Humboldt Bay National Wildlife Refuge Complex

Draft Comprehensive Conservation Plan and Environmental Assessment

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Abbreviations and Acronyms

AFWO	Arcata Fish and Wildlife Office
AQMD	Air Quality Management District
Bay	Humboldt Bay
BCC	Birds of Conservation Concern
BCR	Bird Conservation Regions
BIDEH	Biological Integrity, Diversity and Environmental Health (601 FW3)
BLM	Bureau of Land Management
BMC	Birds of Management Concern
CCC	California Conservation Corps
CCP	Comprehensive Conservation Plan
CDF	California Department of Forestry and Fire Protection (also, CAL FIRE)
CDFG	California Department of Fish and Game
CDPH	California Department of Public Health
CEQ	Council on Environmental Quality
CESA	California Endangered Species Act
CLMA	Cooperative Land Management Agreement
CNDDB	California Natural Diversity Database
CNLM	Center for Natural Lands Management
CNPS	California Native Plant Society
CWA	California Waterfowl Association
DPS	Distinct Population Segment
DU	Ducks Unlimited
EA	Environmental Assessment
EDPA	Eureka Dunes Protected Area
EE/I	Environmental Education/Interpretation
EO	Executive Order
ES	Endangered Species
ESA	Endangered Species Act of 1973, as amended
ESU	Evolutionary Significant Unit (applied to ESA listed fish)
FBM	Freshwater and Brackish Marsh
FOD	Friends of the Dunes
FHBNWR	Friends of the Humboldt Bay National Wildlife Refuge
FTE	Full Time Employee
GIS	Geographic Information System
HACCP	Hazard Analysis and Critical Control Point Plan
HBEP	Humboldt Bay Ecosystem Program
HBHRCD	Humboldt Bay Harbor, Recreation and Conservation District
HBMP	Humboldt Bay Management Plan
HBWAC	Humboldt Bay Watershed Advisory Committee
HFAC	Humboldt Fish Action Council
IFA	Interjurisdictional Fisheries Act of 1986
HSU	Humboldt State University
IIU	Indian Island Unit
Improvement Act	National Wildlife Refuge System Improvement Act of 1997
IPM	Integrated Pest Management
LPP	Land Protection Planning
MBTA	Migratory Bird Treaty Act
MCSD	Manila Community Services District
MDCMA	Ma-le'l Dunes Cooperative Management Agreement

MLPA	Marine Life Protected Area
MMPA	Marine Mammal Protection Act of 1972
MOU	Memorandum of Understanding
MSDS	Material Safety Data Sheet
NCRWQCB	North Coast Regional Water Quality Control Board
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
NRCS	Natural Resource Conservation Service
NWI	National Wetland Inventory
NWR	National Wildlife Refuge
NWRS	National Wildlife Refuge System
PCFWWRA	Pacific Coast Fish Wildlife and Wetlands Restoration Assoc.
PCJV	Pacific Coast Joint Venture
PDO	Pacific Decadal Oscillation
PIF	Partners in Flight
Porter-Cologne	State Porter-Cologne Water Quality Act
PRBO	Point Reyes Bird Observatory
PVA	Population Viability Assessment
RCAA	Redwood Community Action Agency
Refuge System	The National Wildlife Refuge System
RNA	Research Natural Area
SCC	State Coastal Conservancy
SCEP	Student Career Employment Program
SEFI	Southeast Farallon Island
Service	U.S. Fish and Wildlife Service (also, USFWS)
SFBNWRC	San Francisco Bay NWR Complex
SHC	Strategic Habitat Conservation
SHPO	(California) State Historic Preservation Office
SIU	Sand Island Unit
SLAMM	Sea Level Affecting Marsh Management)
SSC	Species of Special Concern
SWFSC	Southwest Fisheries Science Center
TNC	The Nature Conservancy
TS	Threatened Species
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service (also, Service)
USGS	U.S. Geological Survey
WMA	Weed Management Area
WNV	West Nile Virus
WSHRN	Western Hemisphere Shorebird Reserve Network
YCC	Youth Conservation Corps

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1. Introduction

1.1 Introduction

Humboldt Bay National Wildlife Refuge Complex (Complex), which includes Humboldt Bay National Wildlife Refuge (NWR) and Castle Rock NWR, is located on the northern coast of California.

Humboldt Bay NWR is located in the vicinity of Eureka and Arcata with refuge units distributed around Humboldt Bay, the largest bay between San Francisco Bay and Coos Bay, Oregon. In 1971, Humboldt Bay NWR was established to conserve coastal habitats for a great diversity of animals and plants, especially migratory birds. Years later Humboldt Bay NWR added the Lanphere and Ma-le'l Dunes Units to help conserve the most pristine remaining dune ecosystem on the west coast of the United States.

The Humboldt Bay NWR authorized boundary consists of 9,502 acres (3,379 acres owned in fee title) of freshwater, brackish, and salt marsh; agricultural wetlands; intertidal mudflats; eelgrass beds; and some of the most pristine dune habitats in the western United States.

Castle Rock NWR is a 14-acre nearshore island located in Del Norte County, California, less than a mile northwest of Crescent City. The island is primarily rock with sparse vegetation. Castle Rock NWR hosts one of the largest and most diverse assemblages of breeding seabirds on the Pacific coast, provides a critical roost for thousands of Aleutian cackling geese (*Branta hutchinsii leucopareia*) prior to their transoceanic migration, and provides resting sites for seals and sea lions.

1.2. Purpose and Need for the Comprehensive Conservation Plan

The U.S. Fish and Wildlife Service (Service) prepared this draft Comprehensive Conservation Plan (CCP) to guide management of fish, wildlife, plants, other natural resources, and visitor uses on the Humboldt Bay NWR Complex for the next 15 years. The National Wildlife Refuge System Improvement Act of 1997 (16 United States Code [USC] 668dd-668ee) (Improvement Act) requires that all refuges be managed in accordance with an approved CCP by 2012. Under the 1997 Improvement Act, the National Wildlife Refuge System (Refuge System) is to be consistently directed and managed to fulfill the specific purpose(s) for which each refuge was established and the Refuge System mission. The CCP planning process helps the Service achieve the individual refuge's purposes and the Refuge System mission by identifying specific goals, objectives, and strategies to implement on each refuge.

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

1.3.1. U.S. Fish and Wildlife Service Responsibilities

The U.S. Fish and Wildlife 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, interjurisdictional fish, and certain marine mammals. These groups of species are collectively 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 (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

545 units that provide nearly 95 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 to:

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 interjurisdictional 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. Refuge Purposes

Lands within the Refuge System are acquired and managed under a variety of legislative acts and administrative orders and authorities. The official purpose or purposes for a refuge are specified in or derived from the law, proclamation, executive order (EO), agreement, public land order, funding source, donation document, or administrative memorandum establishing, authorizing, or expanding a refuge, refuge unit, or refuge subunit. The purpose of a refuge is defined when it is established or when new land is added to an existing refuge. When an addition to a refuge is acquired under an authority different from the authority used to establish the original refuge, the addition takes on the purposes of the original refuge, but the original refuge does not take on the purposes of the addition. Refuge managers must consider all of the purposes. However, purposes that deal with the conservation, management, and restoration of fish, wildlife, and plants and their habitats take precedent over other purposes in the management and administration of a refuge.

The 1997 Improvement Act directs the Service to manage each refuge to fulfill the mission of the Refuge System, as well as the specific purposes for which that refuge was established. Refuge purposes are the driving force in developing refuge vision statements, goals, objectives, and strategies in the CCP. Refuge purposes are also critical to determining the compatibility of all existing and proposed refuge uses.

Humboldt Bay NWR was established under the authority of the Migratory Bird Conservation Act of 1929, the Migratory Bird Hunting and Conservation Stamp Act of 1934, the Fish and Wildlife Act of 1956, the Refuge Recreation Act of 1962, and the Endangered Species Act (ESA) of 1973, as amended.

According to these authorities, Humboldt Bay NWR's purposes are:

"…for use as an inviolate sanctuary, or for any other management purpose, for migratory birds." 16 U.S.C. §§ 715d (Migratory Bird Conservation Act)

"…as Waterfowl Production Areas subject to… all of the provisions of such Act [Migratory Bird Conservation Act]…except the inviolate sanctuary provisions…" 16 U.S.C. 718(c) (Migratory Bird Hunting and Conservation Stamp Act)

"…for the development, advancement, management, conservation, and protection of fish and wildlife resources…" 16 U.S.C. §§ 742f(a)(4) and "…for the benefit of the United States Fish and Wildlife Service, in performing its activities and services. Such acceptance may be subject to the terms of any restrictive or affirmative covenant, or condition of servitude…" 16 U.S.C. §§ 742f(b)(1) (Fish and Wildlife Act of 1956)

"…suitable for (1) incidental fish and wildlife-oriented recreational development, (2) the protection of natural resources, (3) the conservation of endangered species or threatened species…" 16 U.S.C. §§ 460k-1 and "…the Secretary…may accept and use…real…property. Such acceptance may be accomplished under the terms and conditions

of restrictive covenants imposed by donors…" 16 U.S.C. §§ 460k-2 (Refuge Recreation Act [16 U.S.C. §§ 460k-460k-4], as amended)

"…to conserve (A) fish or wildlife which are listed as endangered species or threatened species ....or (B) plants…" 16 U.S.C. §§ 1534 (Endangered Species Act of 1973, as amended)

Castle Rock National Wildlife Refuge was established under the authority of the Endangered Species Act of 1973, as amended.

According to this authority, Castle Rock NWR's purpose is:

"…to conserve (A) fish or wildlife which are listed as endangered species or threatened species…or (B) plants…" 16 U.S.C. §§ 1534 (Endangered Species Act of 1973)

1.3.4. Refuge Vision Statements

The Humboldt Bay National Wildlife Refuge conserves and manages some of the most significant historic and restored natural areas in the Humboldt Bay area. The refuge sustains varied and important habitats ranging from estuarine and freshwater wetlands to open grasslands and dynamic dune ecosystems. Humboldt Bay NWR also conserves important plant and animal populations and plays a critical role in preserving biodiversity locally, regionally, and within the Refuge System. Refuge staff applies sound scientific principles and adaptive management strategies to sustain the long-term health and ecological integrity of the Humboldt Bay NWR and the surrounding area.

Refuge habitats link with other public and private lands to support threatened and endangered species in addition to hundreds of species of migratory wildlife within the Pacific Flyway. The refuge provides migration and wintering habitats of sufficient size and quality to assist in maintaining migrating bird populations on the Pacific Flyway, especially Pacific brant, Aleutian cackling geese, and shorebirds.

The staff at the Humboldt Bay NWR works with a broad cross section of tribal, governmental, community, and private partners to promote the ecological integrity of the landscape, ecotourism, and the historic and cultural attractions of the region. The refuge staff, assisted by Friends groups, volunteers, and the public, seeks to provide compatible wildlife-dependent recreational opportunities for the public on refuge lands, expand community outreach, and stimulate area residents and visitors to embrace sustainable stewardship of natural resources.

By pursuing this vision, staff and others at the Humboldt Bay NWR seek to ensure healthy fish, wildlife, and plant resources for people to enjoy today and an enduring legacy for generations to come.

Vision Statement for Castle Rock National Wildlife Refuge

Castle Rock National Wildlife Refuge preserves in perpetuity one of the most important seabird nesting colonies on the Pacific coastline. This 14-acre island continues to be preserved in a natural condition with minimal human intrusion.

Management activities focus on research and monitoring of refuge wildlife and on protection and maintenance of a natural, functioning ecosystem. The U.S. Fish and Wildlife Service coordinates with tribes, other agencies and entities, and the public to ensure the long-term health and viability of native seabird and marine mammal populations.

We work with others to provide wildlife viewing and interpretation at selected locations on the adjacent coastline. Fostering an appreciation for Pacific coast wildlife enriches people in a variety of ways and ensures that this outstanding legacy of wildlife is passed on to future generations.

1.4. 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; the Endangered Species Act, as amended; 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, 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).

The 1997 Improvement Act's main components include:

- 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.

First and foremost, refuges are managed for fish, wildlife, plants, and their habitats. In addition, 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 an analytical public process called the ***refuge compatibility process***. All refuge uses are subservient to the Refuge System's primary wildlife management responsibility and they must be determined compatible to be authorized.

The 1997 Improvement Act established the formal process for determining compatibility of uses. A compatibility determination is required for a wildlife-dependent recreational use or any other public use of a refuge. A compatible use is one which, in the sound professional judgment of the refuge manager, will not materially interfere with or detract from the fulfillment of refuge purpose(s) or the Refuge System mission. The Service strives to provide wildlife-dependent public uses when compatible. If financial resources are not available to design, operate, and maintain a priority use, the refuge manager will take reasonable steps to obtain outside assistance from the State and other conservation interests.

