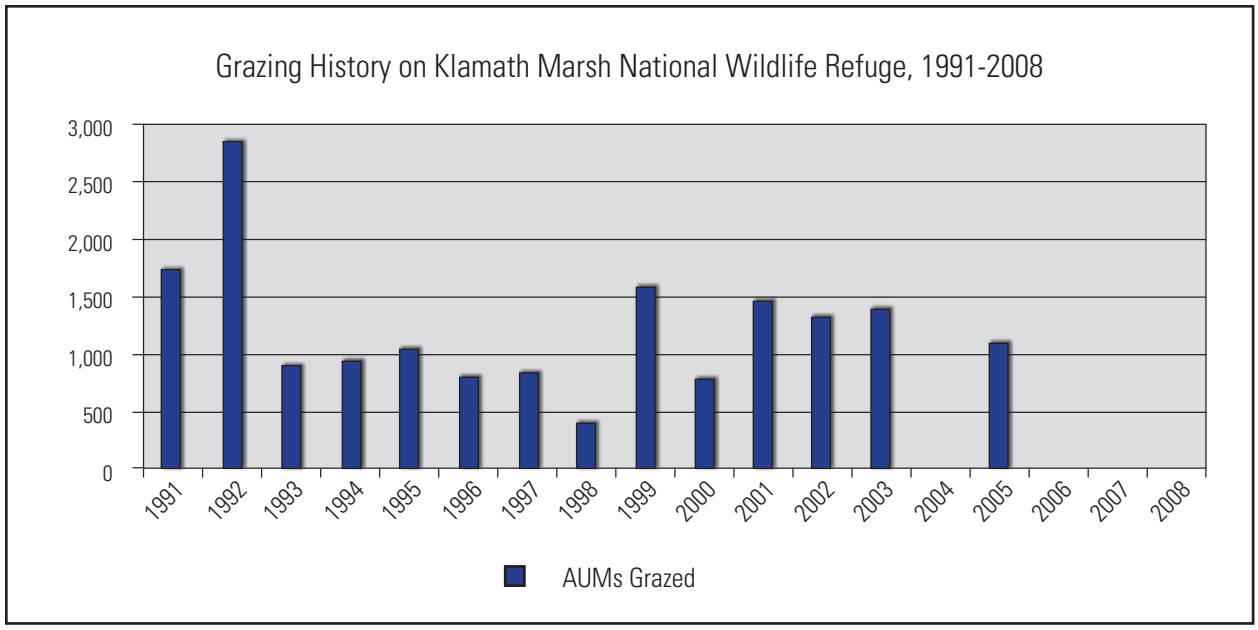


Figure 3-25. Acres grazed on Klamath Marsh National Wildlife Refuge, Chiloquin, OR, 1991-2008

Chapter 4. Management Direction

4.1 Introduction

The Service's priorities for refuge management derive from individual refuge purpose(s), the Refuge System mission, laws that specify Service trust resources, and the mandate to maintain the biological integrity, diversity, and environmental health of all refuges. Management on each refuge should first and foremost address the individual refuge purpose. Purposes are the essential objective of our refuge stewardship. They are the legislative, legal, and administrative foundations for administration and management of a unit of the National Wildlife Refuge System. This includes establishment of goals and objectives and authorization of public uses, which must be shown to be compatible with the refuge purpose(s) before they are allowed.

Service trust species are designated by various statutes governing the Service, as well as treaties that the Service is charged with implementing. These trust species include migratory birds, interjurisdictional fish, marine mammals, and federally listed threatened and endangered species. Although refuge purposes are the first and highest obligation, management for trust species, when appropriate, is a priority for management on a refuge (601 FW 1.9B). Furthermore, management for trust species directly supports the National Wildlife Refuge System mission.

An additional directive to be followed while achieving refuge purposes and the National Wildlife Refuge System mission is that related to biological integrity, diversity, and environmental health (BIDEH). This requires that we consider and protect the broad spectrum of native fish, wildlife, plant, and habitat resources found on a refuge: "In administering the [NWRS], the Secretary shall… ensure that the biological integrity, diversity, and environmental health of the [NWRS] are maintained for the benefit of present and future generations of Americans…" (Refuge Improvement Act, Section 4(a)(4)(B). The Klamath Marsh Refuge, in conjunction with other public lands and waters, provides a biological safety net for native species, trust resources, and state and Federal listed species, which offsets the historic and continued loss of habitats within the ecosystem.

Public uses are allowed on refuges only if they are determined to be appropriate and compatible with the purposes of a refuge. The National Wildlife Refuge System Improvement Act identifies six priority wildlife-dependent public uses, all of which are supported in this plan: hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation. These six priority wildlife-dependent public uses will be provided at a level that is feasible and compatible.

The following sections contain a summary of the proposed action (preferred alternative) and its associated goals, objectives, and strategies that will define the management direction of Klamath Marsh Refuge for the next 15 years.

4.2 Definitions of Key Terms

One of the most important parts of the Comprehensive Conservation Plan (Plan) process for all refuges in the National Wildlife Refuge System (Refuge System) is the development and refinement of each refuge's vision (See Section 1.5.1) and goals. In addition, as part of the Plan, objectives and strategies were developed to help Klamath Marsh Refuge achieve these goals. These key terms are defined in the following text.

> ***Goals:*** Broad statements of the desired future conditions for refuge resources. Refuge goals may or may not be feasible within the 15-year time frame of the Plan.

Objectives: Specific steps taken to achieve a goal. They are derived from goals and provide a foundation for determining strategies, monitoring Refuge accomplishments, and evaluating success. The number of objectives per goal will vary but should be those necessary to satisfy the goal. Where there are many objectives, an implementation schedule may be developed.

Rationale: Each objective should document the rationale for forming that objective. The degree of documentation will vary, but at a minimum should include logic, assumptions, and sources of information. This promotes informed debate on the objective's merits, provides continuity in management through staff turnover, and allows re-evaluation of the objective as new information becomes available.

Strategy: A specific action, tool, and technique, or a combination of actions, tools, and techniques used to meet an objective. Multiple strategies can be used to support an objective.

4.3 Organization

Each objective and each strategy are given a unique numeric code for easy reference. Objectives have a two-digit code (e.g., 1.1, 1.2, 2.1, 2.2). The first digit corresponds to the goal to which the objective applies. The second digit is sequential. Similarly, each strategy has a three-digit code (e.g., 1.1.1, 1.1.2, 2.1.1, 2.1.2). The first and second digits refer to the appropriate goal and objective, respectively. The third digit is sequential.

4.4 Summary of Selected Plan

Implementing the selected plan will result in Refuge lands being protected, maintained, restored, and enhanced for waterfowl, migratory birds, resident wildlife, shorebirds, wading and marsh birds, and threatened, endangered, and imperiled species. Increased wildlife and plant census and inventory activities will be initiated to develop the baseline biological information needed to implement, monitor, and evaluate management programs on the Refuge. All management actions will be directed towards achieving the purposes of the Refuge, while contributing to other state, regional, and national goals. The impacts of climate change will be considered in making future management decisions.

Under the selected plan, the Service will pursue restoration of the portions of the Williamson River and Big Spring Creek on the Refuge to their historic natural functioning conditions to the extent possible. Management of emergent marsh, meadows, ponderosa pine forest, and aspen habitats will be substantially improved via use of various tools (fire, haying, grazing, herbicides, etc.) to increase habitat value for migratory birds and other wildlife. Opportunities for all non-consumptive priority public uses will be expanded, and hunting and fishing programs will be considered for expansion after river restoration is completed. There will be a focus to increase cultural resources protection, and no units of the Refuge would be recommended for wilderness designation. The Service will also revise and update the MOU with the Klamath Tribes regarding subsistence hunting and gathering. Staffing and funding levels will need to increase to implement this alternative.

Figures 4.1 and 4.2 visually depict the habitat and visitor services actions in the selected plan. Additional details about the selected plan (Alternative B) can be found in the Environmental Assessment (Appendix G).

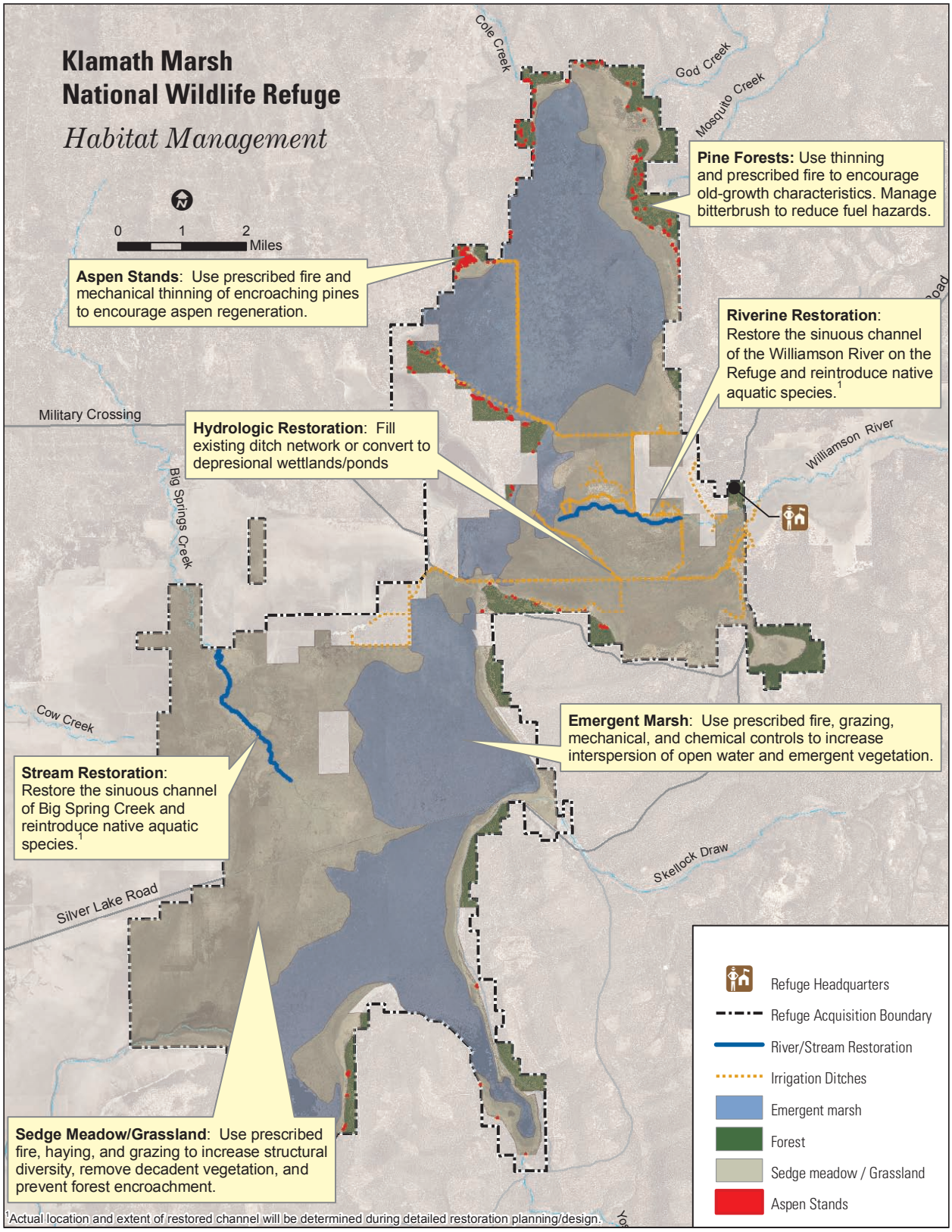


Figure 4-1. Proposed habitat management for Klamath Marsh Refuge

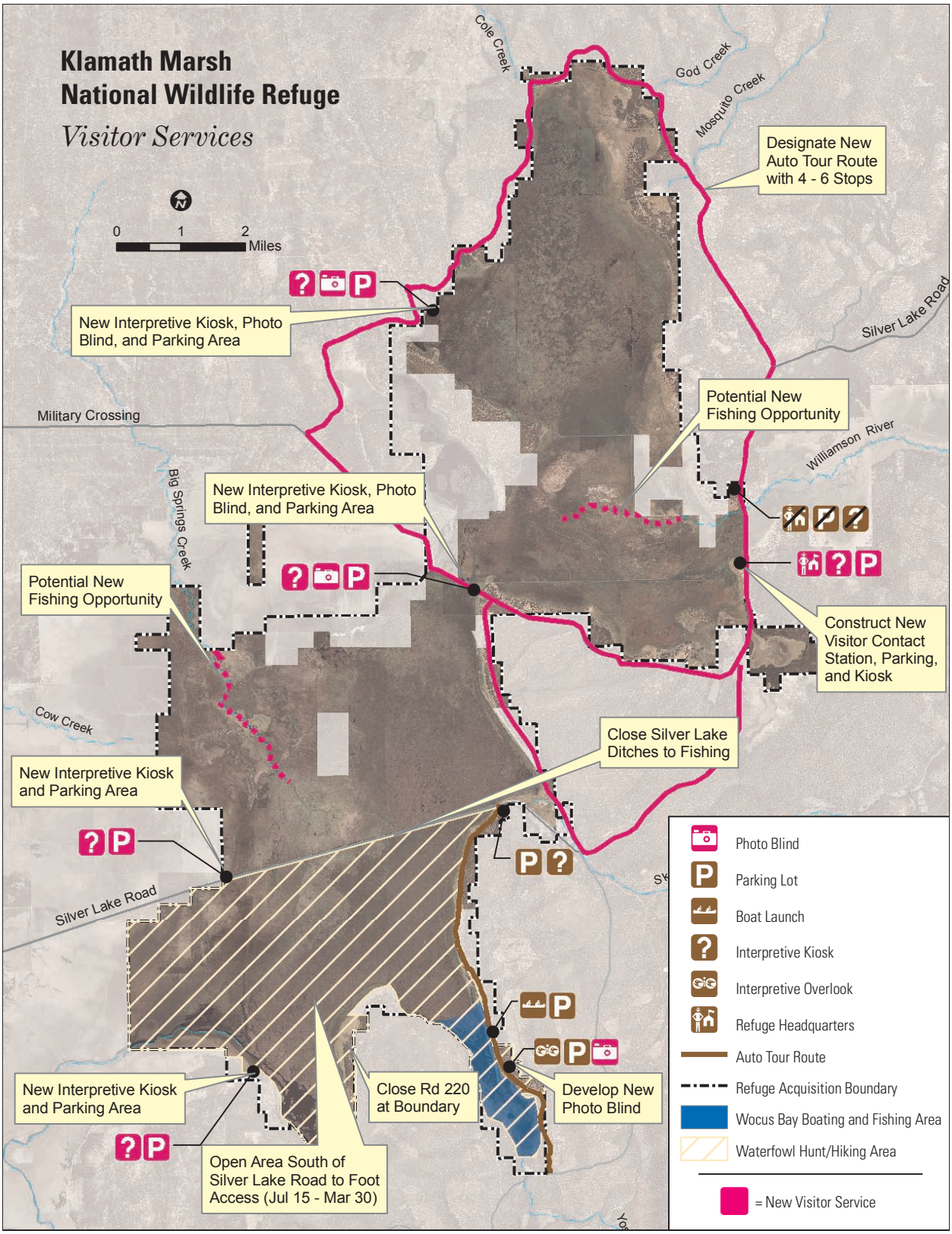


Figure 4-2. Proposed visitor services for Klamath Marsh Refuge

4.5 Refuge Goals, Objectives, and Strategies

Goal 1 Emergent Marsh

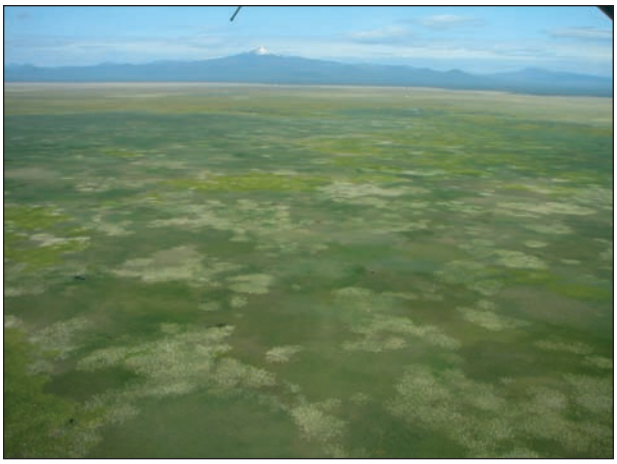
On Klamath Marsh National Wildlife Refuge (Klamath Marsh Refuge, Refuge), restore and maintain optimum interspersion and diversity of aquatic vegetation and open water within the emergent marsh community to support migrating and nesting waterbirds.