This draft CCP contains several draft compatibility determinations for proposed uses on both refuges in the Complex (Appendix F). These compatibility determinations are open to public comment with the draft CCP and finalized along with the CCP.

This document also includes a draft Environmental Assessment (EA) (attached as Appendix E) 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 CCP on the quality of the human environment. The EA includes the components listed below.

- A description of the alternatives considered for the CCP.
- 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, appropriate Tribal governments, nonprofit organizations, and members of the public in the CCP process.

The CCP is also accompanied by a revised sport hunting plan (Appendix C), a revised sport fishing plan (Appendix D), a wilderness review (Appendix G), and a visitor services plan (Appendix B).

1.5. Humboldt Bay National Wildlife Refuge Complex

1.5.1. Humboldt Bay National Wildlife Refuge

The Humboldt Bay NWR boundary (Figure 1) contains much of the remaining natural habitats and shoreline areas of Humboldt Bay, including areas that both conserve key habitats for fish, wildlife, and plants, and are aesthetically pleasing landscapes. However, to understand the health of refuge habitat, it is necessary to consider the general health of the bay as a whole, including the condition of lands and waters outside, as well as inside, the refuge.

The bay area contains many species of native and introduced plants and animals. These species and their habitats have complex interrelationships; significant changes in any one habitat type can directly or indirectly affect other habitats and species that use that habitat. Most fish and wildlife species found on Humboldt Bay NWR use areas both inside and outside of refuge boundaries.

Humboldt Bay NWR is important to the overall Refuge System primarily due to the concentrations of migratory waterbirds, conservation of species listed under the Federal ESA that use refuge habitats, and conservation of globally endangered dune habitats.

Migratory birds largely depend upon the bay and surrounding wetland habitats, including the refuge, in the fall, winter, and spring. This is especially true of the Pacific brant (*Branta bernicla nigricans*). Humboldt Bay NWR is currently the southernmost in a chain of National Wildlife Refuges that provide habitat for most of the world's population of Pacific brant.

Humboldt Bay is an area of international significance to many species of migratory birds, which largely depend upon the bay and surrounding wetland habitats, including the refuge, in the fall, winter, and spring. Chief among these are waterfowl, shorebirds, gulls, and terns. Total use-days for all of the bird species have been estimated at 4 million annually for South Bay alone (Nelson 1989). Most of the birds using the bay frequent areas within the existing refuge boundaries on a daily basis.

Over 260 species of birds, including 39 species of shorebirds and 26 species of raptors, have been seen

Figure 1. Watershed ecosystem map.

in the vicinity of Humboldt Bay (Yocom and Harris 1975, Ralph et al. 1998). In recognition of the species richness found in the bay, it has been identified as an Important Bird Area by the National Audubon Society. The majority of birds use the Humboldt Bay NWR as a stop-over to rest and replenish energy reserves. Others spend the winter on the refuge and some use it for nesting. The wetlands in and around Humboldt Bay are critical to tens of thousands of shorebirds. As a result, the bay has been designated as a site of International Importance by the Western Hemisphere Shorebird Reserve Network. This is the northernmost area on the Pacific coast where species such as American avocets (*Recurvirostra americana*), long-billed curlews (*Numenius americanus*), marbled godwits (*Limosa fedoa*), and willets (*Tringa semipalmata*) spend the winter in large numbers. They can be seen feeding on the mudflats or skimming over the bay in large eye-catching flocks from late July through April.

Humboldt Bay is a key area for Pacific brant. Humboldt Bay NWR is currently the southernmost in a chain of National Wildlife Refuges that provide habitat for most of the world's population of Pacific brant. These small geese require eelgrass-filled bays during their travels between Arctic wetlands where they nest and coastal lagoons of Baja California and mainland Mexico where they overwinter. In November, most Pacific brant fly nonstop from Izembek Lagoon in Alaska to Mexico in 48 to 60 hours. On their return trip from January through April, as much as 60 percent of the flyway population stops in Humboldt Bay, with as many as 10,000 to 20,000 Pacific brant on Humboldt Bay at one time. The Humboldt Bay area has also recently (as of 2002) become the focal area during late winter and spring for the bulk of the Aleutian cackling goose population.

In addition to birds, Humboldt Bay is also a regionally important spawning and nursery ground for commercia1 and sport finfish and shellfish, especially oysters. The bay provides habitat for at least 111 species of fish (Barnhart et al. 1992), many of which contribute to sport or commercial fisheries. Both Jacoby Creek and Salmon Creek provide habitat for anadromous salmonids.

Four species listed as endangered under the Federal ESA utilize habitat within the refuge boundary: the Humboldt Bay wallflower (*Erysimum menziesii* ssp. *eurekense*), beach layia (*Layia carnosa*), tidewater goby (*Eucyclogobius newberryi*), and brown pelican (*Pelecanus occidentalis*). Three species listed as threatened under the Federal ESA use habitat within the refuge boundary: Coho salmon (*Oncorhynchus kisutch*), steelhead (*Oncorhynchus mykiss*), and Chinook salmon (*Oncorhynchus tshawytscha*). Three recovered species, the Aleutian cackling goose, bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*), also use refuge habitat. In addition, the Humboldt Bay NWR provides habitat for rare plants, globally declined species, and marine mammals.

1.5.2. Castle Rock National Wildlife Refuge

Castle Rock is one of only two islands on the outer coast of California included in the National Wildlife Refuge System. These two islands, Southeast Farallon Island (SEFI) and Castle Rock, are the largest, most important seabird colonies in the state. SEFI has a long continuous history of human occupation. Research and monitoring takes place year round on the island primarily through a cooperative agreement with Point Reyes Bird Observatory Conservation Science (PRBO). Until recently, Castle Rock had no management plan or long-term monitoring program, so seabird monitoring was accomplished through short-term projects and large-scale cooperative monitoring efforts aimed at selected species.

Like many other "seabird islands" within the Refuge System, Castle Rock is so rich with sensitive wildlife species and fragile habitat that it cannot accommodate direct public access and still fulfill the purposes for which it was established. Only very limited access is allowed for research, monitoring, and management. The original concept for management of the island was to leave it alone with the caveat that direct management may be needed in the future. The dilemma is that some of the island's most sensitive resources cannot be monitored without some level of presence on the island, and without monitoring species status cannot be determined, nor if management might be warranted.

1.6. Humboldt Bay NWR Complex Location

1.6.1. Flyway Setting

The refuge is located within the Pacific Flyway. The Pacific Flyway is used by millions of birds for migration to wintering and breeding grounds. This refuge provides important habitat is a key migratory stopover and/or wintering area for several species of waterfowl and shorebirds including Pacific brant, Aleutian cackling geese, western sandpipers (*Calidris mauri*), dunlin (*Calidris alpina*), marbled godwits, and long-billed curlews. The north coast of California is one of richest areas in the country

in terms of avian diversity. Between 300 and 350 species of birds can be found from just offshore to the first inland ridgeline (Harris 1996, Ralph et al. 1998).

1.6.2. Humboldt Bay NWR Setting

The Humboldt Bay region is composed of diverse ecosystems. The bay area's topography, wetlands, riparian and coastal areas provide a variety of habitats for wildlife and migratory birds.

Humboldt Bay is 14 miles long and from 0.5 to 3.5 miles wide. It comprises three sub-bays, each situated at the end of one or several stream valleys. It is bounded on the east by mountain ridges of the coast range. Humboldt Bay is California's second largest coastal estuarine system.

Humboldt Bay has been drastically changed since the turn of the 19th century (Figure 2). Vast expanses of wetlands around both North and South Bays have been altered by diking, filling, dredging, sedimentation, and mariculture, as well as residential, industrial, and recreational development. Originally, Humboldt Bay and its natural wetlands encompassed more than 27,000 acres, but by 1980 this area had been reduced by 30 percent to ~17,000 acres (Shapiro and Associates 1980). Consequently, there has been a dramatic change in both the quantity and composition of wetlands.

In 1870, when some minor salt marsh conversion had already occurred, there was an estimated 9,500 acres of salt marsh. After completion of the railroad around the margin of the bay, salt marsh was reduced by 90 percent. The current estimate of the salt marsh area is ~900 acres.

1.6.3 Historic Conditions of Humboldt Bay NWR

The pre-European settlement Humboldt Bay watershed was covered mostly by old-growth redwood (*Sequoia sempervirens*) forest in the uplands. The coastal forests reached from the ocean to 35 miles inland. Pre-1850 it was common to see herds of 40 to 50 elk (Loud 1918). Waterfowl, salmon, deer, and bear were abundant. Forest soils and vegetation diminished rainfall runoff and prevented significant changes in water quality. The bay margins were heavily forested from Arcata south to the Elk River (Coy 1982). The coastline, bay margins, and riparian area forests were dominated by Sitka spruce (*Picea sitchensis*) and red alder (*Alnus rubra*), and contained Douglas-fir (*Pseudotsuga menziesii*), coast hemlock (*Tsuga heterophylla*), red cedar (*Thuja plicata*), and tanoak (*Lithocarpus densiflorus*) (Loud 1918). Lowland and marsh areas around the bay were restricted due to surrounding mountain ridges.

In 1850 there were extensive intertidal flats and salt marshes in Humboldt Bay. The largest salt marshes were along Mad River Slough, McDaniel Slough, Eureka Slough, Hookton Slough, and Salmon Creek (Loud 1918). The lower Elk River and lower Salmon Creek deltas were tidally influenced alluvial plains. The north spit of Humboldt Bay was a mix of unvegetated, herbaceous, and forested dunes. The South Spit was primarily non-vegetated dune. The mouth of the bay was both shallow and narrow (Lewis 1943).

Landscapes found by early explorers and settlers were shaped and regularly renewed in part by the land management practices of Native American people (Anderson 2005).

Before EuroAmerican influence, there were an estimated 1,000 Wiyot people in the Humboldt Bay region. They occupied ~465 square miles, including the entire Humboldt Bay area. At the time of contact with EuroAmericans, the Wiyot were divided into three main groups: the Potawót, the Wigki, and the Wiyot. The Potawót settlements were on the lower Mad River, while the Wigki and the Wiyot settlements were near the Eel River (Seidner 1999). In 1850 there were 32 principal population centers and many smaller villages (Loud 1918). Population decreases were due to a number of factors (all attributable to the coming of the Europeans), and included reduction in the available resource base for subsistence, EuroAmerican-induced epidemics, displacement, and killings. By 1851 the Wiyot population of Humboldt Bay and north to Mad River was estimated at about 300 to 500. By 1910, due to conflicts with settlers, the Wiyot population had decreased to ~100 (Loud 1918).

The Humboldt Bay area provided a cornucopia of plant and wildlife resources to sustain the Wiyot people. The ancestral Wiyot territory extended from Little River to the north, Bear River Ridge to the south, and from the Pacific coast out to as far as Berry Summit in the northeast and Chalk Mountain in the southeast (Wiyot Constitution and Bylaws 1978). The Wiyot people lived along the rivers, bay, and estuarine environments. The land provided redwood for house planks and canoes, iris leaves for nets and ropes, grey pines (*Pinus sabiniana*), California hazelnut (*Corylus cornuta* var. *californica*), huckleberry (*Vaccineum ovatum* and *V. parvifolium*), strawberry (*Fragaria* spp.), grass seeds, clover roots and bulbs, ferns, nettles, sea otter (*Enhydra lutris*), Roosevelt elk (*Cervus*

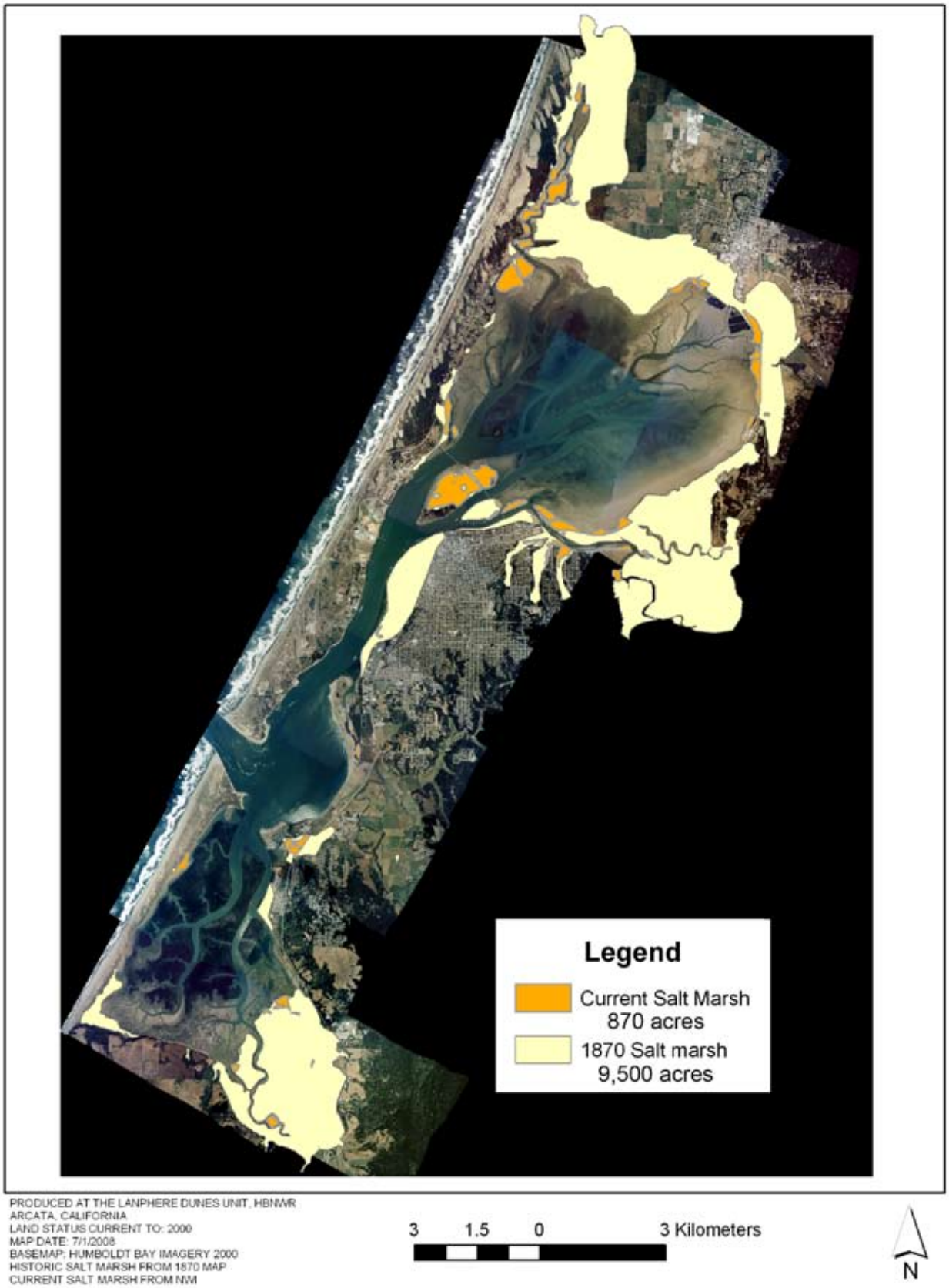


Figure 2. Historic and current tidal marsh surrounding Humboldt Bay.

canadensis roosevelti), Pacific harbor seal (*Phoca vitulina richardii*), Steller Sea lion (*Eumetopias jubatus*), and black-tailed deer (*Odocoileus hemionus*) for food and household materials. It was said that the salmon ran so thick in the Mad River and Arcata sloughs you could catch them with a pitchfork (Loud 1918).

The Wiyot people were intricately involved with their environment. They, as many Pacific North Coast peoples, manipulated the tidal flats to harness the productivity of the salt marshes, one of the world's most biologically productive environments (Deur 2005). The tribe modified estuarine soils, plants, and hydrology for the production of root crops. Silverweed (*Potentilla anserina* ssp. *pacifica*) and coast clover (*Trifolium wormskioldii*) were important food sources, which were cultivated in family plots. Root cultivation methods demonstrated a detailed understanding of environmental systems. With EuroAmerican settlement of the region during the 19th century, estuarine cultivation practices were rapidly swept away.

In 1806, the first EuroAmerican explorers arrived at the bay. However, no settlement took place until the 1850s when Humboldt Bay became a place of departure and supply for the gold mines of Trinity and Siskiyou counties. Most of the current agricultural lands around Arcata and the Mad River bottoms were occupied by settlers by 1853.

In the 1850s the Humboldt timber industry began, which greatly impacted the biological functioning of the bay. The timber industry became successful in part by the passage of the Morril Land Act of 1862, which allowed large areas of timber to be purchased for commercial use. Timber exportation prompted the start of the shipping industry for timber and agricultural exports. Early land use changes in the bay were primarily a result of the shipping industry. Docks were built in Eureka and Fields Landing. Fish companies became established at the mouth of the Mad and Eel rivers by 1854. Clams, sharks, Dungeness crab (*Cancer magister*), oysters, shrimp sole, rockfish, and tuna were all harvested for export.

The completion of the Northwestern Pacific Railroad along the eastern margins of Humboldt Bay in 1901 caused major wetland changes. The railroad functioned as a dike, and tidegates were placed at most slough crossings. Many of the wetlands were converted to agricultural lands with seasonal wetlands used for grazing. By 1927, with the construction of Highway 101, most of the marshes east of Humboldt Bay had been diked and drained.

Exotic invasive species have greatly altered the pre-1850 salt marshes (Figure 3). Dense-flowered cordgrass (*Spartina densiflora*), introduced in the late-1800s, is currently the dominant species in many of the bay's salt marshes. The burrowing exotic isopod, *Sphaeroma quoyanum,* is also currently degrading the salt marsh. Within the bay itself there are 95 species of exotic organisms ranging across a variety of taxonomic groups (Boyd et al. 2002).

1.6.4. History of Humboldt Bay NWR Establishment and Acquisitions

In recognition of the area's unique fish and wildlife resource values, and especially the bay's importance to Pacific brant, parts of Humboldt Bay were initially proposed for refuge status in the early 1960s. However, it was not until September 1971 that refuge boundaries were set and acquisition began, officially establishing the Humboldt Bay NWR. An environmental assessment for proposed land acquisitions was originally written in 1974, and updated in both 1980 and 1988. The original refuge boundary included 7,814 acres, which was increased by 1,122 acres in 1989. With this addition, the refuge totaled 8,936 acres.

Approximately 1,081 acres of the Salmon Creek Unit were purchased by the Service in 1989 following expansion of the refuge boundary (1988) to include all of the former McBride Ranch.

In 1998, the 474-acre Lanphere Dunes Unit was donated to the refuge by The Nature Conservancy (TNC).

Ma-le'l Dunes officially became a unit of Humboldt Bay National Wildlife Refuge on August 12, 2005, the culmination of years of cooperative effort. The acquisition of this property and its transfer to the refuge was jointly funded by the Service and State Coastal Conservancy (SCC), and made possible through the collaborative efforts of many, including the SCC, BLM, Center for Natural Lands Management, Friends of the Dunes, the Humboldt Coastal Coalition, Wiyot Tribe-Table Bluff Reservation, and many individual members of the local community. The 160-acre parcel is managed together with the southern 120 acres of the Lanphere Dunes Unit as the Ma-le'l Dunes Unit. The unit bears the Wiyot name for the locale, which was used for thousands of years by the ancestral Wiyot people for fishing, gathering, and implement-making.

Today, the approved refuge boundary consists of a total of 9,502 acres, of which 3,379 acres are owned in fee title.

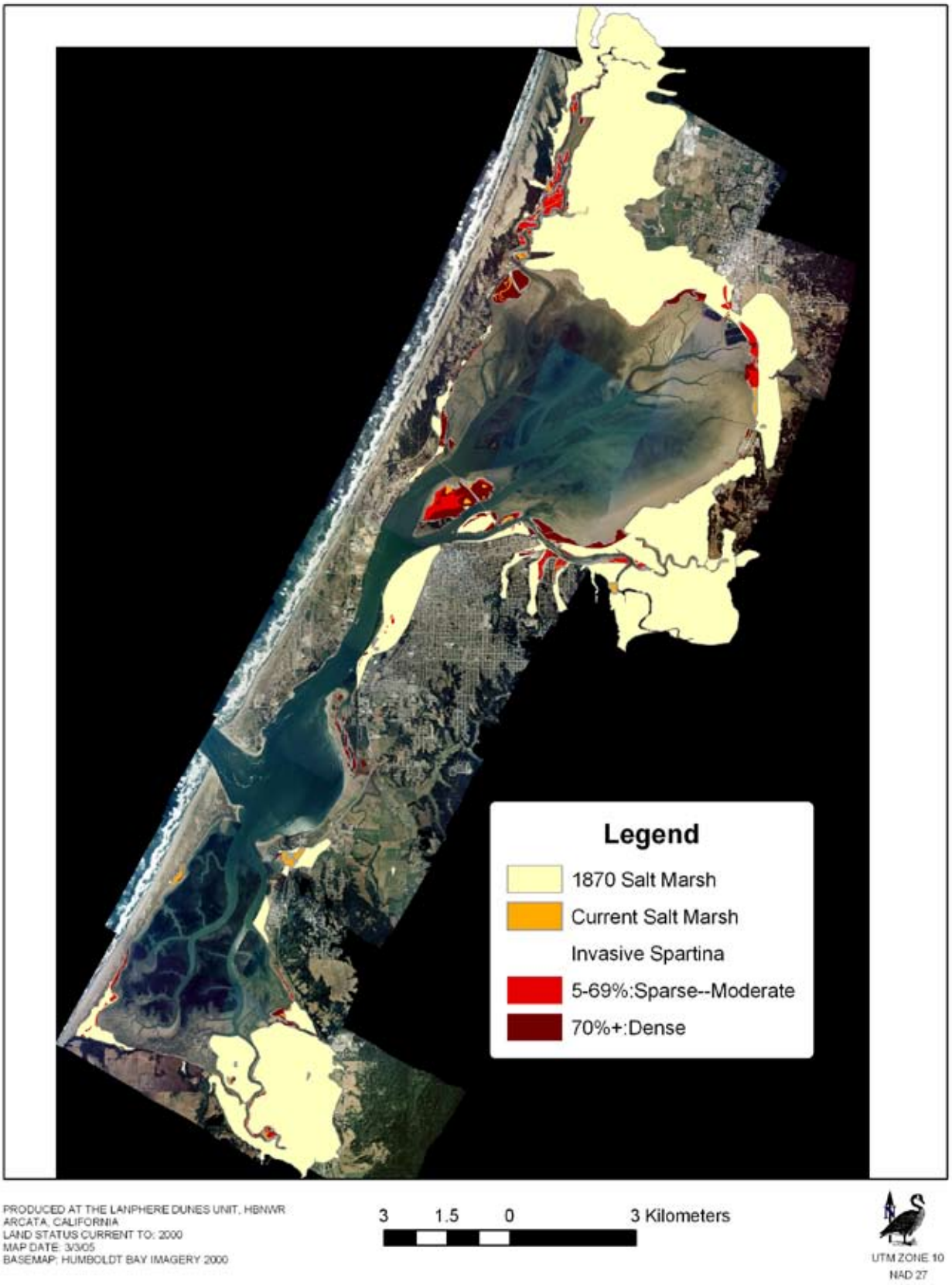


Figure 3. Historic and current tidal marsh surrounding Humboldt Bay, including density of non-native dense-flowered cordgrass populations.

1.6.5. Current Management of Humboldt Bay NWR

The primary focus of Humboldt Bay NWR is the enhancement, restoration, and management of a diversity of wetland and upland habitats for the benefit of all the natural resources that those habitats ultimately help sustain. These habitats include a continuum of estuarine, freshwater, riparian and seasonal wetlands; agricultural grasslands; and a large dune-dominated landscape. Another focus of the refuge is its public use, or visitor services, program. This program is geared toward providing quality opportunities for the public to engage in the six priority public uses which were established by Congress: wildlife observation and photography, environmental education and interpretation, hunting and fishing.

Providing support for the habitat and visitor services programs is the primary role of all refuge staff as well as contractors, volunteers, and the Friends of Humboldt Bay NWR. Support includes a wide range of duties including: facilities maintenance, heavy equipment use, habitat management and administrative assistance.

Habitat Management Program

All of the refuge units in South Bay were historically salt and brackish marsh that was diked off by previous landowners more than 100 years ago. These dikes allowed development and changes in land use, and have resulted in alterations in hydrology, sedimentation, and topography. In some locations these dikes have been actively breached (Table Bluff Unit), while at others (Teal Island) nature has/is taking its course. The dikes on the Salmon Creek and Hookton Slough Units have been, and are currently, maintained where there is risk of flooding to adjacent private lands and/or public facilities and infrastructure.