Objective 1.1 Restore Vegetation and Water Interspersion Ratio

By 2025, manage the 5,000 acres of emergent marsh north of Military Crossing Road for cover ratio (during spring) of 45 percent to 55 percent emergent vegetation (bulrush, cattails) to open water with a high degree of interspersion. Manage the 8,000 acres of emergent marsh south of Military Crossing Road for cover ratio (during spring) of 55 percent to 65 percent emergent vegetation (bulrush, cattails) to open water to provide breeding habitat for black terns and various waterfowl species, and foraging and loafing habitat for a diversity of spring migratory waterbirds. In addition, strive to provide 1,000–2,000 acres of deepwater habitat (4–6 foot depth) to support wocus.

Rationale: The emergent marsh and open water habitat on Klamath Marsh Refuge has changed significantly during the last 100–150 years. Photos of the marsh from 1902 and 1923 show extensive areas of wocus (yellow pond lily). An estimated 10,000 acres of continuous wocus once covered the Klamath Marsh, and historic maps from 1892 and 1905 indicate that extensive areas of open water once occurred within the marsh (Figure 3-1). Today, the areas once dominated by wocus or open water are primarily dominated by dense stands of bulrush. Currently, less than 500 acres of the Refuge is open water habitat.

The precise cause of vegetative changes in the marsh is not known. Channelization of the Williamson River in the early 1900s significantly altered marsh hydrology, allowing ranchers to dry up about 16,000 acres of wetland habitat north of Military Crossing Road. This allowed livestock to graze thousands more acres—even during abnormally wet years. Silver Lake and Military Crossing roads, built in the early 1900s, created new barriers to water and sediment flows, adding to changes in marsh hydrology. Other major factors that have influenced the Refuge's vegetation include:



Aerial photo showing the expansive monocultures of vegetation that now dominate many areas of the Refuge. These areas historically were interspersed with open water habitats but are now dominated by dense stands of bulrush and sedges. Photo taken north of Silver Lake Rd. 2007.

Aerial photo showing a desirable interspersion of open water habitat and emergent vegetation. Photo of Wocus Bay area 2007.

1. Increases in regional water demands (more wells affecting groundwater, and diversions resulting in less surface water in springs and rivers) (Mayer 2007)
2. Climate change (statistically significant decline in October–March precipitation, and a corresponding increase in mean annual temperature since the 1950s (Mayer 2007; Mayer 2008)
3. Fire exclusion (reduced fire frequency because of changes in land ownership, and wildfire and prescribed burning policy)
4. Long-term wetland peat accumulation (possibly 1–3 foot over the past 150 years) (Graham et. al. 2005)
5. Potential modifications to the Kirk Reef lava dam, which may have changed the overall capability of the marsh system to hold water (Klamath Tribes personal communications Joe Kirk, and other tribal members)

The emergent marsh on the Refuge provides important nesting and foraging habitat for black terns, a species of high concern in the Intermountain West Waterbird Conservation Plan (Ivey and Herziger 2005). Other species that utilize this habitat include American bittern, black-crowned night heron, white-faced ibis, great egret, greater sandhill crane, American avocet, greater and lesser yellowlegs, cinnamon teal, bufflehead, redhead, and marsh wrens. The dense monoculture of bulrush

Strategies:	
1.1.1	Use prescribed fire on a 4–5 year cycle within emergent marsh habitats to remove decadent vegetation and improve interspersion. Attempt to burn 2,500–3,500 acres per year of emergent marsh to achieve 4–5 year burn rotation. $S[1]
1.1.2	Supplement prescribed fire with grazing, mechanical (mowing or excavation), and chemical controls as needed to achieve habitat objectives.
1.1.3	Periodically monitor trends (five years) in vegetative cover and interspersion within the marsh using satellite images, aerial photos, and geographic information system (GIS) technology. $S
1.1.4	Conduct periodic surveys of black terns and other waterbird species to determine population trends on the Refuge and evaluate responses to habitat management treatments. Complete monitoring per Habitat and Wildlife Inventory and Monitoring step-sown management plans. S
1.1.5	Conduct fall and spring aerial waterfowl surveys to document use patterns, species, and relative abundance of waterfowl during migration periods and evaluate responses to habitat management treatments.
1.1.6	Hire a seasonal (0.5 FTE or full-time equivalent) maintenance worker during the spring, summer, and fall to assist with Klamath Marsh Refuge maintenance and habitat management needs. This strategy will help achieve all other Plan objectives. $
1.1.7	Hire one full-time prescribed fire specialist/assistant fire management officer/fire technician position (1 FTE) to plan and manage the increased prescribed fire/fuels program. This strategy will help achieve all other habitat objectives. $
1.1.8	Work with the State of Oregon Water Resources Department to ensure compliance with water priorities by all ground and surface water users in the Upper Williamson Watershed.
1.1.9	Encourage the use of appropriate management response (AMR) fire management options that allow for other options beyond strict fire suppression. Develop AMR plans within the Klamath Basin National Wildlife Refuge Complex Fire Management Plan that will allow for natural fire spread in appropriate areas. This strategy will help achieve all other habitat objectives.

1 Strategies followed by an "$" require additional funding to implement over and above the current Refuge budget. Strategies followed by an "S" required additional staff to implement.

that occurs on the Refuge has comparatively low value for birds and other wildlife. Waterfowl prefer marsh areas where open water and emergent vegetation are interspersed in approximately equal ratios (Fredrickson and Reid 1988). The black tern generally selects nest sites with a roughly equal ratio of open water to emergent vegetation that are highly interspersed (Shuford 1999).

Emergent marsh is labeled as a high priority habitat in the Coordinated Implementation Plan for Bird Conservation in Eastern Oregon (Eastern Oregon Working Group and Oregon Habitat Joint Venture 2005). Achievement of this objective for Klamath Marsh Refuge would contribute to achieving the Coordinated Bird Plan objective to "protect, restore, enhance, and maintain 175,000 acres of high quality emergent marsh habitats in priority areas" and would benefit black terns and numerous other waterbird species like those mentioned. Furthermore, the creation of deep water habitats to support re-establishment of wocus vegetation would benefit not only wildlife but also the cultural and subsistence needs of the Klamath Tribes.

Strategies for monitoring vegetation and wildlife under this objective are critical for characterizing potential effects of climate change over time and refining our adaptive management response.

Other objectives or strategies that will help meet this goal include:

- Goal 2, Objective 1: River, Creek, and Spring Restoration
- Goal 7, Objective 1: Invasive Species
- Goal 7, Objective 2: Land Protection/Acquisition, Cleanup, and Development
- Goal 7, Objective 3: Maintain the Integrity of the Refuge Boundary
- Goal 7, Objective 4: Monitor and Inventory Fish and Wildlife Populations and Their Habitats
- Goal 9, Objective 4: Pubic Use Monitoring
- Goal 9, Objective 5: Refuge Information and Regulations

Goal 2 Riverine and Spring Riparian Habitats

Restore the historic form and function of riverine and riparian systems to benefit native fish and wildlife, including redband trout, Oregon spotted frog, and migratory birds.

Objective 2.1 River, Creek, and Spring Restoration

Within three years of Plan completion, complete an assessment of current hydrologic marsh conditions and develop alternatives for restoring the Williamson River/Big Springs Creek and associated floodplain riparian, wetland, and sedge meadow areas. Within four years, initiate implementation of the selected restoration alternative.

Rationale: Similar to many western valleys, early farmers drained marsh lands to facilitate haying and livestock grazing during the spring and summer months. In the early 1900s, the Williamson River (within the Refuge boundary) was diverted into multiple ditches and levee systems (Figure 3-6). These canals and levee systems have lowered the local water surface elevations of the Williamson River and affiliated groundwater tables, thus reducing marsh water storage and the extent of areas that are seasonally and permanently flooded. The creation and enhancement of Silver Lake and Military Crossing roads in the early 1900s also created new barriers to water and sediment flows and contributed to changes in the marsh's hydrology. In addition, Big Springs Creek, which flows into the marsh from the northwest, has been channelized and diverted (on and off-Refuge). Hydrologic studies indicate the contribution of water from this spring can significantly affect the hydrology and health of Refuge wetlands.

These alterations have likely affected many native species, including redband trout, Klamath largescale sucker, Miller Lake lamprey, and wetland/riparian-dependent bird and amphibian species. Water control structures and ditch diversions have directly affected aquatic organisms such as trout by blocking migration pathways, altering natural river flows, and modifying the river channel morphology. The creation of canals and ditches to divert water, drain areas, and/or flood areas have significantly modified

the river system's natural hydrologic cycles—subsequently affecting the health and integrity of associated wetlands. These hydrologic changes, in conjunction with changes to water inflows, fire frequency, and land use practices, have contributed to the marsh's conversion from an open water (with wocus and submergent plants) to closed emergent marsh (monoculture of cattails and bulrush). Shifts in the wetlands have resulted in poorer habitat for fish, migratory birds, mammals, amphibians, and plants.

Riparian communities perform important ecosystem services to the watershed, including protecting streambanks, maintaining fisheries, improving water quality, providing discharge functions, and supplying important wildlife habitat for the Oregon spotted frog, Neotropical migrant birds, and other river/riparian-dependent species. Riparian habitats are considered high priority in all bird planning efforts within Bird Conservation Region 9 of the Intermountain West Joint Venture (Oregon Habitat Joint Venture 2005). Willows and other shrub species important for passerine birds were once a major riparian structural component within the Williamson River Watershed but now only occupy one percent of the watershed (David Evans and Assoc. 2005). Permanently flooded floodplain wetlands, important to amphibian species like the Oregon spotted frog, have been reduced significantly within Oregon, resulting in its listing as a Federal Candidate Species. The repair of riparian and river/spring structural and functional components are crucial to regaining the ecological health of the Klamath Marsh. Future restoration of the river and spring systems will greatly enhance the functioning of Klamath Marsh Refuge's wetlands and provide the optimum opportunity to improve riverine habitat and the associated wetland/riparian vegetative communities. Restoration will also enable the Refuge to respond to the effects of climate change by encouraging a restored system to naturally adapt and respond to changing climatic conditions. However, due to the challenges (warmer and drier) and uncertainties posed by climate change, it may not be possible or even desirable to restore the Williamson River to historic conditions.

The proposed hydrologic assessment would focus on gathering elevation data within the Refuge wetlands and the evaluation of historic photography and maps of the Refuge to determine historic river channel conditions and areas of seasonal or permanent flooding. Sufficient data would be collected that enables future hydrologic modeling to be completed to evaluate various future river, stream, wetland, and riparian restoration alternatives.

Other objectives or strategies that will help meet this goal include:

- Goal 1, Objective 1: Restore Vegetation and Water Interspersion Ratio
- Goal 7, Objective 1: Invasive Species
- Goal 7, Objective 2: Land Protection/Acquisition, Cleanup, and Development
- Goal 7, Objective 3: Maintain the Integrity of the Refuge Boundary
- Goal 7, Objective 4: Monitor and Inventory Fish and Wildlife Populations and Their Habitats

Strategies:	
2.1.1	Conduct an assessment to evaluate current riparian/wetland habitat conditions, restoration potential, and surface/groundwater inputs to the hydrology of the marsh (water budget). Based upon this assessment, the priorities and strategies for restoration of riverine/spring/riparian and wetland complexes can be evaluated in a separate environmental assessment (EA). The assessment should meet the following strategy needs: $S ■ Predict, or at best characterize, the likely historical conditions of the Williamson River within the Refuge. ■ Characterize the existing conditions of the Williamson River within the Refuge. ■ Provide data necessary for modeling and evaluating flood frequency, channel stability, marsh hydrology, sediment supply, and sediment transport capacity. ■ Provide a complete topographic surface of the Refuge, wetlands, and the Williamson River channel and floodplain (including ditches and canals) by merging elevation data and GPS data. This information will be used to predict hydrologic response to various restoration alternatives developed under this project. ■ Develop a range of potential restoration opportunities based on existing site constraints and the probable form and function of the Williamson River, including seasonal and permanently flooded wetland environments. ■ Future restoration designs must consider, where appropriate, the following attributes: sinuosity, channel belt, connectivity with floodplain, water depth, sedge meadow/riparian habitats, native fish passage/migration (removal of barriers), amphibian off-channel breeding habitat, and existing encumbrances (right-of-ways, other private water rights, flooding private lands).
2.1.2	Conduct baseline assessments within each habitat type within the proposed restoration areas prior to implementing restoration projects to determine general species diversity and relative abundance of focal species such as yellow rail, redband trout, Oregon spotted frog, etc. Complete monitoring per Habitat and Wildlife Inventory and Monitoring step-down management plans.
2.1.3	Coordinate closely with ODFW to develop river restoration alternatives that comply with the State of Oregon in regards to fish passage.
2.1.4	Restoration of Big Springs Creek should be considered after the Service has shown success with other projects such as the Williamson River channel restoration on Refuge lands. Restoring Big Springs will likely depend on restoration of the headwaters, which will require cooperation and the permanent protection of the stream corridor on private lands. In addition to direct purchase of lands, consider use of conservation easements or working through the private lands program to restore and protect Big Springs. Less extensive alternatives (e.g., stabilizing banks and planting riparian plants) may be adequate to meet Service habitat management objectives. $
2.1.5	Study the role of beaver in maintaining and creating additional riparian and wetland habitats within the Refuge marsh ecosystem. Evaluate the potential to re-introduce beaver and muskrats into the marsh to enhance and/or increase riparian, sedge, and other wetland habitats.
2.1.6	Work with partners (tribes, states, NGOs, etc.) to secure funding to complete restoration assessment and implementation.
2.1.7	Initiate a water quality monitoring program within the main stem of the Williamson River (e.g., where it enters and exits the Refuge) to monitor water quality for compliance with Total Maximum Daily Loads (TMDLs) within three years of Plan completion. $S
2.1.8	Continue protection of significant willow stands and riparian vegetation from haying, grazing, and fire to meet Refuge objectives. Refine the current vegetation map by ground truthing the location of willow stands.