Wetland Management. The Salmon Creek, Hookton Slough, and White Slough Units are all in the floodplain, and flood seasonally every year, generally from November through March. Prior to refuge acquisition, these lands were managed for grazing. Water was drained off the land as quickly as possible through a system of ditches, culverts, and tidegates. Because the refuge has different objectives, the drainage system has been modified with dozens of water control structures to hold freshwater seasonally, creating hundreds of acres of seasonal wetlands in an area historically occupied by salt and brackish marsh. These seasonal wetlands provide migration and wintering habitat for thousands of waterbirds annually.

Estuarine Restoration. In 1989, the Fish and Wildlife Service purchased what is now the Salmon Creek Unit of Humboldt Bay NWR. The previous landowners had rerouted and channelized Salmon Creek and cleared vegetation from the creek/ditch every few years. One of the refuge's initial goals was to restore the channelized portion of Salmon Creek on the refuge. In addition, the upper portions of the watershed had been extensively impacted through timber harvest, livestock management, and rural development, impacts that carried downstream in the form of sediment buildup and aggradation of the stream and slough channels. Currently, the upper Salmon Creek watershed is the BLM-owned Headwaters Conservation Area, which is dedicated to habitat restoration that is expected to reduce sediment input to the watershed.

In 1993, refuge staff and others were able to reroute approximately half of the creek on the refuge into a meandering channel located as close as possible to the historic channel alignment. This creek channel now includes some large woody debris and riparian overstory that provides shade and structure to the creek habitat. The restoration resulted in increased riparian habitat, increased juvenile fish habitat, and improved water quality, however problems and concerns still exist. An aggraded channel bottom (up to 3-5 feet) reduces stream depth and increases water temperatures and sediment deposition. In addition, in 1997, all salmonids that use Salmon Creek (Coho, Chinook, steelhead, coastal cutthroat) were listed as threatened under the Federal ESA. The tidewater goby had already been listed as endangered in 1994.

Salmon Creek Restoration Project Phase I. In 2001, an effort was initiated to significantly modify the tidegates on lower Salmon Creek and on Hookton Slough to improve fish passage, sediment routing, and water quality. It was a collaborative effort that included the refuge, the Pacific Coast Fish, Wildlife and Wetlands Restoration Association (PCFWWRA), California Department of Fish and Game (CDFG), Coastal Salmon Recovery Fund, the Coastal Program managed from the Arcata Fish and Wildlife Office (AFWO), and many local contractors who have contributed and volunteered significant amounts of time and effort to the project. The work was completed in 2008.

Salmon Creek Restoration Project Phase II. Phase II is in the planning stages and will require excavation of approximately one half mile of former creek channel and construction of a small fish screen to allow seasonal water diversions to flood refuge wetlands. Phase II is needed to complete all the objectives of Phase I and the restoration of that

portion of Salmon Creek on the refuge. It is also expected to significantly improve habitat conditions of the creek up to a mile upstream of the refuge.

Agricultural Grassland Management. The refuge currently manages grazing and haying on the refuge through a cooperative land management agreement with local ranchers, which is based on grazing and haying rates established by the UC Agricultural Extension Office. Grazing and haying provide short grass habitat (2 to 6 inches) primarily used by Aleutian cackling geese, but also wigeon, swans, shorebirds, and other species. Grazing and haying generally occur from late spring (late April to early May) through September or October. The pH of pasture soils is monitored every 3 to 5 years and lime is periodically added as needed to maintain soil conditions favorable to growing pasture grasses. In addition, refuge staff conducts mowing (outside of nesting season) along edges where agricultural grasslands merge into wetland plant communities. This is done throughout the Salmon Creek Unit in places where haying is not feasible to maintain short grass habitat and to control non-native invasive weeds, such as thistle (*Cirsium* spp.).

Dune Restoration. Restoration at the Lanphere Dunes Unit has been ongoing, beginning under ownership by the Lanpheres through 1997 by The Nature Conservancy. In 1998, when TNC donated its holdings at Lanphere Dunes to the refuge, restoration focused on invasive species eradication with associated research on ecosystem function and restoration techniques. Management objectives and associated monitoring plans have been completed for the Lanphere Dunes Unit, and work is ongoing to meet these objectives. In 2003 the refuge created a restoration, management, and monitoring plan for beach pine/Sitka spruce and red alder riparian forest on the Lanphere Dunes Unit (USFWS 2003b) to prioritize forest management tasks. The goal is to restore and maintain the ecological integrity of the native beach pine/Sitka spruce and riparian forest communities. The plan also includes objectives related to monitoring, research, and coordination with tribal entities.

The Ma-le'l Dunes Unit is being restored consistent with a restoration plan prepared as part of a mitigation program funded by California Department of Corrections. This plan includes elements on invasives control, as well as habitat manipulation and revegetation.

The Refuge does not currently have a regionally approved Habitat Management Plan. However, the Service expects that an HMP will be developed within four years of completion of the CCP.

Invasive Species Management. Invasive plant species are regularly surveyed by staff, volunteers, and partners. The refuge does not currently have an approved Integrated Pest Management (IPM) plan. However, once documented and mapped, an attempt is made to either eradicate or control priority invasive plants throughout the Humboldt Bay NWR using a variety of IPM techniques, including mechanical, cultural, and chemical control methods. Plants controlled in the South Bay units include blue gum (*Eucalyptus globulus*), thistles (*Cirsium vulgare* and *C. arvense*), bristly ox-tongue (*Picrus echioides*), reed canarygrass (*Phalaris arundinacea*), white morning glory (*Calystegia silvatica*), Himalayan blackberry (*Rubus discolor*), and others. Two key invasives that have been found in the area (and could do profound damage to existing habitats), but have not yet reached the refuge are Japanese eelgrass (*Zostera japonica*) and purple loosestrife (*Lythrum salicaria*).

Restoration of salt marsh at the Lanphere and Ma-le'l Units has begun, through collaboration with the State Coastal Conservancy and others, to remove dense-flowered cordgrass (*Spartina densiflora*) and revegetate with native salt marsh species. Successful techniques will be adapted for use at other refuge units and likely at other locations around the bay.

Major invasive plant removal initiatives at the Lanphere and Ma-le'l Dunes have included European beachgrass (*Ammophila arenaria*), yellow bush lupine (*Lupinus arboreus*), ice plant (*Carpobrotus edulis x C. chilense* hybrids), English ivy (*Hedera helix*), a suite of invasive annual grasses, and dense-flowered cordgrass. Management of the first three species is in a maintenance stage, where minor work is needed to prevent new starts or complete eradication of any small persisting populations. English ivy management is nearing a maintenance stage, but requires some additional work. Annual grass management work is still in progress. However, while major progress has been made, control is hampered by off-refuge sources. The cordgrass management initiative has resulted in the restoration of 10 to 15 acres of salt marsh in the Lanphere and Ma-le'l units. All of these initiatives have been carried out using manual or mechanical methods of control.

Herbicides that are periodically used to control invasive plants on the Humboldt Bay NWR include Rodeo, Roundup pro, and Roundup pro concentrate. Prior to any herbicide use on Humboldt Bay NWR, a Pesticide Use Permit is filed in the regional and national office for each herbicide. All pesticide usage is in compliance with labeling instructions and under the direction of a certified applicator. The refuge

does not currently have an approved IPM Plan but will be developing one within 4 years of completion of the CCP.

Biological Program

Monitoring and Surveys of Fish, Wildlife, and Plants. Monitoring and survey efforts are meant to complement and inform refuge management, and often vary in degree of intensity and/or regularity based on a combination of refuge staffing, funding, and competing priorities. Habitat management is dependent upon biological information collected through monitoring and research, without which managers have little basis for prescribing management actions.

The refuge participates in ongoing partnerships with AFWO and CDFG to monitor lower Salmon Creek and Hookton Slough for salmonids, tidewater goby, and amphibians.

Other wildlife species monitored or surveyed on the refuge or by refuge staff, contractors, or partners include Aleutian cackling geese, western Canada geese (*Branta canadensis moffitti*), Pacific brant, tundra swans (*Cygnus columbianus*), ducks, shorebirds, snowy plover (*Charadrius alexandrinus*), seabirds, passerine birds, deer, otter, and frogs. In addition, birds on the refuge are monitored annually for avian influenza and avian cholera.

In keeping with the management goals and objectives formulated for the Lanphere and Ma-le'l Dune Units, there is ongoing monitoring of the following target plants and plant communities:

- Humboldt Bay wallflower (*Erysimum menziesii* ssp. *eurekense*)
- Beach layia (*Layia carnosa*)
- Pink sand verbena (*Abronia umbellata* ssp. *breviflora*)
- Humboldt Bay Owl's-clover (*Castilleja ambigua* ssp. *humboldtiensis*)
- Point Reyes bird's-beak (*Cordylanthus maritimus* ssp. *palustris*)
- Dune mat plant community
- Salt marsh plant community
- Forest mycoheterotrophs (orchids and other species that are mutualists with mycorrhizal fungi associated with woody plants) and culturally significant geophytes (bulb plants)

Vegetation surveys were conducted for the wetland and dune vegetation of the refuge from 2005-2007. A vegetation classification based on quantitative sampling is still being finalized.

Visitor Services Program

Visitor Services are managed primarily from the Richard J. Guadagno Office and Visitor Center, located on the Salmon Creek Unit of the refuge. It was opened in spring 2002, and accommodates most of the refuge staff. The Center has several high quality interpretive dioramas and a large room for refuge-designed public events and wildlife viewing of the surrounding seasonal wetlands. The refuge hosts a very informative website that provides detailed information about all refuge programs, especially visitor services opportunities (www.fws.gov/humboldtbay). The proposed Visitor Services Plan is included in Appendix B.

Wildland and Wildlife Observation and Photography. Currently, the refuge maintains the 1.75-mile Shorebird Loop Trail on the Salmon Creek Unit, the 1.5-mile Hookton Slough Trail on the Hookton Slough Unit, and ~2 miles of trails on the Lanphere Dunes Unit. All of these trails offer great opportunities for wildlife observation and photography. There is also a photoblind for use at the Salmon Creek Unit.

Refuge staff coordinates with two Friends groups, (Friends of the Humboldt Bay NWR and Friends of the Dunes), and Audubon volunteers who offer

Birdwatching walk. Photo: Shannon Smith

guided walks on the refuge units several times per month.

The refuge maintains a non-motorized boat dock at the Hookton Slough Unit as a way to encourage wildlife observation from the bay. The refuge is currently working with the State Coastal Conservancy (SCC), the Humboldt Bay Harbor Recreation and Conservation District, the Redwood Community Action Agency, and Explore Northwest to develop safe, sustainable options for boating access on the bay that minimize impacts to natural resources.

The refuge is also working with the SCC, BLM, and Friends of the Dunes on development of the Ma-le'l Dunes Cooperative Management Area Access Plan. This plan will ultimately provide increased opportunities for the public to enjoy this magnificent dune and slough area south of the Lanphere Dunes Unit. The most recent draft of this plan can be found on the refuge website.

Environmental Education and Interpretation. Currently, the refuge accommodates pre-scheduled classroom visits, drop-in classroom visits, and also on-site visits where volunteers and/or staff go into schools and provide programs. The Friends groups are instrumental in providing these opportunities. The refuge currently offers and/or participates in seven annual special events: the Aleutian Goose Fly-off and Family Fun Weekend the first weekend in March, the Aleutian Goose Festival, Godwit Days, Migratory Bird Day, and the Lupine Bash each spring, Outdoor Youth Days in August, and a celebration for National Refuge Week in October.

Hunting. Hunting on Humboldt Bay NWR is managed in compliance with the 1990 Sport Hunting Management Plan. Waterfowl, coot (*Fulica americana*), and snipe (*Gallinago* spp.) hunting is permitted in accordance with State regulations on most areas of the refuge, including the Eureka Slough, Jacoby Creek, and Table Bluff Units. On the Salmon Creek Unit during the regular waterfowl season a lottery draw hunt is held from shoot time until 3:00 p.m. on Tuesdays and Saturdays. The waters and islands of Hookton and White Slough are open concurrently with over-water shoot days on the bay. The proposed Sport Hunting Plan is included in Appendix C.

Fishing. Fishing on the Humboldt Bay NWR is managed in compliance with the 1992 Fishery Management Plan. Fishing is permitted in Humboldt Bay and in tidal sloughs year round in accordance with State regulations. The Hookton Slough Trail and boat dock are open to fishing; access to other areas is by boat. Limited fishing does occur for sharks and rays, and shellfish on Humboldt Bay NWR. The proposed Sport Fishing Plan is included in Appendix D.

1.6.6. Castle Rock NWR Setting

Castle Rock is a 14-acre island located in Del Norte County, less than a mile northwest of Crescent City. Castle Rock in located on California's northwest coast between Arcata and the Oregon border. Castle Rock remains largely in its natural state, as a rocky nearshore island with little disturbance by people.