Goal 3 Sedge Meadows

Maintain and enhance the natural structure, diversity, and productivity of the seasonally flooded sedge meadows with an emphasis on providing nesting and foraging habitat for rails and sandhill cranes.

- Goal 9, Objective 4: Pubic Use Monitoring
- Goal 9, Objective 5: Refuge Information and Regulations

Objective 3.1 Maintain Sedge Meadow Habitats

Maintain the current 13,889 acres of sedge habitat as naturally hydrologically functioning sedge meadows that are dominated by sedge species, including Carex rostrata, Carex simulata, Carex vesicaria, and Juncus effuses; that contain at least two years of senescent vegetation and less than 10 percent woody encroachment; and where less than 10 percent of the cover is comprised of invasive plant species to benefit yellow rails, sandhill cranes, and other sedge-dependent species. The vegetation ranges in height from approximately 5–60 centimeters (2–24 inches) (Berkey 1991), and the degree of wetness should range from damp to 38 centimeters (15 inches) of water (Savaloja 1981). Maintain adequate water levels (of 2–6 inches deep) during the nesting period if water levels can be manipulated (Safina 1993).

Rationale: Klamath Marsh Refuge currently contains approximately 14,000 acres of sedge meadow habitat. This habitat type is important for a number of Refuge species—most notably, the yellow rail and greater sandhill crane. The yellow rail is currently classified as Threatened or Endangered in some eastern and Midwestern states (Bookhout 1995), a Species of Management Concern and a Focal Species by the U. S. Fish and Wildlife Service (USFWS 1995), Sensitive Critical under Oregon's Sensitive Species Rule (as developed by the Oregon Department of Fish and Wildlife), and a Sensitive Species by the Pacific Northwest Region of the Forest Service (Oregon Natural Heritage Program 2001).

The Central Valley population of greater sandhill cranes breeds in southeast and south central Oregon and in northeast California. A few additional nesting pairs occur in northeast Oregon, the Oregon Cascades, and southern Washington, while an undetermined number breed in British Columbia (Littlefield and Thompson 1979). Recent declines in breeding crane pairs in portions of their breeding range, particularly at Malheur National Wildlife Refuge in Oregon, and nesting habitat losses in Oregon and California, resulted in the population being classified a "threatened" species by the State of California in 1983, a "sensitive" species by the State of Oregon in 1989, and a state "endangered" species in Washington in 1981.

The Williamson River is currently diverted and channelized within the Refuge as a result of prior private landowners who sought to drain wetlands for grazing and haying operations. These historic water diversion and control structures have been used since 1958, with varying success, by Refuge staff to re-create and maintain wetlands. The alteration to the area's hydrology has affected the marsh's groundwater and surface water functions. Restoration of the Williamson River and affiliated wetland habitats within the Refuge should improve the overall hydrology of the marsh ecosystem and subsequently benefit sedge habitats. The extent to which sedge marsh habitats will benefit would be determined in a separate environmental assessment that would evaluate future restoration alternatives. In general, restoration efforts would focus on reconnecting the Williamson River with its historic floodplain, re-establishing its historic channel to the extent possible, and enhancing the distribution of water throughout the Refuge to create a better diversity of open water and emergent marsh habitats (with a goal of a 50 percent open water/50 percent emergent vegetation cover ratio).

Prescribed fire, haying, grazing, and mowing can be important management tools for maintaining a healthy sedge marsh community. Periodic disturbance to sedge communities is necessary to reduce willow encroachment (within important yellow rail nesting areas) and revitalize existing sedge plants by removing an accumulation of dead vegetation. These vegetation treatments also provide important spring migration habitat by providing short and new-growth sedge vegetation

Strategies:	
3.1.1	Conduct annual surveys for yellow rails and sandhill cranes pre- and post- river and wetland restorations to monitor populations and determine impacts to nesting populations as a result of restoration techniques. S
3.1.3	Work with researchers and the U.S. Fish and Wildlife Service's Water Resources Department to establish water gauges throughout the sedge habitats to monitor and document water levels pre- and post-restoration and to evaluate rail and crane nesting use relative to water levels. $ S
3.1.3	Continue researcher efforts to collect life history information for yellow rails and sandhill cranes, including breeding biology and demographics, to improve future management programs. S
3.1.4	For yellow rail breeding, maintain large blocks (minimum of 8 hectares) of undisturbed sedge habitat and provide complexes of sedge meadow in conjunction with associated emergent marsh and open water habitats where possible.
3.1.5	Maintain, to the extent possible, natural cycles of fluctuating water levels; conduct additional studies as needed to determine appropriate cycles for a given location.
3.1.6	Monitor sedge meadow vegetation to determine if management (active or passive) is maintaining native diversity. S
3.1.7	Consider predator control actions if habitat improvements do not provide sufficient successful recruitment of cranes or rails and studies indicate predators are a significant problem. S
3.1.8	Minimize all disturbances in known areas of rail and crane nesting. Temporary closures of Refuge areas may be required to provide needed protection.
3.1.9	Conduct burns every 3–5 years on no more than 25 percent of available sedge marsh (approximately 3,500 acres) to achieve desired vegetative conditions, remove encroachment by woody vegetation (non-willow species) or cattail (Bookhout 1995; Stenzel 1982; Evers 1994), and re-vitalize existing sedge growth. Willows will be protected from fire where feasible and only targeted for burning if needed to improve yellow rail habitat (Bookhout 1995). Utilize late season haying or grazing operations (post-August 10 if possible) if completing prescribed burn is not feasible. $S

structure that is used for loafing and feeding by a variety of waterbird species. These tools would be used as needed to achieve vegetative objectives.

Although not all-inclusive, other bird species benefiting from the conservation of sedge meadows include common snipe, marsh wren, black tern American bittern, sora and Virgina rail.

Other objectives or strategies that will help meet this goal include:

- Goal 1, Objective 1: Restore Vegetation and Water Interspersion Ratio
- Goal 2, Objective 1: River, Creek, and Spring Restoration
- Goal 7, Objective 1: Invasive Species
- Goal 7, Objective 2: Land Protection/Acquisition, Cleanup, and Development
- Goal 7, Objective 3: Maintain the Integrity of the Refuge Boundary
- Goal 7, Objective 4: Monitor and Inventory Fish and Wildlife Populations and Their Habitats

Goal 4 Grassland/Shrub

Restore and maintain the composition and structure of existing and historic grassland and shrub habitat to benefit meadowlarks, savannah and vesper sparrows, and sandhill cranes.

- Goal 9, Objective 4: Pubic Use Monitoring
- Goal 9, Objective 5: Refuge Information and Regulations

Objective 4.1 Restore and Maintain Grassland

Restore and or maintain 10,959 acres of grass/shrub habitat dominated by such native species as Idaho bunchgrass, slender wheatgrass, and Western needlegrass where less than 10 percent cover is comprised of invasive plant species (cheat grass, thistle species, etc.).

Rational. Large (greater than 300-acre) grassland habitats on Klamath Marsh Refuge and its vicinity are important feeding and breeding habitat for the greater sandhill crane (GSC). In Oregon, Klamath Marsh Refuge represents one of the largest breeding populations of these birds in the State. During the last 10 years (1997–2007), breeding populations of GSCs on the Refuge have ranged from 45–65 pairs. The Partners in Flight East Slope Cascade Plan (Altman 2000) lists wet/dry grassland meadows as areas of conservation focus and the GSC as the focal species. Upland meadows also provide important foraging habitat for elk and mule deer and pronghorn, and nesting habitat for sparrows, meadowlarks, and various waterfowl.

Conifer encroachment into meadows is evident in all areas of the Refuge where meadows and forested habitats meet. Lodgepole encroachment into meadow and marsh habitats has been occurring

Grassland areas that have been encroached by lodgepole pines. Maintaining the remaining valuable grassland habitats will require active management of encroaching pine trees. Klamath Marsh Refuge 2007.

for decades throughout the Klamath Marsh area. In some areas, this phenomenon is clearly seen, as high densities of small lodgepole can be observed extending out from the older forest edges and subsequently occupying acres of former grassland or wet meadow habitat. In other areas such as Abraham Flat, survey maps from the 1890s indicate that conifer encroachment of meadow habitat, particularly to the south, has completely cut off the connectivity to other meadows currently on U.S. Forest Service lands. In addition, remnant patches of grasses and sedges still remain within what are now closed canopy lodgepole pine stands that are adjacent to meadow habitat. It is likely that decades of fire exclusion have allowed conifers to invade and reduce the acreage of meadow habitats.

Historically, occasional disturbance from fire and grazing prevented significant buildup of dead decadent vegetation that gradually reduces the quality of habitat and increases the potential for colonization by invasive species or conifers. Use of

Strategies:	
4.1.1	Where grasslands are being encroached upon by lodgepole saplings, which occurs in most Refuge meadows adjacent to forest, a combination of cutting and prescribed burns should be implemented to kill encroaching saplings and re-invigorate grass and wet meadow habitats. The most successful strategy is to cut and pile encroaching trees, allow them to dry, burn the area and piles, and then maintain the area with prescribed fire (about every 5–10 years). $S
4.1.2	Lodgepole pine encroachment has occurred in Units 7 and 8 (see Figure 2-1 in Appendix M). The lack of fine fuels (grasses) to support fire may require the cutting of trees less than 14 inches diameter at breast height (dbh) to provide sufficient fuels to carry a fire and re-establish former meadow areas (see Appendix M for details). $S
4.1.3	Where historic grassland habitats have been replaced by older age lodgepole stands, commercial and/or non-commercial mechanical harvest and/or slash treatments would be conducted to remove the lodgepole pine and reduce woody fuels so that prescribed fire could be used to restore and maintain historic grassland edges. Older lodgepole stands would be treated where remnant grasses or sedges still exist within the forest or where thick layers of organic soils indicate that meadow or marsh occupied the site in the recent past. Under this treatment, trees greater than 14 inches dbh would not be removed. These leave trees would likely be targeted by prescribed fire, creating valuable snag habitats. Strategies to create snags would include piling of slash around leave trees to increase prescribed burn impacts or girdling specific trees. This treatment would be applicable to portions of Units 2, 3, 6, and 9 (figure 2-1 in Appendix M). $S
4.1.4	Maintain the health and vitality of existing grasslands utilizing late season (post August 10) haying, grazing, mowing, or prescribed burning management techniques on a 3–5 year cycle, treating no more than 20 percent (2,200 acres) of this habitat type annually. These treatments will not only maintain healthy grasslands for nesting, but also provide important spring migrational feeding and resting habitat for a variety of bird species by creating areas where vegetation is short and newly regenerating.

prescribed burning, haying, mowing, or grazing is important to maintaining the health and vitality of these communities.

Other objectives or strategies that will help meet this goal include:

- Goal 1, Objective 1: Restore Vegetation and Water Interspersion Ratio
- Goal 2, Objective 1: River, Creek, and Spring Restoration
- Goal 5, Objective 1: Restore and Maintain Old-Growth Ponderosa Pine - various Strategies
- Goal 7, Objective 1: Invasive Species
- Goal 7, Objective 2: Land Protection/Acquisition, Cleanup, and Development
- Goal 7, Objective 3: Maintain the Integrity of the Refuge Boundary
- Goal 7, Objective 4: Monitor and Inventory Fish and Wildlife Populations and Their Habitats

Goal 5 Pine Forests

Maintain the structure and diversity of existing old-growth ponderosa pine stands and restore mature and old-growth characteristics to second-growth and other degraded stands.

- Goal 9, Objective 4: Pubic Use Monitoring
- Goal 9, Objective 5: Refuge Information and Regulations

Objective 5.1 Restore and Maintain Old-Growth Ponderosa Pine

Within one year of completing the Plan, begin implementation of the ponderosa pine forest and associated mechanical and prescribed burn management treatments according to the Klamath Marsh National Wildlife Refuge Fire Hazard Reduction and Wildlife Habitat Enhancement Project Final EA 2003 in 998 acres[1] of ponderosa pine stands (units 1, 3, 4, 5, and portions of 6, 9, and 8 (Figure 2-1 in Appendix M). Specific desired conditions for stands (described in the subsequent text) use white-headed woodpecker as the focal species. It is recognized that restoration of late-successional forest is a long-term process, but this short-term (i.e., 10–15 years) objective is for the commitment and initiation of the process of restoration. Strive for full implementation of initial stand treatments within 10–15 years of completing the Plan , with a goal of achieving the following desired future conditions:

- Greater than 10 trees/acre greater than 21 inches dbh, and at least 2 of the trees greater than 31 dbh.
- Greater than 1.4 snags/acre greater than 8 inches dbh with 50 percent greater than 25 in dbh in a moderate to advanced state of decay.
- Manage understory via mowing and/or prescribe fire so that 40–60 percent shrub cover is maintained in a young age class condition (includes shrubs like bitterbrush and currents) and greater than 20 percent of the shrub layer in regenerating sapling conifers, especially ponderosa pines. Burning/mowing should be conducted in a mosaic fashion.
- Where ecologically appropriate, provide conditions described previously in the following minimum areas (patch size) relative to amount of old-growth or late-seral forest present; maintain contiguous blocks of 350 (primarily old-growth) to 700 acres (mixed old-growth and younger stands).
- Strive to creat a mean canopy cover of 10–30 percent.

Rationale: Protection and enhancement of ponderosa pine forests are a priority because of the extensive loss and degradation of this forest type and subsequent declines in numerous dependent wildlife species, including big game and landbirds. Over 85 species of native landbirds breed in ponderosa pine habitats, and several highly associated bird species have declining populations and are species of state and regional concern, including the pygmy nuthatch, white-breasted nuthatch, Lewis woodpecker, and white-headed woodpecker. Declines of ponderosa pine forests are among the most widespread and strongest in an analysis of source habitats for terrestrial vertebrates in the interior Columbia Basin (Wisdom et al. 2000). Within the Northern Cascades, Southern Cascades, and Upper Klamath study units of the Interior Columbia Basin Assessment, old-growth single overstory ponderosa pine forest habitat has declined by 97, 55, and 18 percent, respectively (Wisdom et al. 2000). The loss of ponderosa pine forest is associated with fire exclusion, grazing, logging, and replacement stands of lodgepole pine with closely spaced seedlings.

Fire significantly shapes the old-growth ponderosa pine forests, and ponderosa pine seedlings preferentially germinate on soils modified by recent fires. In many areas, these forests depend upon fire to maintain old-growth characteristics. A study of pre-settlement fire regimes in Big Sagebrush and Aspen communities near the Klamath Marsh estimated that fire burned in these communities every 10–20 years (Miller et al. 2001). In 1998, Winema National Forest estimated that low severity fires occurred every 5–15 years in ponderosa pine stands. Fires within

1 The acreage of forested habitats in this document is less than that reported in the Fire and Habitat EA because grassland/shrub/bare areas within the forest are include in a separate class (grassland/shrub).

mature ponderosa pine stands were generally not very intense, as they burned along the forest floor consuming grasses, shrubs, young saplings, dead limbs, pine needles, and other plant debris. The frequency of these low intensity fires reduced competition from more shade tolerant species, like firs and lodgepole pine (USDA , USFS 2004).

During the twentieth century, the fire policy has generally been one of suppression; and thus, the vegetative conditions in ponderosa forests have changed markedly. Less fire due to grazing and fire suppression triggered a shift to forests with very high tree densities, dense shrub layers, and a buildup in dead woody material. With more fuel, fires burn longer and hotter, which affects the forest more severely than if natural fire intervals were allowed. The combination of mechanical thinning and the use of prescribed fire are needed to restore these stands to the pre-settlement fire regime. Once the pre-settlement fire regime is restored, the stands may be maintained through the application of prescribed fire on a rotation of 5–15 years. Monitoring will be critical to be sure a healthy shrub/grass/forb component is maintained. For some sites, a five-year fire interval may preclude establishment of shrubs such as bitterbrush and currant.

Because of the extensive loss of ponderosa pine forest, habitat restoration is the most important strategy for conservation of landbirds associated with this habitat type. The desired conditions in ponderosa pine forest are a large tree, single-layered canopy with an open, park-like understory dominated by herbaceous cover with scattered shrub cover and pine regeneration. In addition to the overall loss of this forest type, two features—snags and old-forest conditions—have been diminished appreciably and resulted in declines of bird species highly associated with these conditions or features. Wisdom et al. (2000) recommended that landbird conservation in ponderosa pine forest emphasize maintaining large patches of old forest with large snags, large trees, an open understory with regenerating pines, and patches of burned old forest.

Currently, very little old-growth is actually present on Refuge lands due to past logging. Most stands

Strategies:	
5.1.1	Implement the Klamath Marsh National Wildlife Refuge Fire Hazard Reduction and Wildlife Habitat Enhancement Project (2003), which includes the following prescriptive actions: $S ■ Leave all trees greater than 14 inches dbh. Thin stands to 70–170 trees per acre (28–68/ha) with average tree spacing of 20 feet between stems to ensure the maintenance of the large tree component. If necessary, convert trees greater than 14 inches dbh to snag trees to meet desired future conditions and densities. ■ Within 100 foot of the edge of the marsh, ponderosa pine spacing would be increased to an average of 40 feet to allow for the growth of large branches and open crowns for roosting bald eagles. ■ Leave all snags greater than 8 inches dbh and consider creating additional snags by girdling or using biological treatments on trees to improve cavity nesting habitat. ■ Leave small patches of untreated trees in appropriate areas that will increase cover (structural diversity) for deer and elk (one-half acre to two acres). These practices should be implemented in a landscape context to ensure adequate cover and fawning/calving habitat for deer and elk. ■ Depending on stand conditions, the decision on how to designate leave trees will be done using two methods: mark all leave trees or contract stipulations. (See Fire EA for details in Appendix M.) ■ Slash disposal would be dependent on stand condition. Where initial stands are dominated by high densities of small trees, machinery (e.g., slashbusters, etc.) will be used to remove, chip, or masticate small diameter trees and slash. Hand cutting and piling of slash and small trees would be completed where machinery is not appropriate.

5.1.2	Remove lodgepole pines from managed ponderosa stands because they act as ladder fuels and as a seed source for future re-invasion.
5.1.3	Prioritize implementation of silvicultural and prescribed fire prescriptions. Highest priority for forest habitat management is removing hazardous fuels from the old-growth ponderosa pine stands. Consider the following factors when setting the remaining priorities: wildlife benefits, tribal interests, funding sources, controversy, and degree of threat to mature trees (e.g., fire, disease, overcrowding) and archaeological resources. The priorities should be flexible enough to take advantage of available funding and opportunities to coordinate with partners to implement management actions.
5.14	Explore opportunities to partner with the U.S. Forest Service (USFS), Bureau of Land Management, private landowners, and Klamath Tribes to implement habitat management practices in forest habitats on and around Klamath Marsh Refuge.
5.1.5	While implementing management prescriptions within forest habitats on Klamath Marsh Refuge, ensure USFS and Refuge projects contribute to ecosystem function at greater landscape scales. For example, coordinate the management actions within Units 7 and 8 on Klamath Marsh Refuge with habitat enhancements for bald eagles on adjacent USFS lands.
5.1.6	Consider inviting stakeholders and/or other interests along with USFS to mark trees for removal in ponderosa pine stands. By doing so, the art of silvicultural practices utilized by the USFWS can be conveyed to environmental groups so they understand the complexity of stand management. Also seek opportunities to involve stakeholders in pre- and post- habitat monitoring programs to expand their knowledge of management effects.
5.1.7	Support partnerships, especially with adjacent landowners, that seek to acquire and/or restore ponderosa pine forest habitat.
5.1.8	Develop conservation agreements with private landowners to enhance the quality of ponderosa pine forest habitat. Seek to maximize contiguous areas of ponderosa pine forest habitat, and thus minimize fragmentation. The larger the area, the greater the likelihood of maintaining populations of area-sensitive and large territory species.
5.1.9	Conduct understory burns every 10–15 years in prescriptively thinned areas to mimic the natural fire regime that historically occurred in mature ponderosa pine forests (approximately 200 acres per year burned). $S
5.1.10	Conduct vegetation monitoring and photo plots to evaluate the effectiveness of management strategies over time. Work with the USFS to establish monitoring protocols and techniques. S
5.1.11	Complete monitoring per Habitat and Wildlife Inventory and Monitoring step-down management plans (Goal 7, Objective 4). S
5.1.12	Hire a prescribe burn specialist to write and implement Refuge burn plans and assist with forest management activities. $

on the Refuge are populated with some remaining large trees; however, encroachment of smaller age trees is intense. Along meadow edges, most of this encroachment is lodgepole pine; within more interior upland areas, small diameter ponderosa pine has reached unnaturally high densities. These overstocked conditions contribute to a variety of forest health concerns, including susceptibility to insect and pathogen outbreaks and stand replacement fire, decrease in individual tree and stand health, decrease in individual tree growth, decrease in shrub and grass/forb diversity and abundance, and competitive pressure on large mature trees. Sustainability of these stands over

the long term requires a combination of thinning and prescribed fire, along with coordination with U.S. Forest Service management plans, to create larger and healthier stands. This approach may also make a small contribution to mitigating the effects of global climate change. Though, in the short term, thinning and prescribed fire release CO2, in the long term this management approach is expected to result in more stable carbon storage than unmanaged forests (North *et al* 2009).

Other objectives or strategies that will help meet this goal include:

- Goal 1, Objective 1: Restore Vegetation and Water Interspersion Ratio
- Goal 2, Objective 1: River, Creek, and Spring Restoration
- Goal 7, Objective 1: Invasive Species

Goal 6 Aspen

Enhance and maintain the natural regeneration of existing aspen stands.

- Goal 7, Objective 2: Land Protection/Acquisition, Cleanup, and Development
- Goal 7, Objective 3: Maintain the Integrity of the Refuge Boundary
- Goal 7, Objective 4: Monitor and Inventory Fish and Wildlife Populations and Their Habitats
- Goal 9, Objective 4: Pubic Use Monitoring
- Goal 9, Objective 5: Refuge Information and Regulations

Objective 6.1 Restore, Enhance and Maintain Aspen Stands

Where ecologically appropriate at the landscape level, initiate actions in aspen habitat to maintain or provide some areas with natural (e.g., fire) or mechanical disturbance regimes to ensure proper successional development. Initiate management actions (outlined in the Klamath Marsh National Wildlife Refuge Fire Hazard Reduction and Wildlife Habitat Enhancement EA 2003) within one year of Plan completion. Strive to achieve the following desired future conditions within aspen stands 2–8 (see Figure 2-1 in Appendix M).

Aspen stands that have been invaded by pine trees on Klamath Marsh Refuge 2008. Aspen stands are limited on the Refuge, and removing competing pine trees will enhance the health of stands and allow them to expand.

- 10 percent cover of sapling aspen in the understory to provide adequate representation of younger seral stages for replacement.
- Strive for more than 4 trees per acre and also provide an average of 1.5 trees within each acre that are greater than 39 feet in height and 10 inches dbh.
- Mean canopy cover 40–80 percent, either clumped with patches and openings or relatively evenly distributed.

Rationale: Aspen is a keystone species. With the exception of riparian areas, aspen communities are considered the most biologically diverse ecosystems in the Intermountain West (Kay 1997). As aspen-dominated landscapes convert to other cover types, tremendous biodiversity is lost (Bartos and Amacher1998; Bartos and Campbell 1998a; Bartos and Campbell 1998b). These losses include not only vascular plants and vertebrate animals but also nonvascular and invertebrate organisms. Aspen communities in the western U.S. are considered at risk because of low levels of disturbance and high levels of herbivory by wild and domestic ungulates.

Strategies:	
6.1.1	Clear all conifers less than 14 inches dbh from within aspen stands. $S
6.1.2	Clear all confers less than 14 inches dbh within 30 feet of aspen stands. $S
6.1.3	Use prescribed fire (fall season) to encourage recruitment of young aspen and mimic the natural fire regime (10–20 years) (Miller et. al. 2001) once aspen stands are established. $S
6.1.4	Build enclosures if needed to protect stands from over browsing by wildlife or chronic trespass cattle. Eliminate domestic grazing in aspen stands.
6.1.5	Stimulating clonal sprouting of aspen groves via selective cutting or severing roots of trees within non-reproducing colonies. Do not girdle trees as this technique will not stimulate clonal sprouting (Dale Bartos Personal Communication 2007).
6.1.	Maintain all snags and initiate active snag creation (e.g., fungal inoculation, topping) where snags are limiting and restoration leading to recruitment of saplings is underway.
6.1.7	Complete monitoring per Habitat and Wildlife Inventory and Monitoring step-down management plans (Goal 7 Objective 4). S

There appears to be a trend toward the loss of aspen-dominated stands throughout the west. In some cases, the loss is caused by succession, with shade-tolerant conifers becoming dominant (Shaw 2004). This habitat type is listed as a unique conservation focus habitat within the Partners in Flight East Slope Cascades Plan (Altman 2000), with the focal bird species being the red-naped sapsucker. Other bird species, according to Partners in Flight, that would benefit from large aspen trees and snags are the house wren, mountain bluebird, Williamson's sapsucker, tree swallow, northern pygmy owl, western screech owl, and northern flicker.

Aspen groves on and adjacent to Klamath Marsh Refuge exist on the edge of meadows and within both lodgepole and ponderosa pine habitats. Unfortunately, conifer encroachment, fire suppression, and past grazing practices have severely limited recruitment of young trees. Many of the existing stands are in decline with little evidence of new recruitment.

Other objectives or strategies that will help meet this goal include:

- Goal 1, Objective 1: Restore Vegetation and Water Interspersion Ratio
- Goal 2, Objective 1: River, Creek, and Spring Restoration
- Goal 5, Objective 1: Restore and Maintain Old-Growth Ponderosa Pine – various Strategies
- Goal 7, Objective 1: Invasive Species
- Goal 7, Objective 2: Land Protection/Acquisition, Cleanup, and Development
- Goal 7, Objective 3: Maintain the Integrity of the Refuge Boundary
- Goal 7, Objective 4: Monitor and Inventory Fish and Wildlife Populations and Their Habitats
- Goal 9, Objective 4: Pubic Use Monitoring
- Goal 9, Objective 5: Refuge Information and Regulations

Goal 7 Protection and Monitoring

Conserve and protect the natural diversity of migratory birds, resident wildlife, fish, and plants through protection of lands, invasive species management, and biological, water, and climate monitoring program.

Objective 7.1 Invasive Species

Within two years, develop and implement an invasive weed management plan to reduce the area coverage of non-native invasive plants that adversely impact native plant and wildlife communities. Strive to minimize invasive plant species populations to less than 100 acres within 10 years of Plan implementation.

Strategies:	
7.1.1	Inventory the occurrence and map the distribution and size of non-native invasive weed populations on the Refuge and incorporate into the GIS database to allow monitoring through time. S
7.1.2	Attempt to treat 90–95 percent of invasive plant populations within the Refuge each year. $S
7.1.3	Avoid or minimize disturbance to soils in all habitat types to limit establishment potential of invasive plant species.
7.1.4	Minimize spread and introduction of invasive species by thoroughly inspecting and cleaning all equipment that is transported within the Refuge or brought to the Refuge from other sites (other complex refuges, private contractors, etc.).
7.1.5	Conduct annual monitoring to assess results of control activities and to detect the presence of any new infestations of current or newly established species. $S
7.1.6	Seek opportunities for funding invasive or pest management activities through local, state, and Federal initiatives.
7.1.7	Cooperate with U.S. Department of Agriculture (USDA) and academic institutions to research new methods for controlling invasive plants. Support research to find bio-controls for invasive species.
7.1.8	Recruit and train volunteers to help with non-native invasive species surveys, monitoring, and control measures, including data collection, entry, and analysis. S

Rationale: Non-native invasive plants are present at varying degrees throughout the Refuge. They have the potential to dominate sites and subsequently alter vegetative communities, lowering overall diversity and creating marginal or unsuitable habitat conditions for native plants and wildlife. The spread of invasive plants threatens successful restoration of all habitat types on the Refuge. Species of greatest concern include Canada thistle, perennial pepperweed, cheat grass, and reed canary grass.

Objective 7.2 Land Protection/Acquisition, Cleanup, and Development

Within 15 years of the Plan completion, seek to acquire 25–50 percent of the remaining private lands within the current acquisition boundary from willing sellers (Figure 4-3) and protect another 500–1,500 acres in conservation easement. Remove and dispose of all buildings and structures that are not utilized for Refuge management or considered cultural resources within 10 years.

Rationale: Land acquisition and protection is a critical component of fish and wildlife conservation since it permanently protects basic habitat needs. It can be a cornerstone for promoting wildlife-dependent recreation by providing areas of open land and water for the public to visit. Land protection is also a critical component of restoring habitat connectivity needed for the health of many species.

Furthermore, land acquisition is a key adaptive response to climate change. It helps ensure adequate representation, redundancy, and resilience of ecosystems (CCSP 2008). Land acquisition and protection can also be cost effective in the long term due to inflation of land costs and the costs of acquiring undeveloped land versus developed land that also needs restoration.

Several land tracts purchased in the 1980s and 1990s continue to harbor structures that can be removed and disposed of. Cleanup and restoration of these sites will improve the Refuge's view shed and improve the health and integrity of habitat for wildlife.

Opportunities to benefit wildlife at Klamath Marsh Refuge exist outside the approved Refuge acquisition boundary. Lands outside the current boundary offer the potential for increasing the protection of both wetland and riparian habitats, as well as for increasing the connectivity of Refuge lands with similar type habitats in the Klamath Marsh region.