1.6.7. Historic Conditions of Castle Rock NWR

The first historic accounts of seabird populations on Castle Rock came from the field notes of Clay, an egg-collector in the early 1900s (Clay 1901-1953 MS). Clay first visited the island in 1916, spent two weeks there in late July 1917, and returned in 1934 and 1935. He reported that Leach's storm-petrels (*Oceanodroma leucorhoa*) were nesting by the "tens of thousands" on the island. Fork-tailed storm-petrels (*Oeanodroma furcata*) and tufted puffins (*Fratercula cirrhata*) were also present and breeding. Another egg-collector, T. Fraser, visited the island around the same time. Altogether, nine seabird species were observed, including common murre (*Uria aalge*), Brandt's cormorant (*Phalacrocorax penicillatus*), western gull (*Larus occidentalis*), and Cassin's auklet (*Ptychoramphus aleuticus*). Ornithologist Robert Talmage (in Osborne 1972) visited the island in the mid-1930s and observed a few double-crested cormorants (*Phalacrocorax auritus*) describing their breeding status as sporadic. He looked for rhinoceros auklet (*Cerorhinca monocerata*) without success. Osborne observed breeding rhinoceros auklets on Castle Rock in 1969-1970. Black oystercatchers (*Haematopus bachmani*) have bred in small numbers on the island since at least the 1930s (Osborne 1972). All of the contemporary seabird species breeding on Castle Rock were present during the early 1900s, as recorded in the notes of early ornithologists.

Over the last century, distinct changes to the vegetation has occurred, as have the populations of seabirds. Unfortunately, the cause and effects of these changes are primarily unknown. Meadow areas once covered with Pacific reedgrass (*Calamagrostis nutkaensis*) have receded and been replaced with goldfields (*Lasthenia maritima*) and sand spurrey (*Spergularia macrotheca*) (Castle Rock NWR plant communities are discussed in detail in Section 3.7.3). Photographs taken in 1935 show reedgrass growing over most of the meadow, covering an estimated 3 acres (Osborne 1972). By 1961 the area covered in reedgrass was reduced by

about 50 percent. In 1970, reedgrass covered only 1 acre and was largely replaced by bluegrass (Poa sp.) (Osborne 1972). By 1984 the hummocks of reedgrass were mostly dead. "Rhizomes and roots were all that was left of the once extensive populations" (Sawyer 1984). In 1989 only a few tussocks remained on the east end of the island (Carter et al. 1992). By 2000 there was no evidence of this species as viewed from shore or boat (D. Jaques unpublished). Aleutian geese have been known to use Castle Rock since at least pre-European times as they are known from Tolowa verbal history. In 1974, there were fewer than 1000 geese using the island and today there are ~20-25,000 which use the island for roosting each winter and spring. The effects of that many geese include impacts on vegetation and substrate, biological contribution of their droppings, and possible exclusion of area to other species due to their large numbers and interspecific behavior.

1.6.8. History of Castle Rock NWR Establishment and Acquisitions

The Service proposed to purchase Castle Rock in 1978 to protect critical habitat for the then-endangered Aleutian Canada goose (now called Aleutian cackling goose) (USFWS 1978). The geese were first detected at Castle Rock in spring of 1975. It was later found that the island and nearby mainland agricultural grasslands were the spring staging ground for virtually the entire population of Aleutian Canada geese (Woolington et al. 1979). The island was recommended for critical habitat status in 1977 (USFWS 1991), and a negative declaration for purchase of the island was completed in 1978 (USFWS 1978). The original proposal included lease acquisition, a Memorandum of Understanding (MOU), and Cooperative Agreements to also preserve nearly 800 acres of grazing habitat on Point St. George.

In 1979, TNC purchased Castle Rock from the G. E. Kibbe Estate. The Service purchased the island from TNC by fee acquisition in 1980 for $41,250, using funds from the Land and Water Conservation Fund. A letter from the Service to TNC on July 5, 1980 stated, "We plan to manage Castle Rock primarily for its values to endangered species (mainly the Aleutian Canada goose) and nesting marine birds (murres, auklets, petrels, etc.)…Like the Farallon Island NWR, Castle Rock would be managed by the FWS as a sanctuary. Human disturbance is the main factor that must be controlled…We would expect to permit a limited amount of research but only that which would have high potential to increase management knowledge of these avian resources."

1.6.9. Current Management of Castle Rock NWR

Castle Rock NWR is so rich with sensitive wildlife species, and the habitat so fragile, that only very limited access for research, monitoring, and management has been allowed. Currently, refuge staff collaborates with San Francisco Bay National Wildlife Refuge Complex (SFBNWRC) and partners such as Humboldt State University (HSU), the Service's Coastal Program at Humboldt Bay, the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Coast Guard (USCG) to conduct photo surveys of birds and marine mammals utilizing Castle Rock NWR and associated habitat. Associates from HSU and SFBNWRC maintain remote automatic cameras on Castle Rock NWR used to assess the ecology and populations of nesting seabirds, and are working with the refuge to develop a long-term monitoring plan. Live video from these cameras can be viewed seasonally by the public at the National Park Service (NPS) Visitor Center in Crescent City or over the internet. In addition, the refuge is looking into using this footage to develop short educational/interpretive films appropriate for different grade levels. Interpretive panels highlighting Castle Rock NWR wildlife are located on Pebble Beach Drive, adjacent to the shore overlooking Castle Rock NWR.

1.7. Related Projects and Studies in the Area

1.7.1. U.S. Fish and Wildlife Service, NOAA, and Pacific Flyway Projects and Studies

Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (*Charadrius alexandrinus nivosus****)***
The Pacific coast population of the western snowy plover is listed as threatened under the Federal ESA (USFWS 2007). The Pacific western snowy plover is a small bird that winters mainly in coastal areas from southern Washington to Central America. The Pacific coast population breeds primarily above the high tide line on coastal beaches, sand spits, dune-backed beaches, sparsely-vegetated dunes, beaches at creek and river mouths, and salt pannes at lagoons and estuaries. Habitat degradation, caused by human disturbance, urban development, introduced beachgrass, and expanding predator populations, has resulted in a decline in nesting areas and in the size of the populations (USFWS 2007).

Recovery Plan For the Tidewater Goby (Eucyclogobius newberryi)
The tidewater goby is listed as endangered under the Federal ESA (USFWS 2006a). This small fish inhabits coastal brackish water habitats entirely within California, including portions of the Humboldt Bay NWR, which are identified in the plan as critical habitat.

The tidewater goby is uniquely adapted to coastal lagoons and the uppermost brackish zone of larger estuaries, rarely invading marine or freshwater habitats. Principal threats include loss and modification of habitat, water diversions, predatory and competitive introduced fish species, habitat channelization, and degraded water quality.

Recovery Plan for Seven Coastal Plants and the Myrtle's Silverspot Butterfly (Speyeria zerene myrtleae)
Seven plants and one invertebrate native to the coastal dunes of northern and central California are covered in this recovery plan (USFWS 1998).

Two species, Humboldt Bay wallflower and beach layia, are present on the Humboldt Bay NWR. The recovery plan calls for seven primary actions to be taken to recover the two species:
1. Protect existing populations and habitats.
2. Minimize the threats to the plants.
3. Develop management strategies incorporating ecological and land use strategies.
4. Manage populations and habitats to achieve delisting.
5. Monitor population trends to evaluate recovery success.
6. Coordinate recovery actions to protect other listed and sensitive species.
7. Develop and implement an outreach program.

Final Revised Steller Sea Lion Recovery Plan
Current Species Status: The Steller sea lion was listed as a threatened species under the ESA on April 5, 1990 (55 FR 12645) due to substantial declines in the western portion of the range. At the time of listing, the overall abundance of sea lions in the eastern portion of the range (in southeastern Alaska and Canada) was increasing at approximately 3 percent per year. Critical habitat was designated on August 27, 1993 (58 FR 45269) based on the location of terrestrial rookery and haulout sites, spatial extent of foraging trips, and availability of prey. In 1997, based on demographic and genetic dissimilarities, NOAA Fisheries Service designated two distinct population segments (DPSs) of Steller sea lions under the ESA: a western distinct population segment (DPS) and an eastern DPS (62 FR 24345, 62 FR 30772). Due to persistent decline, the western DPS was reclassified as endangered, while the increasing eastern DPS remained classified as threatened. The eastern DPS was estimated to number between 46,000 and 58,000 animals in 2002, and has been increasing at approximately 3 percent per year since the late 1970s (Pitcher et al. 2007). Castle Rock NWR is within the range of and used by a portion of the eastern population segment. The Final Revised Steller Sea Lion Recovery Plan can be viewed at http://www.fakr.noaa.gov.

Tidewater Goby Photo: © Greg Goldsmith

The primary objective of all recovery plans is to manage the threats to and improve the population status of the species sufficiently to warrant reclassification (from endangered to threatened status) or delisting.

Pacific Flyway Management Plan for the Pacific Population of Brant
The goal of the Pacific Flyway Management Plan for the Pacific Population of Brant is to identify the requirements and responsibilities necessary to cooperatively manage the population on a sustained basis (PFC 2002). An essential part of this goal is the continued availability and health of Pacific brant habitats throughout their range, including eelgrass beds and associated habitat in Humboldt Bay and on the refuge.

Pacific brant are found in the United States, Canada, Mexico, Russia, and Japan. As such, a cooperative effort has been, and will continue to be, required for sound management. The winter population objective of Pacific brant for Humboldt Bay is 5,000 (PFC 2002). The overall population objective for Pacific brant is 150,000.

Pacific Flyway Management Plan for Pacific Population of Aleutian Cackling Geese
The goal of the Pacific Flyway Management Plan for Aleutian Cackling Geese is to identify the requirements and responsibilities necessary

to cooperatively manage the Aleutian cackling goose population on a sustained basis (PFC 2006). Essential components of this goal are to reduce the goose population to 60,000, and manage goose habitat on public lands in northern California to the maximum extent practicable in order to reduce depredation impacts on private landowners.

Pacific Flyway Management Plan for the Western Population of Tundra Swans

The purpose of the Pacific Flyway Management Plan for the Western Population of Tundra Swans is to establish guidelines for the cooperative management of the Western Population of tundra swans (PFC 2001).

The goal of the Pacific Flyway Management Plan for the Western Population of Tundra Swans is to ensure the maintenance of the Western Population of tundra swans at a size and distribution that will provide for all their benefits to society. The objectives are to:

- Maintain a population of at least 60,000 swans to provide suitable public benefits.
- Maintain current patterns of distribution throughout the Western Population tundra swan range.
- Provide breeding, migration, and wintering habitats of sufficient quantity and quality to maintain the desired numbers and distribution of swans.
- Provide for aesthetic, educational, and scientific uses of swans.
- Provide for sustainable sport and subsistence harvests of western population tundra swans.

Seabird Conservation Plan, Pacific Region

The Seabird Conservation Plan identifies the Service's priorities for seabird management, monitoring, research, outreach, planning, and coordination (USFWS 2005). The Seabird Conservation Plan prioritizes all species at a regional scale (California, Oregon, Washington, Hawaii, and U.S. Pacific Island commonwealths, territories, and possessions), and identifies prioritized recommendations for conservation actions.

Objectives and strategies with implications for Castle Rock NWR include:

- 7.g.(i). Count archived common murre and cormorant aerial photographs from 1980 through the present from California and Oregon colonies. Highest priority to photographs taken 1995 through the present.
- 10.a. Develop K-12 curricula on seabirds with specific chapters on the California Current System and tropical/subtropical island systems.

Tundra swans at the Salmon Creek Unit.
Photo: USFWS

Southern Pacific Shorebird Conservation Plan

The Southern Pacific Shorebird Conservation Plan (Hickey et al. 2003) identifies priority shorebird species, habitats, sites and conservation actions within coastal California and the Central Valley. It specifically identifies Humboldt Bay as one of 25 Coastal Wetlands of Importance to shorebirds in the region. Specific conservation actions for Humboldt Bay include:

- Prohibit further alteration of tidal flats for oyster culture.
- Eliminate the introduced salt-water cordgrass from the tidal flats of Humboldt Bay.
- Protect seasonal wetlands and pastures important to shorebirds from development.

Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities: Humboldt Bay NWR

In 2003, the Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities document (Salmon Creek Restoration Plan) was funded through the CDFG's Coastal Salmon Recovery Fund (PCFWWRA 2003). The Salmon Creek Restoration Plan identifies opportunities for salmonid habitat restoration and improved salmonid access on Humboldt Bay NWR's Salmon Creek Unit and is the template for ongoing restoration work there.

1.7.2. California Department of Fish and Game Projects and Studies

California Wildlife Action Plan

In compliance with the Congressionally enacted State Wildlife Grants Program, CDFG created the California Wildlife Action Plan (comprehensive wildlife conservation strategy) (CDFG 2007). A

major component of the Wildlife Action Plan is to identify and compile information on wildlife species, including low and declining populations that are indicative of the diversity and health of the State's wildlife populations.

The CDFG uses a Special Animals List, which is maintained and updated within the California Natural Diversity Database (CNDDB). This list is commonly referred to as the list of special status species. Many of the special status species have been identified as Species of Special Concern due to their low or declining numbers. In addition, the Wildlife Action Plan regional chapters describe major problems and threats that may adversely affect wildlife and their habitats within each region.

Recovery Strategy for California Coho Salmon
The CDFG, with the assistance of recovery teams representing diverse interests and perspectives, created the Recovery Strategy for California Coho Salmon as a guide for recovering Coho salmon on the north and central coasts of California (CDFG 2004a).

Five primary goals have been identified to recover Coho salmon on the north coast of California:
1. Maintain and improve the number of key populations and increase the number of populations and cohorts of Coho salmon.
2. Maintain and increase the number of spawning adults.
3. Maintain the range, and maintain and increase distribution of Coho salmon.
4. Maintain existing habitat essential for Coho salmon.
5. Enhance and restore habitat within the range of Coho salmon.

1.7.3. Other Pertinent Projects, Programs, and Documents

Wiyot Tribe Restoration Project on Indian Island
Indian Island, the largest contiguous salt marsh area left in Humboldt Bay, provides food and shelter for hundreds of species of native plants, fish, shellfish, and birds.

Around 1870, a shipyard repair facility was built on the property now owned by the Tribe. This shipyard operated until the 1980s. Creosote, solvents, and other chemicals used to maintain ships remain. Dilapidated buildings and tons of scattered metal and wood debris still litter the area. Remains of dikes and drains built by settlers to control tidal flow across the island still impact the land, and continue to degrade valuable habitat.

The Table Bluff Reservation/Wiyot Tribe plans to clean up the debris and pollutants left on the village site. The Tribe is exploring ways to restore the natural waterways of the area to allow the bay to interact more naturally with the tidal marsh area, increasing native plant and fish populations. The result will be a cleaner place for people, surrounded by more productive and diverse habitats for wildlife.

The Bureau of Land Management
The Bureau of Land Management manages lands that directly impact both refuges of the Complex. They manage the Headwaters Reserve, which includes the headwaters of both Elk River and Salmon Creek. These terminate in Mid and South Bay respectively. BLM also manages South Spit, which is owned by CDFG. On the North Spit, BLM manages additional lands, including part of the Ma-le'l Dunes Cooperative Management Area. The Ma-le'l Dunes Cooperative Management Area consists of the BLM's Manila Dunes and the refuge's Ma-le'l Dunes Units. This 444-acre stretch of dune and wetland habitats is managed cooperatively by USFWS and BLM. Partners in this project include the State Coastal Conservancy; the Wiyot Tribe, Blue Lake Rancheria, and Bear River Band of Rohnerville Rancheria; Friends of the Dunes; and the Redwood Gun Club.

In addition, BLM manages the California Coastal National Monument, which includes all the rocks, reefs, and islands of the California coast not owned by the Service, National Park Service, or other entities.

Pacific Coast Joint Venture Northern California Component
The Pacific Coast Joint Venture (PCJV) was established in 1991 to implement the North American Waterfowl Management Plan of 1986 to restore waterfowl populations of the Pacific Coast in Canada, the United States, and Mexico to the levels recorded during the 1970s (PCJV 2004). The PCJV partners have acquired and restored important wetlands, including portions of the Humboldt Bay NWR.

State Coastal Conservancy
The State Coastal Conservancy is involved in multiple projects and planning efforts on the north coast, including the Ma-le'l Dunes Cooperative Management Area, Aleutian Cackling Goose Management, *Spartina* Control Research and Implementation, and Humboldt BayTrails Projects (both water-based and land-based).

The Humboldt County Dunes Cooperative
This cooperative consists of Federal, State, Tribal, local, and private entities that work together to

research, evaluate, prioritize, and implement dune conservation and restoration in Humboldt County. One of their first projects was the Coastal Dune Mapping Project, which will result in the classification and mapping of all dune vegetation in Humboldt County.

Friends of the Dunes
Plans are currently underway to transform the ocean and bay view property formerly known as the Stamps House into a "gateway to the dunes." Featuring an interpretive nature center, restrooms, ample parking, and a marked trail system, the Humboldt Coastal Nature Center will provide the community with an easy point of entry to the coastlands and dune trails that will connect to the Ma-le'l Dunes Cooperative Management Area to the north, and Manila Community Services District to the south. The linked trail system will provide visitors with access to ~1,000 acres of coastal dune habitats, and the nature center and an adjacent loop trail will be wheelchair accessible. In addition, the facility will serve as a home base for the Friends of the Dunes ongoing education and restoration activities.

Humboldt/Del Norte County Weed Management Area
This group's purpose is to effectively manage, coordinate, and implement the invasive plant species programs among the BLM, U.S. Forest Service, NPS, US Fish and Wildlife Service, California State Parks, CDFG, California Department of Transportation, Humboldt County, Del Norte County, Natural Resource Conservation Service (NRCS), Humboldt County Resource Conservation District, California Cattlemen's Association, California Department of Food and Agriculture, UC Cooperative Extension, City of Eureka, City of Arcata, Friends of the Dunes, Center for Land Management, Manila Community Services District, and the North Coast Chapter of the California Native Plant Society. The groups have mutually agreed to:

1. Participate and/or cooperate in the development of a Weed Management Plan, which will be created for the Humboldt-Del Norte County Weed Management Area (WMA).
2. Share information among cooperators and provide assistance and expertise regarding alien species management (e.g., control methods, introduction prevention measures, restoration tools) activities on their units.
3. Provide opportunities to outside interest groups, private landowners, and the public for involvement in carrying out the Weed Management Plan on lands within the Humboldt-Del Norte County WMA.

The Humboldt Bay Management Plan
In order to balance port-related commercial and industrial uses, expanding recreational uses, and environmental protection, a planning document for Humboldt Bay was deemed necessary by the Humboldt Bay Harbor, Recreation and Conservation District (HBHRCD 2007). The HBMP is the region's first ecosystem-based management approach intended to improve the management of Humboldt Bay. The Humboldt Bay Management Plan (HBMP) is a large cooperative project funded by Federal, State, and local agencies. Many Conservation Element Policies from the HBMP are relevant to Service cooperation with other regional organizations and management of Humboldt Bay NWR. The Humboldt Bay Management Plan contains a tremendous amount of information on the history of development and the natural ecology of Humboldt Bay (www.humboldtbay.org).

Humboldt Bay Ecosystem Program
The Humboldt Bay Ecosystem Program (HBEP) is a relatively new ecosystem-based management program coordinated by the Eureka Sea Grant Office (UCANRP 2007). The mission of the Humboldt Bay Ecosystem Program is to increase the scientific understanding of the Humboldt Bay ecosystem and to create an integrated framework for resource management and collaboration that links the needs of people, habitats and species to ensure a healthy future for Humboldt Bay's natural and human communities.

The HBEP defines ecosystem-based management as a comprehensive process of integrated resource management that considers the entire ecosystem, including humans. It integrates the best available scientific, traditional and local knowledge, is geographically specific, defines management based on ecological boundaries, addresses complexities of natural processes and social systems, considers multiple simultaneous factors influencing management, and is collaborative, integrating social and environmental goals. The purpose of this project is to develop practical implementation of an ecosystem approach.

The foundation for this program is two community based plans, the Humboldt Bay Management Plan and the Humboldt Bay Watershed Salmon and Steelhead Conservation Plan. Issues, priorities and recommendations in these plans were used to develop ecosystem-based management approaches to sediment dynamics, governance, ecosystem and socio-economic indicators concept proposals. These proposals will be further developed and explored in 2009.

The Humboldt Bay Watershed Salmon and Steelhead Conservation Plan

The Humboldt Bay Watershed Salmon and Steelhead Conservation Plan compiles and evaluates watershed information, with a list of high priority goals and objectives aimed at protecting and/or restoring watershed processes to preserve and enhance salmon and steelhead habitat (HBWAC, RCAA 2005). The Salmon and Steelhead Conservation Plan was developed by the Humboldt Bay Watershed Advisory Committee (HBWAC), a diverse group of watershed stakeholders, "to improve the Humboldt Bay watershed's anadromous salmonid populations and related resources while considering regional ecological and socioeconomic needs."

Other Wetland Habitat Restoration Projects

Other wetland habitat restoration projects in the Humboldt Bay/Eel River area include the City of Arcata's McDaniel Slough and Baylands Restorations, and collaborative efforts involving the Service, CDFG, the Redwood Community Action Agency (RCAA), and other parties on Jacoby Creek, Gannon Slough, Rocky Gulch, Washington Gulch, Cochrane Creek, Fay Slough, Freshwater Slough and Wood Creek, Martin Slough, Elk River, and Salmon Creek on Humboldt Bay, and the Salt River (tributary on the lower Eel River). Service staff of the Partners for Fish and Wildlife Program and the Coastal Program at Humboldt Bay have provided funds and technical assistance to many of these projects.

Steller Sea Lion Photo: © Ron LeValley

Marine Mammal Monitoring Surrounding Castle Rock NWR

The NOAA Fisheries Service monitors pinnipeds on and surrounding Castle Rock NWR. The Southwest Fisheries Science Center (SWFSC) conducts a Pinniped Aerial Surveys Project, which includes censuses at the refuge. Surveys are flown for breeding elephant seals in February, harbor seals in May to July, and Steller's and California sea lions in July. Surveys are conducted at an altitude of either 750 to 800 feet, or 1400 feet, depending on the camera equipment used and sensitivity of marine mammals at a particular location. Stock assessment reports are produced and are available online (swfsc.noaa.gov). The reports generally do not provide specific information for Castle Rock NWR populations, but can be used to assess regional trends.

2. The Planning Process

2.1. Planning Process Policies

Service policy, the Improvement Act, and NEPA provide specific guidance for the planning process, such as seeking public involvement in the preparation of the Environmental Assessment document. The development and analysis of a reasonable range of management alternatives within the EA include a no action alternative (Alternative A) that reflects current conditions and management strategies for both refuges in the Complex. Management alternatives were developed as part of this planning process (see Appendix E: Environmental Assessment).

2.1.1. The Planning Process

Part of comprehensive conservation planning includes preparation of a NEPA document. Key steps in the CCP planning process and the parallel NEPA process include (Figure 4):

- Preplanning and Team formation
- Public Scoping
- Identifying issues, opportunities, and concerns
- Defining and revising vision statement and Refuge goals
- Developing and assessing alternatives
- Identifying the preferred alternative plan
- Draft CCP and EA
- Revising draft documents and releasing final CCP
- Implementing the CCP
- Monitoring / Feedback (Adaptive Management)

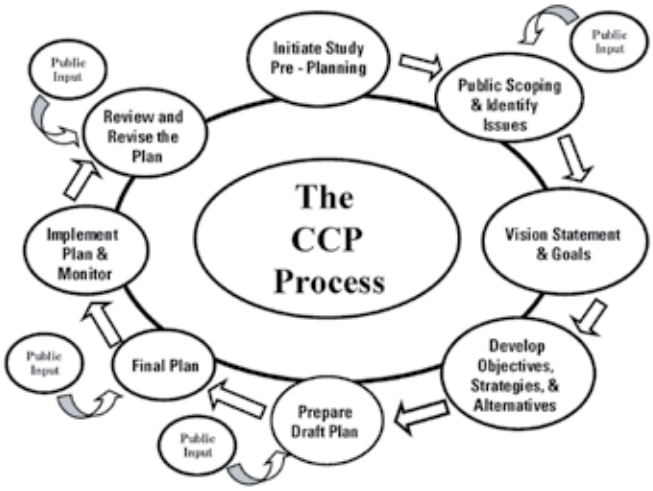


Figure 4. The CCP planning process.

2.2. Humboldt Bay NWR Complex CCP Process

Preliminary CCP planning began with information gathering in the fall of 2006. The official process began on January 29, 2007, when a Notice of Intent to prepare a CCP and EA published in the Federal Register (Vol. 72, No. 18, p. 4020). The Notice of Intent requested that the public submit comments on the scope of issues to be considered in the CCP and EA by March 15, 2007. A core planning team was established to prepare the CCP and EA. Planners, biologists, and managers from the Service formed the core planning team. The extended planning team included members of tribal governments, Service archaeologists, and specialists from various relevant disciplines. Elected officials and State resource agencies were offered briefings on the CCP/NEPA process and were invited to provide input on Complex management. CCP briefings were provided to representatives of interested County, State, Congressional, and Tribal governments. Meetings were held with the planning teams throughout the process to discuss various planning issues and develop vision statements, goals, alternatives, objectives, and strategies, as well as to share information about the Complex.