Strategies	
7.2.1	Seek acquisition funds and willing sellers to meet the objective. $
7.2.2	Explore land exchanges with the USFS to remove intermingled ownerships and simplify boundaries (Figure 4-4) for public understanding, land management, and facilitating fire unit boundaries.
7.2.3	Cluster facility development at a minimum number of locations on the Refuge, and leave the remainder of the Refuge in a primitive and semi-primitive condition.
7.2.4	Remove remnant facilities from Refuge lands that are not designated cultural resources, including Loosely house and Summers ranch, and any non-functional or non-utilized facilities acquired in future years.
7.2.5	Pursue conservation easements on lands that are within the Refuge acquisition boundary that are important to habitat protection but may not be acquired in the foreseeable future via fee title. $
7.2.6	Consider pursuing expansion of the Refuge acquisition boundary if information indicates that additional acres are necessary for management of selected species (threatened and endangered), to simplify boundary management, to protect or buffer Refuge resources, or for mitigation purposes. Such areas may include the Big Springs riparian area and private lands along the west boundary that harbor important habitats or provide habitat buffers. Any additional land acquisition or disposal would go through a public involvement process and be on a willing seller basis only. $
7.2.7	Encourage restoration and protection of habitat on private lands surrounding the Refuge and throughout the Williamson River Watershed via the promotion of an active Partners for Wildlife Program.

Service easements or Partners for Wildlife Program (Partners) projects on private lands provide benefits to wildlife at lower cost than Refuge land acquisition, although they do not always provide the same degree of management flexibility or overall benefit to wildlife. However, the easements and Partners programs provide an opportunity to leave lands in private ownership while increasing the level of habitat protected for wildlife surrounding Refuge lands.

Objective 7.3 Maintain the integrity of the Refuge boundary

Post the entire Refuge with standard U.S. Fish and Wildlife Service boundary signs; have surveys conducted as needed to clarify areas of conflict with private landowners within five years of the Plan completion. Evaluate and modify fencing needs within 10 years.

Rationale: Maintaining and enforcing a boundary is one of the basic and critical components of Refuge management to ensure the integrity of an area is protected. Without attention to this basic task, there is a tendency for adjacent development and use to creep and take over Refuge lands and waters. This encroachment includes tree cutting, dumping, construction, storing of equipment and materials, and mowing Refuge lands. The current Refuge boundary is posted sporadically in areas and needs to be posted or re-posted with clearly visible standard signs to avoid issues with visitors and adjacent landowners. Portions of the Refuge are fenced to reduce livestock trespass or reduce off-road travel.

The need for fencing and type of fencing should be evaluated based on wildlife, livestock, and public use patterns to effectively protect Refuge habitats.

Strategies:	
7.3.1	Fencing will be evaluated on the Refuge to determine what fences need to remain or be removed.
7.3.2	Fences remaining on the Refuge will be modified to be as wildlife friendly as possible and yet still protect habitats from trespass livestock and off-road vehicles. $S
7.3.3	Conduct an annual review of the posted Refuge boundary to detect and address any encroachment incidents and resolve issues appropriately.
7.3.4	Trespass livestock will be recorded on a regular basis and immediate efforts made to have trespass livestock removed from Refuge lands. Non-compliance with Refuge requests will result in legal actions.
7.3.5	Identify boundary areas most in need of clarification of posting and potential surveying. Repost boundaries with standard Refuge boundary signs, ensuring that signs are visible and boundary lines easily determined.
7.3.6	Hire a maintenance position for the Refuge Complex that is assigned to Klamath Marsh Refuge from May–October. $

Objective 7.4 Monitor and Inventory Fish and Wildlife Populations and Their Habitats

Within two years, develop and implement a Refuge wildlife inventory and habitat monitoring program that incorporates existing and new surveys and/or censuses of plants, fish and wildlife, as well as their responses to restoration and management activities that can be employed to guide the management of the Refuge.

Rationale: Monitoring is essential to understanding the status and trends of selected species groups and habitats and their responses to management actions. Management effectiveness can be evaluated and corrected, if needed, based on a monitoring program. Furthermore, monitoring will provide some indication of the overall biological integrity, diversity, and environmental health of the Refuge, which is critical for implementing effective and integrated habitat management and public use programs. This objective will help meet directives in the Refuge Improvement Act requiring monitoring of the status of fish, wildlife, and plant species. Monitoring is also critical to defining and adapting to the effects of global climate change on Refuge resources.

Monitoring will consist of both long- and short-term projects and will be conducted by Refuge staff, partners, contractors, and other researchers. Some monitoring efforts will be conducted to meet Refuge data needs, while others will contribute to or be part of larger-scale ecoregion, flyway, or national monitoring initiatives.

Strategies:	
7.4.1	Develop and implement a wildlife monitoring plan (step-down plan) to determine the relative abundance, distribution, and productivity of Neotropical migratory birds, wetland dependent birds, mammals, reptiles, amphibians, and fish using Refuge lands. Focus monitoring strategies on focal species identified by various conservation plans (state, Partners in Flight, TNC, Federal, etc.) to assess the effectiveness of current strategies and guide future restoration and management strategies. S
7.4.2	Continue annual surveys of yellow rail, sandhill cranes, waterfowl (aerial), bald eagles, and Oregon spotted frogs. Incorporate these surveys into the Refuge wildlife monitoring plan and modify protocols as necessary to create a comprehensive and adaptive monitoring program.
7.4.3	Develop and implement a habitat management monitoring plan (step-down plan) to measure vegetation changes and results of restoration and/or treatment actions. For example, establish permanent monitoring sites to monitor bird and vegetation changes in ponderosa pine stands that are treated with prescribed fire or are mechanically thinned. S
7.4.4	Submit proposals for regional fire effect monitoring to obtain additional funding for conducting vegetation monitoring related to fire impacts.
7.4.5	Pursue opportunities to recruit qualified volunteers and develop partnerships with resource agencies, academic institution, and private organizations to accomplish monitoring.
7.4.6	Create a GIS database to document locations of habitat management practices over time. Integrate wildlife and habitat monitoring results (e.g., surveys, studies) with GIS habitat layers to evaluate management actions. $S
7.4.7	Conduct vegetation monitoring and photo plots to evaluate the effectiveness of management strategies. Work with the U.S. Geological Survey and other agencies to establish monitoring protocols and techniques. S
7.4.8	Work with USGS, universities, tribes, and other organizations and individuals to develop research projects regarding natural resource issues that can be used to guide management on the Refuge.
7.4.9	Identify special status species locations off Refuge lands and prioritize these, if needed, for long-term protection via easements, Partners for Wildlife Program, or possible acquisition. S
7.4.10	Continue to work with the State, USGS, the Service, Klamath Bird Observatory, and other organizations in sharing of data on monitoring species and habitats.
7.4.11	Hire one seasonal summer bio-tech (0.5 FTE) to assist with biological and refuge operation needs. This strategy will help achieve all other Plan objectives. $
7.4.12	Develop an annual habitat management plan that identifies location, acreage, and timing of land management activities that will be applied to Refuge habitats. The annual plan should identify objectives that management treatments strive to produce. A database should be created that contains annual treatment information, spatial data, and results of annual treatments.

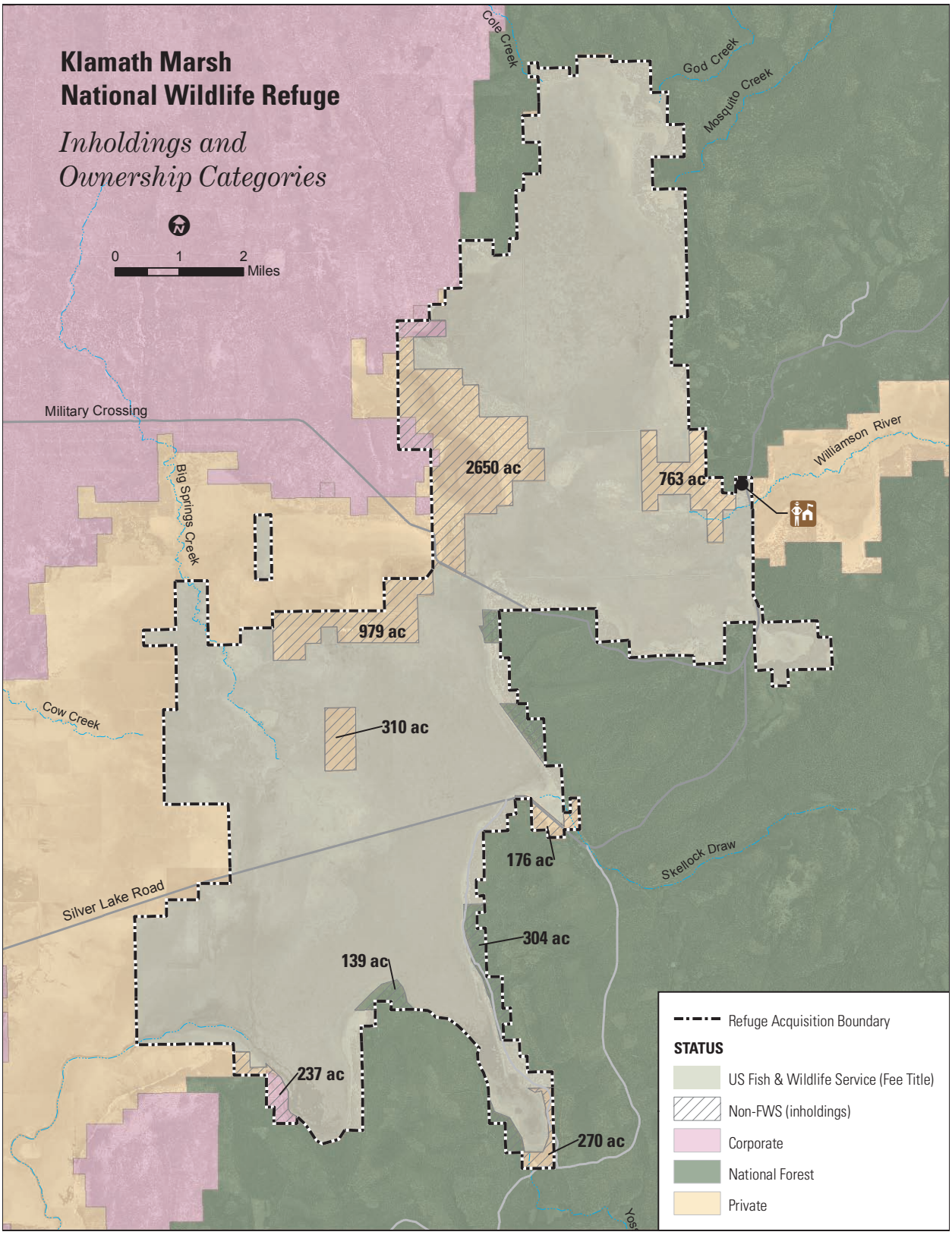


Figure 4-3. Ownership of lands within and surrounding the Klamath Marsh Refuge acquisition boundary

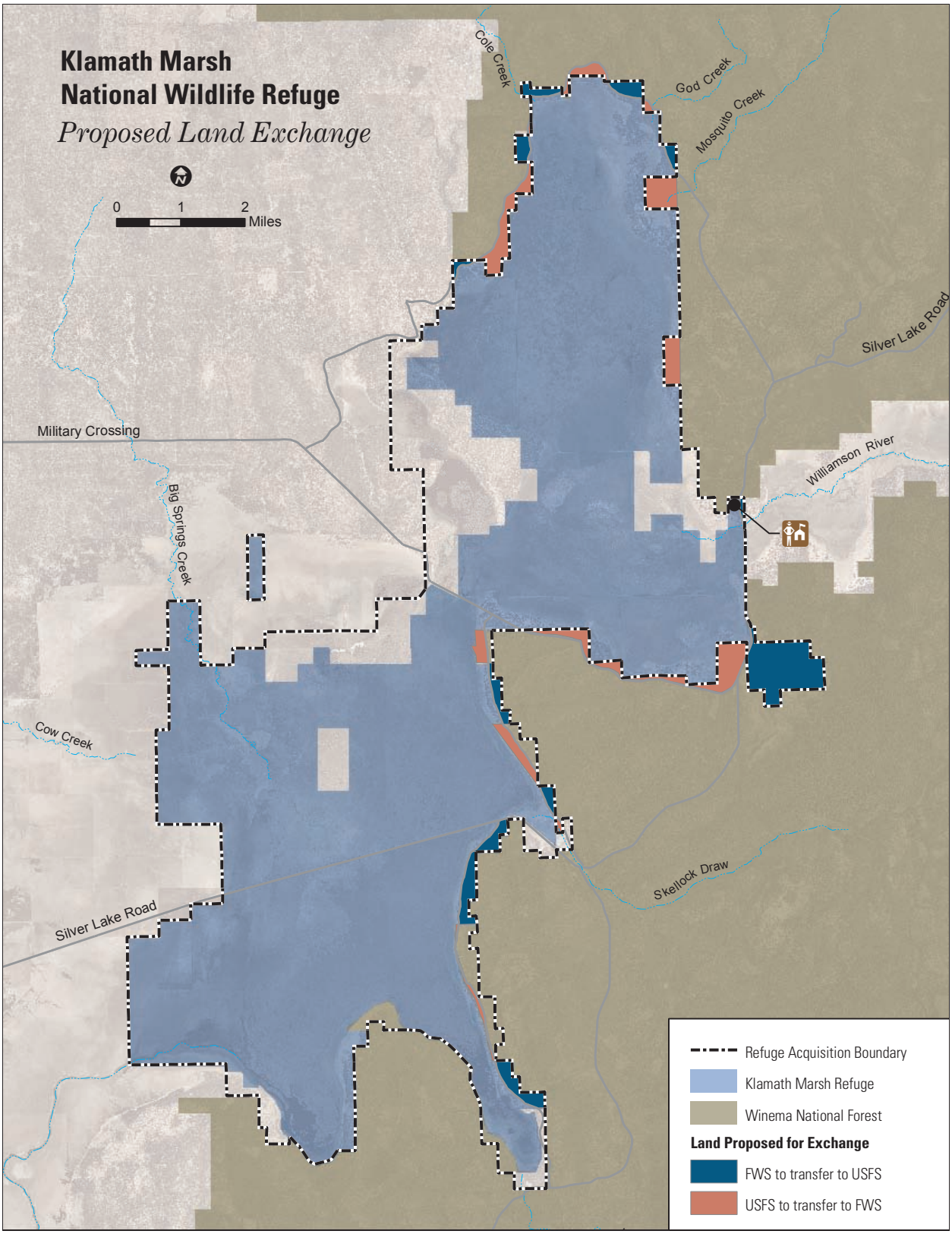


Figure 4-4. Proposed U.S. Fish and Wildlife Service/U.S. Forest Service land exchange

Goal 8 Cultural Resources

Visitors gain an understanding and appreciation for the cultural significance of the Klamath Marsh. Cultural resources of the Refuge are preserved and connect visitors and the community to the area's past and present.

Objective 8.1 Cultural Resource Management

Implement a proactive cultural resource management program that focuses on meeting the requirements of the National Historic Preservation Act, including consultation, identification, inventory, evaluation, and protection of cultural resources. In cooperation with the Klamath Tribes, prepare a cultural resource management plan within 15 years of Plan approval.