2.2.1. Public Involvement During Public Scoping Meetings and Initiation of CCP/NEPA Process

Prior to public scoping meetings, the Complex issued a press release to many local media outlets such as local radio stations including KHSU, KHUM, KSLUG, and KEKA; local newspapers including the Eureka Times Standard, Eureka Reporter, Humboldt Beacon, EcoNews, and the North Coast Journal; and local television stations including FOX, ABC, NBC, and PBS (community calendar). Flyers advertising the public meetings were posted on community bulletin boards by

members of the Service in January of 2007. Service staff provided an interview to a local television news show and to a radio station prior to the public meetings. A planning update was distributed in January 2007 to interested stakeholders that had been identified through prior planning processes. An issues workbook was also distributed to the mailing list and at public meetings to help focus public input on issues relevant to the CCP.

2.2.2. Public Scoping Meetings

Three Public Scoping Meetings were held in Del Norte and Humboldt counties to receive public input on the scope of the Complex's CCP and associated NEPA document. Each public scoping meeting consisted of a presentation by Service staff on the CCP/NEPA process, a presentation on the history of the Complex's refuges, questions and answers, and documentation of public comments. The majority of each public meeting was spent documenting public comments.

The first meeting was held on February 13, 2007, at the Del Norte Family Resource Center from 6:00 p.m.–8:30 p.m. in Crescent City, CA. Five members of the public attended the meeting. The second meeting was held on February 15, 2007, at the College of the Redwoods from 5:30 p.m.–8:00 p.m. in Eureka, CA and 23 members of the public attended and signed in. The third meeting was held on February 17, 2007 at the Humboldt Area Foundation from 2:30 p.m.–5:00 p.m. in Bayside, CA and 14 members of the public attended and signed in. Members of the public attending the meetings were encouraged to also submit written comments by March 15, 2007. Copies of the Issues Workbook were distributed to interested stakeholders at the meetings.

2.2.3. Supplemental Request for Comments on Castle Rock NWR

Due to Castle Rock NWR's seasonal popularity, primarily related to birding events, the Service attempted to obtain additional public input on the CCP by distributing an additional planning update to members of the public attending the annual Aleutian Cackling Goose Festival during the week of April 2, 2007. The second planning update encouraged the public to provide comments on the future management of Castle Rock NWR by May 17, 2007.

2.2.4. Comments Received

A complete list of public comments received orally and in writing during the public scoping process are contained in Appendix M: Public Involvement Process. Hundreds of comments were received during the public scoping meetings on a wide variety of Complex management topics. In total, 14 completed issues workbooks were returned during the public scoping period. In total, 13 letters or e-mails were received during the open comment period. In addition, three sets of written comments were turned in during public meetings.

3. Refuge Resources

3.1. Overview of Humboldt Bay NWR

California's north coast ecoregion is a unique area where the southern extension of the temperate coastal rain forests of the Pacific Northwest meet the relatively drier coastal forests of California. The north coast region is characterized by mountain ranges that parallel the coast, ranging in elevation from sea level to over 4,000 feet. Ocean currents and plate tectonics combine to produce long narrow valleys and large rivers that produce rich estuaries as they drain into the Pacific Ocean. Foggy forested mountain ranges descend into remnants of once vast coastal marshes. A variety of habitat types still exist along the coast supporting a wide diversity of flora, fauna, recreational uses, and resource economies. Northern California's coastal habitats include grasslands, terrace prairies, dunes, marshes, eelgrass beds, mudflats, and diverse forest types. Lowland areas near the north coast are dominated by coastal redwood, Sitka spruce, and Douglas-fir forest. Inland ecosystems include Douglas-fir/tanoak forest, Oregon oak woodland, annual grasslands, and mixed broadleaf/coniferous evergreen forests.

3.1.1. Humboldt Bay NWR Physical Environment Geography and Climate

The Humboldt County coast has a Mediterranean climate characterized by moderate temperatures, heavy precipitation, with many foggy days throughout the year (HC 2001). The average annual precipitation for Eureka, California, just north of the Complex, is 38.10 inches as recorded for the period 1887–2003. Record annual average precipitation rates range from a high of just over 67 inches in 1983 to a low of about 21 inches in 1929. In this coastal area the rainy season lasts from October through April, accounting for 90 percent of its annual precipitation. Table 1 displays the average monthly and annual precipitation data for Eureka, CA (WRCC 2007). On December 27, 2002, a new all-time record was set for maximum daily rainfall for any calendar day in Eureka, 6.79 inches of rain, breaking the previous record of 5.04 inches set in 1950. This event also broke the 24-hour rainfall record of 6.32 inches set 1996. Prevailing winds during spring and summer are from the northwest (WRCC 2007). Winter storms can bring winds, generally from the south or southwest, sometimes exceeding 55 to 69 miles per hour.

The climate of the Humboldt Bay NWR is completely maritime with high humidity prevailing throughout the year. The rainy season begins in October and continues through April, with the refuge receiving ~40 inches of rainfall annually (WRCC 2007). The dry season from May through September is marked by considerable fog or low cloudiness that usually clears by late morning. Temperatures are moderate throughout the year. The usual yearly range is from lows near 35°F (2 °C) to highs near 75 °F (24 °C). Summer temperatures are generally between 46 °F (8 °C) and 75 °F (24 °C).

3.1.2. Humboldt Bay NWR Global Climate Change and Sea Level Rise

The recent warming trend of the global climate is unequivocal, and is confirmed by observations of increases in global average air and ocean temperatures and rising mean sea level (IPCC 2007). Global average temperature increased 0.74°C in the past 100 yrs and is expected to increase another 0.4°C in the next 20 years (Hazeltine 2008). For the next two decades a global warming of about 0.36 °F (0.2 °C) per decade is expected to occur (IPCC 2007). Continued greenhouse gas emissions at or above current rate would cause further warming and may induce changes beyond those seen in the twentieth century (IPCC 2007).

Since at least the twentieth century, sea levels have been rising in correlation with the overall globally increasing temperatures. Sea level rise can occur from both land-based ice melting and thermal expansion of ocean water. As land-based ice melts and flows into the oceans, the volume of liquid water in the world's oceans increases. As ocean temperatures increase, water expands to a greater volume than the same amount of water would at a lower temperature.

Between the period of 1961–2003, sea level rose by an average rate of 0.07 inch per year, totaling a 2.94 inch increase over the period (IPCC 2007). Notably,

Table 1. Monthly and annual precipitation data for Eureka, CA (near Humboldt Bay NWR), from 1948 through 2007 (adapted from WRCC 2007).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	54.4	55.5	55.5	56.4	58.7	60.8	62.0	62.9	63.0	61.1	58.0	54.9	58.6
Average Min. Temperature (F)	41.4	42.6	43.1	44.6	47.8	50.6	52.4	53.1	51.3	48.1	44.8	41.8	46.8
Average Total Precipitation (in.)	6.82	5.43	5.26	3.02	1.67	0.64	0.15	0.33	0.75	2.66	5.70	7.12	39.54
Average Total SnowFall (in.)	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Period of Record : 7/1/1948 to 12/31/2007
Percent of possible observations for period of record.
Max. Temp.: 99.8% Min. Temp.: 99.8% Precipitation: 99.8% Snowfall: 99.8% Snow Depth: 99.8%
Source: http://www.wrcc.dri.edu/summary/Climsmnca.html

the average rate of sea level rise nearly doubled over the period of 1993–2003 to ~0.12 inch per year (IPCC 2007).

Globally, approximately 20 to 30 percent of species will be at increasingly high risk of extinction by 2100 if global mean temperatures exceed a warming of 2 to 3°C above pre-industrial levels (medium confidence) (IPCC 2007).

Climate Change and Sea Level Rise in the U.S.
The U.S. Department of the Interior issued an order (Order Number 3226, January 19, 2001) requiring Federal agencies under its direction with land management responsibilities to consider potential climate change effects as part of long-range planning endeavors.

Parmesan and Galbraith (2004) discuss the many important impacts of global climate change that have already been detected in U.S. ecosystems and stress that climate change should be a primary consideration in the preservation of biodiversity. Important conclusions from their analysis of the observed impacts of climate change on U.S. ecosystems include:

1. The timing of important ecological events, including plant flowering and wildlife breeding, has shifted in conjunction with changes in U.S. climate.
2. Ranges of some plants and animals have shifted northward and upward in elevation, or contracted.
3. Species composition within communities has changed in concert with local temperature rise.
4. Findings that climate change is affecting U.S. ecosystems are consistent across different geographic scales and species.
5. Species range contractions are more likely than simple northward or upslope range shifts.
6. Reducing adverse effects of climate change on ecosystems can be facilitated through a broad range of actions, including adaptive management, providing transitional habitat between preserved areas, and alleviating non-climate change stressors.

Climate Change and Sea Level Rise in California

During the next few decades, average temperatures in California are expected to rise between 1 and 2.3 °F (CCCC 2006). Major changes to California's precipitation are not predicted to occur over the life of this CCP, but are likely to occur over the next century (CCCC 2006).

Smerling et al. (2005) projected localized sea level rise for each U.S. state. According to their projections, California will experience a sea level rise of between 1.26 inches (low, historic extrapolation), to 2.96 inches (medium, 50

percent probability), to 6.0 inches (high, 5 percent probability) sea level rise by 2020 (Smerling et al. 2005). Their projections predict even greater increases over the next 50 to 100 years, which is beyond the intended scope of this CCP.

In addition to the relatively steady impacts likely to occur from global trends, sea levels along the California coast are expected to undergo more variability above or below predicted tide levels because sea level rise will coincide with decadal oscillations (Cayan et al. 2006), such as the ENSO and LNSO (*see section 3.6.2*). Historically, the highest Pacific coastal sea levels have occurred when winter storms and Pacific climate disturbances, such as El Niño, have coincided with high tides (Cayan et al. 2006).

Climate Change and Sea Level Rise for Humboldt Bay NWR

Considering that nearly one third (161 of 548) of refuges are coastal, sea-level rise is a highly significant factor in Refuge System management and planning. Shriner and Street (1998) estimate that a rise of ~20 inches (50 centimeters) in sea level could lead to the loss of 50 percent of North American coastal wetlands. Major effects of sea-level rise on coastal refuges include inundation and loss of terrestrial habitats, saltwater intrusion and an increase in frequency and severity of flooding events. All of these factors have the potential to alter ecosystem dynamics. In some cases, wetlands may move inland in response to sea-level rise (Shriner and Street 1998), but in many cases this possibility is compromised by coastal development (Bedoya et al. 2008). This is very much the case around Humboldt Bay.

The south Humboldt Bay NWR units are, in part, below mean high water level and are currently protected by dikes. This elevation makes many of the southern unit habitats vulnerable to dike failures, particularly as sea level continues to rise. The current elevation of these units below mean high water is largely due to land subsidence caused by draining lands for agriculture combined with anthropogenic modification of streams, which has changed sediment recruitment and distribution. There are methods being studied by the U.S. Geological Survey in the Sacramento Delta to use wetland vegetation (cattail and tules) to increase soil elevations. At one site on Twitchell Island, soil elevations have risen 1 to 2 feet in 15 years. This process, as well as better information on current sedimentation rates and distribution should be studied in the Humboldt Bay area.

While various climate change models differ in their predictions, all agree that sea level will continue to rise over the 15-year life of the CCP. Given the current predictions of sea level rise, it is unlikely that most of the Complex habitat would be substantially affected by sea level rise over that time period. However, without further action, likely future impacts from global climate change and sea level rise on the Humboldt Bay NWR include:

- Foraging habitat for wintering and migrating shorebirds may suffer severe losses as sea level rise inundates current intertidal foraging areas (Galbraith et al. 2002).
- Changes in the timing of migration and nesting of birds could put some bird species breeding and migration cycles out of synchronization with the life cycles of their food sources.
- Changes in ocean currents could put marine mammal breeding out of synchronization with the migration of primary prey species that provide food at critical life stages, such as pup rearing.
- Changes in precipitation and temperature may affect the population dynamics of plants of dune and marsh communities (including listed species)
- Shifts in ranges of both native and invasive plant species may cause extirpations on the refuge, increase management needs, and result in significant changes to community composition.
- Changes in the ecosystem dynamics (precipitation and temperature) of headwater forests could impact sedimentation, temperature, dissolved oxygen, and other habitat parameters on lower Salmon and Jacoby Creek on Humboldt Bay NWR.
- Changes in rainfall, storm patterns, sedimentation, littoral transport, and wind speed could affect dune stability/migration, and may affect plant communities on dunes and salt marshes.
- Continuing changes in sea level, sedimentation, turbidity, currents, and wave energy could affect estuarine plants including eelgrass and salt marsh species.
- Continuing changes in winter storm frequencies and relatively minor increases in tidal heights could dramatically increase costs to maintain some refuge infrastructure, such as dikes and tidegates.