Rationale: The management and protection of cultural resources is an integral element in fulfilling Refuge goals. Refuge acquisitions and changes to Refuge habitats and facilities warrant a comprehensive cultural resource management program. Although record searches have been conducted for all Service-managed properties, a complete compilation of site records and relevant reports summarizing the number and locations of all recorded sites within the approved Refuge boundary would aid in planning land conservation, management, and landowner outreach. Refuge planning efforts would be enhanced by identifying the location and composition of collections of human remains, funerary objects, sacred objects, or objects of cultural patrimony that were discovered and removed from within the approved Refuge boundary prior to the Service assuming land management authority. However, this overview would be for the sole purpose of identifying cultural resources, and these collections would not fall under Service jurisdiction.

Strategies:	
8.1.1	Identify archaeological sites that coincide with existing and planned roads, facilities, public use areas, and habitat projects. Evaluate threatened and impacted sites for eligibility to the National Register of Historic Places. Prepare and implement activities to mitigate impacts to sites as necessary.
8.1.2	In consultation with archaeologists and tribal representatives, approximate the location of unrecorded sites and culturally sensitive areas within the approved Refuge boundary by using site records, maps, and other data. Identify cultural resource issues and needs, and draft potential solutions.
8.1.3	Develop a GIS layer for cultural resources that can be used with other GIS layers for the Refuge, yet contains appropriate measures to protect sensitive information.
8.1.4	To aid with Refuge planning, identify the location and composition of any collections of human remains and Native American Grave Protection and Repatriation Act (NAGPRA) covered items removed from within the approved Refuge boundary prior to the Service's assumption of land management.
8.1.5	Develop partnerships with the Tribes for cultural resources inventory, evaluation, and project monitoring, consistent with the regulations of the National Historic Preservation Act.

Objective 8.2 Cultural Resource Education and Interpretation

In partnership with the Klamath Tribes and other preservation stakeholders, develop a program for education and interpretation about cultural resources of Klamath Marsh National Wildlife Refuge within 15 years of Plan approval. Develop or revise a minimum of one interpretative panel, and explore the development of a cultural resources brochure.

Rationale: The Refuge supports a variety of cultural resources and has opportunities to provide interpretation and education to diverse audiences on these unique aspects of the Klamath Marsh area. Interpretation of cultural resources can instill a conservation ethic among the public and others who encounter or manage them. Development of signs and brochures will aid Refuge staff in explaining historical ecological conditions, the importance of restoring and/or maintaining the integrity of those conditions, and the role fish and wildlife play historically and currently in American Indian culture.

The goals of the cultural resource education and interpretive program are two-fold: 1) to relate the connection between cultural resources and natural resources and the role of humans in the environment, and 2) to instill an ethic for the conservation of our cultural heritage.

Strategies:	
8.2.1	Prepare cultural resources education materials and interpretive media (e.g., pamphlets, signs, etc.) for education purposes concerning cultural resources of the Refuge, the perspective of Native Americans, the history of the area, and the conservation and protection of cultural resources. S
8.2.2	Solicit input and advice from concerned tribal representatives in planning, information gathering, and review of educational, interpretive, and outreach programs and publications. Work with tribes and universities to identify the messages and resources that would be most appropriate to share with the public. S
8.2.3	Review existing interpretative panels and revise messages, as appropriate, in consultation with interested tribes. S
8.2.4	In publications or exhibits, provide a brief history of the indigenous peoples of the Klamath Basin, scaling down to the Klamath Marsh region to educate the public. S
8.2.5	Include a cultural resources element in special events held on or off the Refuge, like National Wildlife Refuge Week, etc.

Objective 8.3 Cultural Resource Monitoring

Within 10 years of Plan approval, evaluate conditions of known cultural resource sites on Refuge managed lands, and conduct annual monitoring of known sites.

Rationale: The Service is required to ensure that the integrity of any cultural sites on Refuge lands is protected. As a result of the activities of previous landowners, sites may have been affected or may still be vulnerable to continued degradation (e.g., erosion, traffic, theft). Therefore, sites should be evaluated by qualified professionals, and measures to stop and/or reverse deterioration of the sites should be developed and implemented.

Strategies:	
8.3.1	Conduct quarterly monitoring visits of known cultural resource sites on the Refuge to ensure areas are intact and undisturbed. S
8.3.2	As needed, consult with professional archaeologists, tribal representatives and the regional office archaeologist regarding any necessary protection or remediation measures for cultural resource sites.
8.3.3	Develop additional measures to protect sites and/or remediate past damages, if necessary.

Objective 8.4 Cultural Resource Surveys (new lands)

Identify and delineate any cultural resources on new lands coming under Refuge management within one year of acquisition.

Rationale: Identifying historic properties on lands as they come under Refuge management will enable staff to ensure that any restoration and management programs for fish and wildlife will also protect the integrity of sensitive cultural resources.

Strategies:	
8.4.1	As funding is available, a qualified archeologist will survey new properties coming under Refuge management to locate and delineate, as needed, any known or previously unrecorded cultural resource sites.
8.4.2	In consultation with the appropriate Service or other professional cultural resource experts, and Klamath tribal representatives, evaluate sites on newly-managed properties to identify any protection, restoration, and/or management measures that may be necessary.

Objective 8.5 Tribal Coordination

Meet at least annually, or as needed, with the Klamath Tribes and other concerned tribal groups to discuss land management and restoration activities planned for the upcoming field season.

Rationale: The Refuge has made it a priority to meet with the Klamath Tribes to keep them informed regarding planned Refuge activities. Often there are several meetings conducted each year to discuss Refuge management activities. Promoting and continuing this communication has allowed projects to be completed in a timely and efficient manner and ensures that tribal concerns have been addressed or evaluated.

Strategies:	
8.5.1	Hold a minimum of one meeting each year to review previous projects or summarize management or restoration projects and public events that are planned by the Refuge for the upcoming year, regardless of whether these activities will require formal State Historic Preservation Office consultation.
8.5.2	Update the 1985 MOU between the Refuge and the Klamath Tribes to provide specific guidelines and protocols regarding tribal subsistence hunting and gathering activities on Refuge lands within 10 years of Plan completion.

Goal 9 Recreation

Nurture an understanding of and appreciation for wildlife and other natural resources of Klamath Marsh National Wildlife Refuge by providing opportunities for compatible wildlife-dependent recreation while maintaining the primitive uncrowded nature of the area.

Objective 9.1 Hunting

Maintain the current 11,200 acres of land and water within the Refuge open to waterfowl hunting (Figure 3-13) *in accordance with respective State and Federal regulations. Evaluate and consider opening additional lands to big game or waterfowl hunting after river and wetland restoration projects are completed.*

Rationale: Keeping the Refuge open to hunting is in accordance with the Refuge Improvement Act directive to facilitate wildlife-dependent uses when compatible. The 11,200 acres currently open for waterfowl hunting provide reasonable access, potentially flooded areas in the fall, and an easily understood Refuge boundary for visitors, while still affording sanctuary areas for wildlife in other Refuge locations. During the past 10 years, fewer than 50 waterfowl hunt visits occurred per year—with no use during years of extreme drought. Historically, when better waterfowl habitat existed, hunt visits often exceeded 50 per year. This objective represents a balanced approach between the needs of waterbirds and the public as reflected in the following overall protection goals: 1) provide migrating waterbirds a balanced and effective network of feeding and resting areas, 2) minimize disturbance to feeding and resting waterbirds in areas closed to hunting, 3) provide waterfowl hunters with some reasonable hunting opportunities.

Strategies:

9.1.1	Continue yearly review of Refuge hunting regulations to ensure clarity, to address any emerging issues or concerns, and to give the tribes and public an opportunity to review and comment on any changes.
9.1.2	Update and continue to publish the Refuge hunting regulations brochure to inform the public of hunting opportunities and Refuge-specific regulations.
9.1.3	Continue to improve the hunting experience through improvements to habitat and enforcement of regulations.
9.1.4	Review and update the 1985 Refuge Hunting Plan and modify as needed within three years of Plan completion to comply with new regulations, policies, and Plan objectives.
9.1.5	Clearly sign areas open to hunting and ensure notification through news releases and other means of any changes well before the hunting season(s) begin.
9.1.6	Continue to conduct fall aerial waterfowl surveys every two weeks in the fall to evaluate waterbird use on the Refuge and determine use patterns and relative abundance of species. Continue posting survey information on the Web site for public viewing.
9.1.7	Regularly monitor and evaluate hunting program with feedback from hunters and other users to determine if objectives are being met and to allow for adaptive management.
9.1.8	Maintain one dual-function Refuge officer on-site or provide at least 25 percent of a full-time officer's time to enforce hunting program regulations.
9.1.9	Coordinate with state, tribal, and U.S. Forest Service law enforcement officers regarding patrol of Refuge lands and surrounding lands during the fall hunting seasons.
9.1.10	Provide sufficient feeding and resting habitat for waterfowl in areas closed to hunting.

Refuge hunt programs are designed to provide high quality experiences. A quality hunting experience means that hunters are safe, hunters exhibit high standards of ethical behavior, hunters are provided with uncrowded conditions, hunters have reasonable harvest opportunities, hunters are clear on which areas are open and closed, and minimal conflicts occur between hunters and other visitors.

Other parts of the Refuge are closed to public entry to protect habitat and cultural resources. After future restoration efforts are complete, the Refuge may be re-evaluated to determine if big game or other waterfowl hunting opportunities might be accommodated. A separate EA and public process would be conducted to open any new areas to hunting.

Objective 9.2 Fishing

Within one year, provide safe fishing opportunities on 515 acres of the Refuge. Within three years after river and wetland restoration is completed, evaluate the potential to open additional areas and/or modify fishing opportunities within the Refuge.

Rationale: Fishing is one of the six priority public uses identified in the National Wildlife Refuge System Improvement Act of 1997 and is to be facilitated when compatible with the purposes of the Refuge and the mission of the Refuge System. Compatible opportunities can be provided with reasonable restrictions, good compliance with regulations, and minimal administrative oversight.

Strategies:	
9.2.1	Eliminate fishing from Silver Lake Highway borrow ditches (18 acres). This area provides a very poor quality fishing opportunity and promotes the activity along a narrow and unsafe highway corridor that sees moderate truck and vehicle traffic.
9.2.2	Change current provisions in 50 CFR part 32 to allow fishing from boats in Wocus Bay. Currently, fishing is restricted to areas along the shoreline. Although fishing in the area is presently very poor, the restoration of the Williamson River and associated riparian/wetland habitats may improve fishing opportunities.
9.2.3	Explore opportunities after the Williamson River and associated riparian/wetland habitats have been restored to open reaches of the Williamson River and Big Springs Creek to fishing for trout. If such opportunities were feasible and compatible with Refuge purposes, a separate EA would be completed to open new areas. Partner with Oregon Department of Fish and Wildlife to explore future fishing opportunities.
9.2.4	Fishing is conducted in accordance with state regulations and special Refuge restrictions.
9.2.5	Fishing would be restricted to taking of fish only (no frogs, crayfish, etc.) and conducted with rod and reel only (no nets, etc.).
9.2.6	Add fishing regulations to the new Klamath Marsh National Wildlife Refuge general brochure or combine information with the hunting brochure.
9.2.7	Cooperate with the state in its ongoing fishery management programs.
9.2.8	Within three years after Plan approval, update the Refuge fisheries management plan (USFWS 1992) to be consistent with the Plan, Federal policies, and State regulations.
9.2.9	Periodically monitor and evaluate fishing programs and users to determine if objectives are being met.
9.2.10	Work with the state to adopt a "no lead weight or lure" policy that mandates use of artificial bait or lures only (no bait). This would reduce the threat of lead poisoning to wildlife and reduce potential introductions of exotics (worms, minnows, etc.).

Fishing opportunities are currently minimal and of poor quality on the Refuge. Fishing is currently allowed in Wocus Bay and within the borrow ditches that parallel Silver Lake Highway. In the past two years, Refuge staff estimate only 1–2 fishing visits per year. The primary species historically harvested in fishing areas is the non-indigenous brown bullhead. Removing recreational fishing from borrow ditches along Silver Lake Highway will not significantly reduce quality fishing opportunities and would improve the quality of the program by promoting a safer fishing experience. The following strategies would enable the Refuge to offer a better quality, safer program for the public. A quality fishing experience means that anglers are safe, anglers exhibit high standards of ethical behavior, anglers are provided with uncrowded conditions, anglers are clear on which areas are open and closed to fishing, and minimal conflicts occur between anglers and other visitors.

Objective 9.3 Wildlife Observation and Photography

Within 10 years, construct adequate facilities and develop programs for visitors to visit the Refuge to observe, photograph, and enjoy the Refuge's unique natural habitats and wildlife during all seasons of the year with a target of 4,000 visit opportunities per year.

Rationale: Wildlife observation and photography are two of the six priority visitor uses identified in the National Wildlife Refuge System Improvement Act of 1997 and are to be facilitated when compatible with the purposes of the Refuge and mission of the Refuge System. Wildlife viewing, nature observation, and wildlife photography are the primary visitor activities at Klamath Marsh Refuge. It is estimated that 2,000 to 3,000 visits per year focus on these activities. Currently, visitors are restricted to viewing or photographing wildlife from vehicles, from designated roads (no hiking off-road), from one overlook area at Wocus Bay, and from non-motorized boats in Wocus Bay (July 1–September 30).

This objective represents an increase in the number of photo blinds and self-guided auto routes, and the amount of acreage open to walking. This expansion of facilities reflects a balanced and measured increase in facilities for wildlife observation and photography while continuing to meet fish, wildlife, and cultural resource protection and management responsibilities.

Strategies:	
9.3.1	Following habitat restoration activities and as part of a visitor service plan, determine the need for and locations of 1–2 permanent photo blinds. New photo blinds would be constructed and placed in areas that would have the least amount of disturbance to wildlife but provide good photographic opportunities. Possible locations include Wocus Bay and areas near Military Crossing Road. Registration with the Refuge office for use of blinds would be implemented if needed. At least one blind should be accessible to people with disabilities. $S
9.3.2	Evaluate current use and needs of photographers on the Refuge.
9.3.3	Include information on photography and ethical behaviors in the general Refuge brochure.
9.3.4	Evaluate and modify pullouts along Silver Lake Highway to create safe and user friendly observation and photography points. Any modifications would be coordinated with state and county transportation departments.
9.3.5	Create pullouts at key locations along a new North Refuge self-guided auto tour route where wildlife may be observed or scenic vistas observed and/or photographed (see Objective 10.2 interpretative strategies for details). $
9.3.6	Modify the boating period in Wocus Bay to July 15–Sept 30 (versus staring July 1) in order to better protect nesting birds.

9.3.7	Allow electric motors to be used on boats in Wocus Bay to better accommodate people with disabilities.
9.3.8	Improve parking area at boat ramp to delineate where people should park. Allow parking for four vehicles with trailers. Add gravel to the boat ramp and parking areas to improve access to the bay.
9.3.9	Open the area south of Silver Lake Highway and west of Wocus Bay Road to walking from July 15–March 30 to provide for better wildlife observation and photography opportunities while maintaining protection for nesting birds and sensitive cultural resource sites.
9.3.10	Develop a Refuge brochure that highlights what to see and do, provides Refuge regulations, and includes a detailed Refuge map highlighting locations where facilities are provided for wildlife observation and photography. $S
9.3.11	Schedule annual inspection and maintenance of recreation facilities.
9.3.12	Ensure adequate signing and information in brochures, on Web sites, and on maps so the public is aware of the facilities.
9.3.13	Continue to promote wildlife observation and photography opportunities of the Refuge through public education, outreach, special programs, and partnerships with the state and private conservation groups.
9.3.14	Seek new funding and partnership opportunities, including volunteers, for construction and maintenance of facilities.
9.3.15	Within 15 years following approval of the Plan, develop a visitor service plan that covers all Refuge public use programs.
9.3.16	Conduct regular evaluations, including feedback from visitors, to determine if objectives are being met.

Objective 9.4 Public Use Monitoring

Within 10 years of Plan approval, determine public use levels year round and monitor impacts to habitat and wildlife via surveys.

Rationale: Determining public use volumes and patterns will allow the Refuge to improve protection of Refuge habitats, potentially improve visitor services via solicitation of feedback, improve the efficiency of law enforcement operations, and create a more accurate estimate of visitor use. There is currently no mechanism in place to determine visitor use numbers other than general observations by staff.

Strategies:	
9.4.1	Install visitor registration boxes at the Wocus Bay boat launch, Wocus Bay overlook, Wocus Bay road entrance kiosk, Military Crossing Road, and the Refuge office to estimate visitation and assess what recreational activities are most popular.
9..4.2	Install traffic counters at 2–4 locations to assist in tracking visitation. Analyze and summarize traffic data annually to determine trends. S $
9.4.3	Close areas of the Refuge to visitor use as needed to protect sensitive wildlife or habitat.

Objective 9.5 Refuge Information and Regulations

Within one year of Plan completion, conduct annual review and update of the general public use regulations governing entry and use of the Refuge.

Rationale: Providing updated and accurate information to the public regarding public use regulations, recreational opportunities, and general Refuge orientation is critical to running an effective visitor use program that protects Refuge habitats. The current Refuge brochures and regulatory signing are not adequate and need updating.

Other Objectives or Specific Strategies that will help meet this goal include:

- Goal 10 Environmental Education and Interpretation – all objectives

Strategies:	
9.5.1	Complete a law enforcement step-down plan for the Refuge in cooperation with the state and other Federal agencies within three years of Plan completion. S
9.5.2	Reduce fragmentation, damage to habitat types, and disturbance to wildlife by closing select roads that enter sensitive areas. Coordinate with USFS to achieve this strategy.
9.5.3	Close non-public roads that have been created on the Refuge via a combination of gates, locks, and signs.
9.5.4	Develop and install entrance and regulatory signs on all public access points to the Klamath Marsh Refuge in coordination with the USFS. Post pertinent regulations at primary public use areas, such as primary kiosks and boat ramps.
9.5.5	Provide tribes, the public, and the state ample opportunity to review and comment on any new or substantially changed regulations.
9.5.6	Develop a new stand-alone Klamath Marsh Refuge brochure that includes public use regulations. Annually review Refuge brochures for changes. S $
9.5.7	Improve directional, regulatory, and/or boundary signing on the Refuge to ensure visitors comply with regulations. Use signs, brochures, fact sheets and the Web site to provide Refuge regulations to the visiting public.
9.5.8	Continue proactive law enforcement to inform and educate the public on Refuge regulations and to seek their compliance.
9.5.9	Conduct an education and information campaign using news releases and public meetings to gather public comments on proposed changes to Refuge management and to inform the public of regulation changes.
9.5.10	Ensure information stations located throughout the Refuge are filled regularly with Refuge brochures.
9.5.11	Provide 0.25 FTE (law enforcement) or one dual-function law enforcement officer to ensure protection of Refuge resources and public safety. S
9.5.12	Seek to cross-deputize Refuge law enforcement officers with the U.S. Forest Service law enforcement program.
9.5.13	Close Road 220 at Refuge boundary.
9.5.14	Coordinate with Oregon Department of Transportation to improve signs directing visitors to the Refuge along Highway 97.

Goal 10 Environmental Education and Interpretation

Provide interpretive and education services that emphasize the natural setting and function of Klamath Marsh Refuge and its role in the National Wildlife Refuge System.

Objective 10.1 Environmental Education

Within 10 years of Plan completion, develop an environmental education program with a target of providing 3–5 on-site environmental education programs per year and 3–5 offsite programs that educate participants about the Refuge's role in the conservation of Klamath Basin habitats and its fish and wildlife.

Rationale: Environmental education is one of the six priority public uses of the Refuge system and should be fostered if compatible with the Refuge purpose and Refuge System mission. Interpreting the resources and challenges of the Refuge to the public and incorporating these topics into school curricula are important ways to influence the future well-being of the Refuge and the Klamath Basin resources. Only through understanding and appreciation will people be moved to personal and collective action to ensure a healthy Refuge for the future. Klamath Marsh Refuge is in a unique position to offer education agencies, teachers, and students an opportunity to study natural resource management and conservation issues in a remote outdoor setting. Since the establishment of the Refuge, there has been sporadic use of the Refuge by educators or various interest groups as a place to conduct educational field trips. The importance of utilizing Refuges as outdoor classrooms to promote the importance of wildlife conservation is a growing initiative for the Service. Developing and providing a limited number of educational programs or outreach events will support the Service's goals and promote an understanding of the importance of Klamath Marsh Refuge to the National Wildlife Refuge System and to the regional ecosystem.

Strategies:	
10.1.1	Work with partners, including the Klamath County schools, the Klamath Tribes, and Klamath Bird Observatory, among others, to develop specific environmental education programs covering topics such as habitat management practices and principles; the value of wetland, river, forested, and riparian habitats; water issues and uses in the Williamson Watershed and Klamath Basin; and the National Wildlife Refuge System. S
10.1.2	Integrate, if appropriate, with existing education programs such as the Klamath City School's Forestry Camp at Fort Klamath, and other civic youth group programs (e.g., Boy Scouts, Girl Scouts, 4-H, etc.).
10.1.3	Develop an educator-led age-appropriate curriculum for school children that is specific to the resources and goals of the Klamath Marsh Refuge and includes pre- and post-visitation activities. S
10.1.4	Promote partnerships with educational groups to foster and facilitate environmental education opportunities at Klamath Marsh Refuge.
10.1.5	As changes are made to habitats on the Refuge, create opportunities to include teachers, students, volunteers, and interns in long-term restoration activities and monitoring. Conduct regular evaluations and gather feedback from teachers and students to improve and modify programs as needed.
10.1.6	Conduct presentations off-Refuge at local schools, universities, clubs, agencies, etc., as time permits.

Objective 10.2 Interpretation

Provide high quality interpretive opportunities focused on Klamath Marsh Refuge and its wildlife during all seasons for up to 4,000 visitors a year within 10 years of Plan completion.

Rationale: Interpretation is also one of the six priority public uses of the Refuge system that should be fostered if compatible with the Refuge purpose and Refuge System mission. Many visitors who stop at this remote Refuge must rely on signs, kiosks, and brochures for information, as on-site Refuge staff is minimal. Improving existing interpretative facilities would allow visitors to garner an understanding of why the Refuge was established, what the Refuge provides, how it contributes ecologically to the regional landscape, and how it links to the rest of the Refuge system.

A new visitor contact station and office area will be a center for visitor orientation and information at the Refuge. The contact station will provide visitors their first impression of the Refuge and access to facilities and interpretive materials about the Refuge. The current visitor contact station is a house that is needed as additional Refuge housing and is located within the maintenance and Refuge housing area. The current setup is not accessible for visitors with disabilities, allows visitors unacceptable access to maintenance and housing facilities, and provides a poor location for orientation and access into the Refuge. Construction of a new accessible building approximately one-half mile from the current site will free up additional Refuge housing and create an appropriate location for visitors to orient and receive an outstanding overlook of the Refuge.

Strategies:	
10.2.1	Hire a 2–4 year term employee (GS-9) to assist with the development of interpretative materials, educational programs, and outreach activities specific to Klamath Marsh Refuge. $
10.2.2	Conduct an annual condition review of interpretive signs, and complete maintenance and sign replacement as needed.
10.2.3	Continue to place interpretative signs at public access and overlook points in cooperation with the tribes and various interested entities.
10.2.4	Develop a portable Refuge display for use at fairs, shows, and festivals that highlights Klamath Marsh Refuge. S
10.2.5	Develop a welcome kiosk at the west entrance of the Refuge on Silver Lake Highway that contains a parking area sufficient to allow two buses or large recreation vehicles room to park or turn around. The kiosk would be accessible and contain three interpretative signs that showcase the National Wildlife Refuge System, Refuge regulations, and recreational opportunities on the Refuge. $S
10.2.6	Develop a new accessible visitor contact station at milepost 16.5 on Silver Lake Highway (about three-quarters of a mile west of current office). In addition to office space needs, the facility should include a small indoor interpretive area, accessible outdoor and indoor bathrooms, a three-panel outdoor welcome kiosk, parking for 15 vehicles and two buses, and a small covered outdoor shelter for environmental education gatherings. The facility should be accessible to all visitors and built as energy efficient as possible. $S
10.2.7	Erect various bird feeders near the new visitor contact station with an interpretive sign identifying the birds frequently observed.
10.2.8	Develop a wildlife garden area near the new visitor contact station that shows how to identify several common native plant species.

10.2.9	Develop a self-guided auto tour loop around the north end of the Refuge using existing primitive roads. The route would be marked by plastic Carsonite signs with numbers, and the road route markers would be shown in the general Refuge brochure. Three to five primitive pullouts would be provided along the route and include a one-panel interpretative sign highlighting such topics such as marsh ecology, species' life histories, habitat management, and watershed conservation. $S
10.2.10	Develop a brochure interpreting the history of the local region. $S
10.2.11	Improve and update the informational brochure for the Refuge canoe route.
10.2.12	Maintain or replace interpretive panels and the kiosk at Wocus Bay entrance road and the interpretive panels at Wocus Bay overlook as needed. $
10.2.13	Add one interpretive panel at the boat launch site along Wocus Bay road that informs visitors about the canoe route, marsh ecology, and Refuge regulations. $
10.2.14	Work with county and state transportation programs to develop and install directional signs on public roads (e.g., Highway 97, Silver Lake Highway, Highway 31) directing visitors to Klamath Marsh Refuge. Replace the outdated sign at the Highway 97 and Silver Lake Road intersection with advance directional signs north and south of this intersection.
10.2.15	Ensure that Refuge office, housing, and maintenance needs are reflected in budget needs databases. Maintain and expand shop facilities if needed to comply with safety standards.
10.2.16	Continue to maintain Service-owned facilities using annual maintenance budget allocations.
10.2.17	Develop interpretive panel and brochure explaining climate change and its effects on Klamath Marsh Refuge vegetation and water resources. S $

Objective 10.3 Outreach and Partnerships

Develop a public outreach program within five years of Plan completion to provide information on the Klamath Marsh Refuge, the National Wildlife Refuge System, and the U.S. Fish and Wildlife Service. Create opportunities for new partnerships among Federal, state, county, and local agencies; organizations; schools, corporations; and communities to promote and sustain the Refuge. The Refuge will take a leadership role in developing and strengthening partnerships and will conduct a variety of outreach efforts to more effectively achieve Refuge goals and contribute to the protection and enhancement of the Klamath Marsh region and Williamson River Watershed.

Rationale: An outreach program is a key component in helping the public become aware of the Refuge, its resources, and the public use programs developed for their use and enjoyment. An outreach program would also inform the public about the National Wildlife Refuge System and the Service.

Strong partnerships will be essential for the Service to achieve its vision and goals for the Refuge. Cooperative efforts with key partners will further habitat protection and restoration, watershed efforts, and education and interpretation. The Refuge's location in the Williamson Watershed and Klamath Basin provides a focal point that encourages participation by a variety of partners to come together to strengthen watershed protection. Outreach efforts will enable the Refuge to reach new audiences.

Strategies:	
10.3.1	Use existing outreach opportunities as they occur, such as International Migratory Bird Day and National Wildlife Refuge Week, and participate in local, county or state events that provide a venue to conduct environmental education. Continue to seek grants to fund events and programs.
10.3.2	Continue providing articles about Klamath Marsh Refuge for publication in the quarterly Klamath Basin Complex Newsletter. Revise and enhance information about biological, public use, and outreach programs at Klamath Marsh Refuge on the Klamath Basin Refuge Complex web site.
10.3.3	Stay actively involved in other neighboring Federal, state, and private planning processes to protect Refuge resources and foster cooperative management of those resources in the Klamath Basin.
10.3.4	Continue or expand opportunities with the Klamath Falls Chamber of Commerce, Travel Klamath (county tourism group), and other neighboring communities to participate in local events, develop Web sites, and improve dissemination of literature about the Refuge.
10.3.5	Participate in Oregon Partners in Flight Program, Williamson River Watershed Working group, Joint Venture of North American Waterfowl Mgt. Plan, USFWS Private Lands Programs, and USFWS Partners for Wildlife Program.
10.3.6	Provide natural resource information collected at the Klamath Marsh Refuge to other interested agencies, groups, and researchers to foster collaborative efforts and support ecoregion-wide natural resource databases.
10.3.7	Encourage universities and researchers conducting ecoregion natural resources investigations to include Klamath Marsh Refuge.

Objective 10.4 Volunteers

Improve the existing volunteer program and strengthen the existing relationship with the Klamath Basin Refuge Complex Friends Group within five years of Plan completion.

Rationale: Volunteer programs provide the capacity, at low economic cost, to benefit the Refuge in many different facets. Refuge volunteers can provide valued services in many program areas, including biological monitoring, resource management, administration, nature interpretation, maintenance, etc. Volunteers frequently increase the productivity of a station, particularly when it is limited by staffing and funding shortages. A volunteer program also provides avenues for greater community involvement with the Refuge. Currently, the Klamath Marsh National Wildlife Refuge operates a small volunteer program. The administration of a larger volunteer program will require additional volunteer, seasonal, or permanent staff to effectively manage the program. The Refuge is recognized and supported as needed by the umbrella Klamath Basin Refuge Complex Friends Group.

Other objectives or strategies that will help meet this goal include:

- Goal 9 Recreation – all objectives

Strategies:	
10.4.1	Determine tasks and projects suitable for volunteer programs on a seasonal basis and implement as volunteers are available.
10.4.2	Recruit 1–2 student volunteers seeking natural resource working experiences to assist with projects during the summer months. Housing would be available in the Refuge duplex facility. $
10.4.3	Hold a volunteer recognition event annually for the Klamath Marsh Refuge volunteers. Annually recognize volunteers and their accomplishments via certificates or small awards.
10.4.4	Further involve the Klamath Basin Wildlife Refuge Association (KBWRA) Friends Group in Klamath Marsh Refuge activities and seek to expand the group in the local area.
10.4.5	Develop two trailer pad sites with water, electricity, and septic to provide for volunteers that provide their own recreational vehicle housing. The site may be affiliated with the existing maintenance area or with the new visitor contact building. $S
10.4.6	Utilize a variety of sources (Web sites, email, university contacts, wildlife and fishery professional societies) to recruit volunteers with diverse backgrounds.

Chapter 5. Implementation and Monitoring

5.1 Introduction

This chapter summarizes the actions, funding, coordination, and monitoring required to implement the selected plan (Plan), as presented chapter 4. The Plan will serve as the primary management reference document for Refuge planning, operations, and management for the next 15 years or until it is formally revised or amended within that period. The Service will implement the final Plan with assistance from existing and new partner agencies and organizations and from the public. The timing and achievement of the management strategies proposed in this document is contingent upon a variety of factors, including:

- Funding & Staffing
- Completion of Step-Down Plans
- Compliance Requirements
- Adaptive Management
- Monitoring

Each of these factors is briefly discussed here as it applies to the Service's proposed action.

As noted in the inside cover, these plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition. These decisions are at the discretion of Congress in overall appropriations, and in budget allocation decisions made at the Washington, Regional and Refuge Complex levels of the Service.

5.2 Priority Setting

In the Refuge Improvement Act of 1997, Congress established a three-tiered hierarchy, or three priorities, for refuge management. As a first priority, every refuge is to be managed to fulfill its purposes and the Refuge System mission, namely conservation of fish, wildlife, and plants. Secondly, refuges are to facilitate wildlife-dependent or "Big 6" public uses: hunting, fishing, wildlife observation and photography, and interpretation and environmental education. Of lowest priority is managing other uses and activities such as general recreation.

However, setting priorities in a linear or in-order fashion (e.g., implementing from top to bottom on a list of prioritized actions) is generally not realistic when dealing with the complexities and multi-program nature of managing a national wildlife refuge. In practice, a linear approach is not always workable. The following text explains a few of the reasons why some actions identified in this chapter must be done simultaneously and/or why some general recreation actions are done before other resource-related actions.

- Funding allocations from Congress may not follow an established hierarchy. For example, there may be no appropriations for land acquisition or habitat restoration in a given year, but Congress may choose to fund visitor services enhancement packages.
- A high priority such as habitat restoration is costly on an impaired river and dependent on funding from other sources. Thus, habitat restoration may be the highest priority for the Refuge, but if the funding is lacking, it cannot be accomplished.
- The public or other units of government may strongly urge actions that may not be high-resource priorities, or staff may be confronted with health, safety, or societal needs that must be addressed. Examples include a right-of-way expansion for a utility or highway project or protection of archeological resources.
- Some actions must be conducted when weather or climate conditions are suitable. For example,

if the region is in a drought cycle, it may be the Refuge could successfully burn or graze an area that typically is not dry enough to conduct these practices.

5.3 Step-Down Management Plans

Some refuge programs or initiatives require more in-depth planning than the Plan process is designed to provide; for these programs and initiatives, the Service prepares step-down management plans. The following text lists step-down plans that are called for in the Draft Plan or that are required by Service policy. The planned completion date is in parenthesis, as well as a notation as to whether the step-down plan is new or a revision of an existing plan. These Refuge-specific plans provide the details of implementing the respective program or initiative described in the broad terms in the objectives and strategies. These plans will be developed in consultation with other agencies, states, and partners. The public will be given ample opportunity for plan review and comment. Environmental assessments or other documentation may also be needed to comply with National Environmental Policy Act or other requirements.

- Fire Management Plan (revise as needed)
- River and Wetland Restoration Plan (new 2011)
- Wildlife Inventory and Monitoring Plan (new 2015)
- Habitat Management Plan (new 2015)
- Hunting Plan (revise 2018)
- Fishing Plan (revise 2018)
- Fishery Management Plan (new 2020)
- Visitor Services Plan (new 2024)
- Law Enforcement Plan (new 2020)
- Cultural Resource Management Plan (new 2024)

5.4 Funding and Staffing

Resources are required to operate a National Wildlife Refuge, including capital outlay for equipment, facilities, labor, other expenses, and recurring expenses. Many of the actions listed in Chapter 4 (Goals and Objectives) can be accomplished with existing resources. Some of these actions reflect current, ongoing efforts. Other actions identified in Chapter 4 require new funding and/or staffing to fully implement. The completion target for these actions is generally 2024, given the unknown nature of funding. Actions in Goals 1–7 are the highest priority since they directly support the protection and enhancement of fish and wildlife and their habitat. Details of these actions are identified in Chapter 4.

The estimated initial capital outlay to implement the actions described in this Plan is approximately $8.3 million (Table 5-1). Not all of these capital expenditures would occur in the same year. Many of these strategies would be most likely implemented during the next 15 years, depending on the availability of funding. The largest costs for initial outlays are for habitat restoration. Some contracts or cooperative agreements will be needed to provide specialized services beyond the core Refuge functions for which staff are required. The estimated annual recurring cost to fully implement the Plan is approximately $592,000 (Table 5-3).

Costs are estimates and will likely be higher or lower based on detailed project planning and timing of implementation. Staff costs reflect 2010 salary and benefit rates at grades normal for the positions described. These needs will be reflected in key Refuge System databases such as the Refuge Operating Needs System and in the Service Assessment and Maintenance Management System which provide information used in budget formulation and allocation. The Service will also seek other project funding such as cost share agreements with partners, agency grant programs, grants from non-profit groups, and cost-saving or reprogramming measures within existing budget allocations.

5.5 Partnership Opportunities

As described in Chapter 1, a wide array of private and public partners play an important role in helping the Service achieve its goals and objectives for the Refuge. The Service will continue to rely on these and other partners to help implement the final Plan and to provide input for future Plan updates. This draft Plan identifies many projects that provide

new opportunities for existing or new partners. The forum for bringing together such a diversity of partners, who often have different missions and agendas, is both formal and informal. Established associations, commissions, committees, and working groups bring people together; plans, planning, and public meetings allow input from everyone. Specific projects and events let citizens lend a helping hand. These partnerships will remain an important part of Plan implementation, both in gaining and maintaining public and partner understanding and support, and through the joint funding of specific actions.

Table 5-1. Estimated project specific costs to fully implement the Plan

Action	Total Cost	Priority[1]
Monitor vegetation trends every 5 years via GIS (1.1.4)	$25,000	M
Conduct an assessment to evaluate current riparian/wetland habitat conditions, restoration potential, and surface/groundwater inputs to the hydrology of the marsh. Develop range of restoration alternatives via modeling process (2.1.1–2.1.14)	200,000	H
Implement preferred river and wetland restoration alternative after completion of EA (2.1.15)	$2,000,000	H
Establish water gauges throughout the sedge habitats to monitor and document water levels pre- and post-restoration and to evaluate rail and crane nesting use relative to water levels (3.1.2)	$25,000	H
Evaluate and modify fencing needs (7.3.1–7.3.2)	$150,000	L
Funding for conservation easements and land acquisition	> $5,000,000	M
Following habitat restoration activities and as part of a visitor service plan, plan, design, and implement 1–2 permanent photo blinds (9.3.1)	$40,000	L
Develop a general Refuge brochure (9.3.10)	$5,000	M
Develop welcome kiosk at the west entrance of the Refuge on Silver Lake Highway (10.2.5) (includes kiosk, interpretative panels, parking area)	$70,000	M
Develop a new accessible visitor and office contact station (10.2.6)	$700,000	M
Develop a self-guided auto tour loop around the north end of the Refuge (10.2.9) (carsonite signs, brochure guide)	$15,000	L
Develop a brochure interpreting the history of the local region (10.2.10)	$5,000	L
Develop interpretive panel and brochure explaining Climate Change and its effects on Klamath Marsh Refuge vegetation and water resources.(10.2.17)	$8,000	L
Develop two trailer pad sites with electricity, water, and septic to support the volunteer program (10.4.6)	$25,000	M
Funding to support implementation of the Fire Hazard Reduction and Wildlife Habitat Enhancement Project EA (all habitat objectives)	$40,000	H
Install traffic counters (9.4.2)	$5,000	L
Improve boat ramp and parking area at Wocus Bay (9.3.8)	$10,000	L
Replace or add interpretative signs at Wocus Bay (10.2.12–10.2.13)	$20,000	L
TOTAL	**$8,268,000**	

[1] Relative priority for action (H = high, M = medium, L = low).

Table 5-2. Estimated annual re-occurring costs to fully implement CCP

Expenditure	Total Cost
Existing staff (refuge manager GS-12, biologist GS-11, heavy equipment operator WG-9)	$225,000
Seasonal maintenance worker WG-8 (6 month)	$40,000
Biologist FTE GS-9/11	$75,000
Seasonal bio-tech GS-5/7 (4-6 month)	$30,000
Law enforcement officer GS-9 (located at Klamath Complex Headquarters –provides 25% of time to Klamath Refuge if Dual function officer Position (Manager) is not available)	$20,000
Public use specialist (4-year term) GS-9	$60,000
Prescribe fire specialist FTE GS-9/11	$75,000
Prescribed fire	$15,000
Water quality monitoring (TMDLs)	$5,000
Invasive species monitoring and treatment	$12,000
Vegetation and wildlife monitoring	$10,000
Maintenance (repairs, replacement, rentals, etc) and utilities (fuel, electricity, phones, postage)	$80,000
Computer services and maintenance, field supplies and equipment	$20,000
TOTAL	**$592,000**

Refuge staff work closely with the Klamath Tribes and Oregon Department of Fish and Wildlife in designing and carrying out projects and programs. The U.S. Forest Service (Chemult and Chiloquin Districts of the Winema-Fremont National Forest) is also a critical partner due to its land ownership around the Refuge and throughout the watershed.

The U.S. Geological Survey, Environmental Protection Agency, APHIS, and state-level counterpart agencies all play a role in biological monitoring, research, environmental regulation, and policy making within the watershed, and thus the Refuge. Other U.S. Fish and Wildlife Service programs such as ecological services can also play a key role in supporting Refuge projects and programs. The Service's Partners for Fish and Wildlife Program will continue to play a critical role in working with private landowners to improve the Williamson River Watershed.

Conservation organizations are active in policy issues and/or land acquisition affecting the Refuge, including National Audubon Society and The Nature Conservancy. A host of local conservation and sporting organizations like the Klamath Bird Observatory are also active in supporting and working with the Refuge. Lastly, many citizen conservationists help the Refuge as volunteers or as members of the Refuge Friends group (The Klamath Basin Wildlife Refuge Association).

5.6 Monitoring and Evaluation

The Plan is designed to be effective for a 15-year period. The plan will be reviewed and revised as required to ensure that established goals and objectives are still applicable and that the Plan is implemented as scheduled. The monitoring program will focus on issues involving public use activities, habitat management programs, wildlife inventory,

and other management activities. Monitoring and evaluation will use the adaptive management process (see Section 5.8).

Collection of baseline data on wildlife populations will continue. This data will be used to update existing species lists, wildlife habitat requirements, and seasonal use patterns. Migratory birds, raptors, and species of management concern will be the focus of monitoring efforts.

Where information gaps exist, a concerted effort will be made to obtain information. With new information, goals and objectives may need modification. Public involvement will be encouraged during the evaluation process.

Monitoring of public use programs will involve the continued collection of visitor use statistics. Monitoring will be done to evaluate the effects of public use on Refuge habitat, wildlife populations, and visitor experience.

The wildlife inventory and monitoring plan will be critical since fish and wildlife are important barometers of habitat condition and health. This plan will deal directly with better monitoring and evaluation, and in this regard, adequate staffing and continued partnerships with U.S. Forest Service, ODFW, and others will be important.

Many actions inherent in the Plan are new directions, and monitoring will help the Service understand the effects of various management actions on habitat, fish and wildlife populations, and public use patterns and levels. In addition, the Williamson River and Klamath Basin Watersheds will certainly change over time. Land use changes, invasive species, wildfires, disease outbreaks, and climate changes may alter expected outcomes, and monitoring will be critical to detecting and reacting to such change.

5.7 Plan Amendment and Revision

The Plan is intended to evolve as the Refuge changes, and the Refuge Improvement Act specifically requires that comprehensive conservation plans be formally revised and updated at least every 15 years. The formal revision process would follow the same steps as the Plan creation process. In the meantime, the Service would be reviewing and may update this Plan periodically based on the results of the adaptive management program, which uses monitoring, evaluation, and experimentation to learn and change aspects of the management plan as needed. The Plan may also be reviewed during routine inspections or programmatic evaluations and while preparing annual work plans. Results of any or all of these reviews may indicate a need to modify the Plan. The goals described in this Plan would not change until they are re-evaluated as part of the formal Plan revision process. However, the objectives and strategies may be revised to better address changing circumstances or to take advantage of increased knowledge of the resources on the Refuge. It is the intent of the Service to have the Plan apply to any new lands that may be acquired. If changes are required, the refuge manager would determine the level of public involvement and associated NEPA documentation.

The intent of the Plan is for refuge objectives and strategies to be attained over the next 15 years. Management activities would be phased in over time and implementation is contingent upon and subject to results of monitoring and evaluation, funding through Congressional appropriations and other sources, and staffing.

5.8 Adaptive Management

Adaptive management is the process of implementing policy decisions as scientifically-driven experiments that test predictions and assumptions about management plans, using the resulting information to improve the plans. Adaptive management provides the framework within which biological measures and public use can be evaluated by comparing the results of management to results expected from objectives. Management direction is periodically evaluated within a system that applies several options, monitors the objectives, and adapts original strategies to reach desired objectives. Habitat, wildlife, and public use management techniques and specific objectives would be regularly evaluated as results of a monitoring program and other new technology and information become available. These periodic evaluations would be used over

time to adapt both the management objectives and strategies to better achieve management goals. Such a system provides new information for future decision making while allowing resource use.

5.9 Appropriate Use Requirements

The Appropriate Use policy describes the initial decision process the refuge manager follows when first considering whether or not to allow a proposed use on a refuge. The refuge manager must find a use is appropriate before undertaking a compatibility review of the use. Uses that have been administratively determined to be appropriate are the six wildlife-dependent recreational uses (hunting, fishing, wildlife observation and photography, and environmental education and interpretation) and the take of fish and wildlife under state regulations. A review of appropriateness of existing and proposed refuge uses was completed for the Refuge. Grazing and haying for wildlife habitat management, research, snow shoeing and cross country skiing, and bicycling were found to be additional appropriate uses beyond the administratively approved uses listed above (See Appendix H Compatibility Determinations).

5.10 Compatibility Determinations

Federal law and policy provide the direction and planning framework to protect the Refuge System from incompatible or harmful human activities and to insure that Americans can enjoy Refuge System lands and waters. The Improvement Act is the key legislation on managing public uses and compatibility. Before activities or uses are allowed on a refuge, uses must be found to be "compatible" through a written compatibility determination. A compatible use is defined as a proposed or existing wildlife-dependent recreational use or any other use of a national wildlife refuge that, based on sound professional judgment, will not materially interfere with or detract from the fulfillment of the Refuge System mission or the purposes of the national wildlife refuge. Sound professional judgment is defined as a decision that is consistent with the principles of the fish and wildlife management and administration, available science and resources, and adherence to the requirements of the Improvement Act, and other applicable laws. Wildlife-dependent recreational uses may be authorized on a refuge when they are compatible and not inconsistent with public safety. Compatibility determinations for hunting, fishing, wildlife observation and photography, environmental education and interpretation, haying and grazing, research, snow showing, cross country skiing, and bicycling are included in Appendix H.

5.11 Compliance Requirements

This Plan was developed to comply with all Federal laws, executive orders, and legislative acts to the extent possible. Some activities (particularly those that involve a major revision to an existing step-down management plan, or preparing a new one) would need to comply with additional laws or regulations besides NEPA and the Improvement Act.