3.1.3. Humboldt Bay NWR Hazardous Materials and Contaminants

An inactive nuclear reactor is located adjacent to Humboldt Bay. The reactor operated from 1963 to 1976 (RCEA 2005). In 1976, the plant was shut down for a normal refueling and subsequently a number of unresolved seismic issues led Pacific Gas & Electric (PG&E) to keep the plant shut down for an extended period of time. In 1984, the fuel was removed from the reactor vessel and the plant was inactivated,

with spent nuclear fuel rods stored in water pools on site (RCEA 2005). More recently, PG&E announced its intent to remove 390 spent (irradiated) fuel rods from the pool at the plant, and place them in on-site steel containers called dry casks pending permanent removal (RCEA 2005). While in the local area, the inactive nuclear reactor is not known to pose any foreseeable risk to the Humboldt Bay NWR.

In late 2006, the California Water Resources Control Board placed Humboldt Bay on its list of water bodies impaired by dioxins. Dioxins are a group of chemical compounds that share certain chemical structures and biologically active characteristics. In laboratory animals dioxins are highly toxic, can cause cancer, and alter reproductive, developmental, and immune system function (NIH 2007). Studies have shown that exposure to dioxins at high doses can cause a number of adverse health effects (USEPA 2006). Although they are at low levels in food, some dioxins are very slowly removed from the body and accumulate in human fat tissue (NIH 2007). Chlorine bleaching of pulp and paper, certain types of chemical manufacturing and processing, and other industrial processes that have occurred around Humboldt Bay, can create dioxins (USEPA 2006).

No area within the Humboldt Bay NWR is listed as a hazardous waste site by the U.S. Environmental Protection Agency.

3.1.4. Humboldt Bay NWR Air Quality

Air Pollution Control Agencies

The Federal Clean Air Act (42 U.S.C. §§ 7401, as amended) mandates the establishment of ambient air quality standards and requires areas that violate these standards to prepare and implement plans to achieve the standards by certain deadlines. The deadline for attaining both the ozone and carbon monoxide standards was August 31, 1988. Areas that do not meet Federal primary air quality standards are designated as "nonattainment" areas. Areas that comply with Federal air quality standards are designated as "attainment" areas. Attainment and nonattainment designations are pollutant specific. The Federal Environmental Protection Agency (EPA) sets health protection standards for 8 substances called "criteria pollutants." Humboldt and Del Norte counties are in attainment of Federal EPA standards for these criteria pollutants, including carbon monoxide, nitrogen dioxide, sulfur dioxide, sulfates, and lead; however, they are nonattainment areas and do not meet State standards for particulate matter less than 10 microns in diameter (PM10). Del Norte County is unclassified for hydrogen sulfide; Humboldt County is classified as an attainment zone for hydrogen sulfide. Both counties are unclassified for visibility reducing particles.

In the winter months, the air quality in Humboldt, Del Norte and Trinity County does not fully meet the State health standards for clean air. The two pollutants of greatest concern are ozone and particulate matter. The ambient air in portions of the air quality management district (AQMD) with Humboldt County exceeds the State PM10 standard during many of the winter months. Some sources of particulates in Humboldt County include automobile emissions, saw pulp mills, and residential home heaters (wood stoves). Geographic features that adversely influence air quality include mountains and valleys that trap stagnant air (North Coast Unified Air Quality Management District) http://www.ncuaqmd.org/.

Many agencies are involved in air pollution control, including the U.S. Environmental Protection Agency (USEPA 2006), California Air Resources Board (ARB), and air quality management districts (AQMDs).

In California, all agricultural burning is regulated jointly by the ARB and local AQMDs. Each day the ARB determines, based on recent and anticipated weather conditions, whether the following day will be a permissible burn day or a no-burn day. Each ARB's primary objective in making this determination is to control the amount of smoke from agricultural burning that reaches urban areas. On permissible burn days few restrictions are placed on the amount of land that may be burned in the region. On no-burn days fields may be burned only if a special permit has been issued by the local AQMD. Such burn permits are allocated based on an estimated allowable acreage for the entire region, or air basin. Air basin boundaries generally follow political boundary lines and are defined to include both the source area and the receptor area. Both refuges in the Complex fall within the North Coast Air Quality Management Basin, which includes Del Norte, Humboldt, Mendocino, and Trinity counties, and a portion of Sonoma County (ARB 2005).

Ambient Air Quality Standards and Quality in the North Coast Air Quality Management District

Both the State of California and the Federal government have established a variety of ambient air quality standards. The North Coast Air Quality Management District (NCAQMD) collects and analyzes ambient air samples to determine concentrations of regulated pollutants within the North Coast Air Quality Management Basin. There

are three monitoring sites where samples are collected: Crescent City, Eureka, and Weaverville. By analyzing the samples, the NCAQMD is able to determine the concentration of particulate matter less than 10 microns (PM10) and less than 2.5 microns (PM2.5). Air quality data is reported to a Federal database maintained by the U.S. Environmental Protection Agency. The following discussion focuses on the ambient standards and existing concentrations for PM10 because the ambient air in portions of the NCAQMD exceeds the State PM10 standard during many of the winter months (NCAQMD 2007). It is the primary pollutant that could be affected by Humboldt Bay NWR management.

Particulate Matter Less Than 10 Microns Diameter

Both Humboldt and Del Norte counties are classified as nonattainment zones for PM10 (ARB 2007). Atmospheric particulates are the result of many types of dust and fume-producing industrial and agricultural processes (HC 2001). The NCAQMD PM10 emissions are generated primarily by entrained road dust, construction and demolition activities, farming operations, and agricultural waste burning (HC 2001).

Health concerns associated with suspended particles focus on those particles small enough to reach the lungs when inhaled. Few particles larger than 10 microns in diameter reach the lungs. Consequently, both the Federal and State air quality standards for particulate matter have been recently revised to apply only to these small particles, designated as PM10. According to ARB (2005), exposure to particulate matter aggravates several respiratory illnesses and can cause early death in people with heart and lung diseases. Both long- and short-term exposure to PM10 can have adverse health impacts. All PM10 particles are harmful. PM10 also includes the subgroup of PM2.5. These finer particles pose an even higher health risk because they can deposit deeper in the lungs and contain substances particularly harmful to human health (ARB 2005).

PM10 particles are a mixture of substances that includes elements such as carbon and metals; compounds such as nitrates, sulfates, and organic compounds; and mixtures such as diesel exhaust, and soil (ARB 2005). These substances and mixtures may occur as solid particles or liquid droplets. Some particles are emitted directly into the atmosphere, while other secondary particles are the result of gases that are transformed into particles through various physical and chemical processes in the atmosphere (ARB 2005).

Toxic Air Contaminants

A toxic air contaminant is an air pollutant that may cause or contribute to an increase in mortality or in serious illness, or which may pose a hazard to human health (ARB 2005). No management activities carried out on the Complex would be expected to produce toxic air contaminant levels that would cause negative impacts to human health.

3.1.5. Humboldt Bay NWR Paleontological Resources

No known paleo-faunal remains occur within the approved refuge boundaries. However, diatoms (eukaryotic algae encased in persistent silica) are present and could be used as a tool in interpreting paleoecology (Hemphill-Haley 1992).

3.1.6. Humboldt Bay NWR Minerals

There are no known mineral deposits within the Humboldt Bay NWR boundaries (USFWS 1985). Areas in western Humboldt County, including the bay, are underlain by sedimentary rock from the Tertiary Age and have some potential for oil and natural gas extraction. The only oil production recorded was near Petrolia, ~30 miles to the south, in 1954.

There are natural gas deposits in Humboldt County, mainly in the Eel River basin (RCEA 2005). Currently, there are 38 producing wells and 15 shut-in (not producing) wells in the county (RCEA 2005). The active gas wells are concentrated in the Tompkins Hill gas field, where there are 31 producing wells. Net gas production from these wells in 2003 was 1,010,605 thousand cubic feet (RCEA 2005).

Due to changes in energy markets, there are now multiple active proposals for both wind and wave energy development not far from the refuge. Any such project(s) would likely have impacts on migratory bird and other natural resources, but all proposals are still in planning stages.

3.1.7. Humboldt Bay NWR Geology

Humboldt Bay NWR is located within the Coast Range of northern California. The Coast Range geological province is located along the coastal portion of the Klamath ecoregion from Sonoma County to the Oregon border. It includes the entire watershed of most of the smaller coastal streams, as well as portions of the Smith, Klamath, and Eel River hydrobasins. It consists of a system of north and northwest trending mountain ridges and valleys formed by folding and faulting.

Barnhart et al. (1992) provides a thorough description of Humboldt Bay geology. Humboldt Bay is ~30 miles northeast of the Gorda-Pacific-North American plates triple junction. The Pacific plate is to the south, the Gorda plate to the northwest, and the North American plate to the east. The region is tectonically active with many northwest-southwest faults, as the Gorda plate is subducted beneath the North American plate. Uplifting and folding, fault lines and erosion have exposed a complex pattern of rock formations around Humboldt Bay.

Four geologic formations are predominantly exposed in the Humboldt Bay region: the Franciscan Formation (Late Jurassic to Late Cretaceous in age); the Yager Formation; the Wildcat Group (Late Cenozoic in age); and the Hookton Formation (Pleistocene in age) (Barnhart, et al. 1992). Older geologic formations are largely overlain by more recent river channel deposits, floodplain deposits, beach and dune sands, tidal flat deposits, and landslide debris. Most of these deposits, from the Mad and Eel rivers, are 16 to 23 feet deep.

Current sediments in Humboldt Bay are derived from runoff, oceanic input, and biological activity. Most of the silt and clay in Humboldt Bay probably enters the bay during flood tides. A smaller amount of sediment is introduced by small rivers and creeks that enter the bay. Decaying organic material from biological activity probably contributes the least amount of sediment to the bay.

Dune Geology

The persistence of the Humboldt Bay dune sheet over long periods is the result of a localized subsiding basin, which continues to provide receptive areas near sea level (Orme and Tchakerian 1986, Orme 1992). In the Pacific Northwest (including Humboldt Bay), episodes of subsidence are believed to occur as rapid, co-seismic events along the Cascadia subduction zone at intervals of between 300–700 years, generating tsunamis (Clarke and Carver 1992, Carver et al. 1998).

California's Holocene dunes formed up to 7,000 years BP (middle to late Holocene) during high to falling sea levels (Orme 1992, Peterson et al. 2004). In Humboldt Bay, the dunes represent two phases of activity. The most recently accreted or re-mobilized Holocene dunes support early successional vegetation (foredune grassland and dune mat) although wetland conditions favorable to later successional (shrub) vegetation may exist in low-lying areas. Older, stabilized Holocene dunes located on the eastern edge of the dune system are stabilized by coniferous and riparian forests (Pickart and Barbour 2007).

Because of the location of faults and seismic activity, the entirety of the low lying Humboldt Bay area, including the entire refuge and all infrastructure, is a high-risk zone for tsunamis (tidal waves). The county has worked diligently to prepare an action plan, post signs, and deploy warning sirens.

3.1.8. Humboldt Bay NWR Soils

Soils of Humboldt Bay NWR are in the process of being revised and remapped by the Natural Resources Conservation Service (Soil Survey Staff 2007). Soils of Humboldt Bay NWR include the poorly drained Weott and Arlynda Series derived from old salt marsh soils. Dune areas are characterized by the Samoa, Clambeach, and Lanphere Series derived from marine and eolian sands and characterized by well to excessively drained sand (Soil Survey Staff 2007).

According to the maps available at the time of this document, all of the Salmon Creek Unit except a small portion of Salmon Creek Overflow is classified as the Weott Series, characterized by very poorly drained silt loam in the top 12 inches with frequent ponding and very high surface runoff. The Hookton Slough Unit is classified as the Arlynda Series, composed of peat in the top 3 inches and underlain by silty clay loam to 14 inches. Hydrologic characteristics are similar to Weott soils: very poorly drained, subject to frequent ponding, and very high surface runoff. Weott soils are described as having a salinity of 0–2.0 dS/m and pH of 6.1–7.3 in the top 0–12 inches. Arlynda soils have a reported salinity of 0 dS/m and pH of 5.1–6.0 to a depth of 3 inches, with higher salinity (0–2.0 S/m) and more acid pH (6.1–7.3 from 3–14 inches.

Dunes soils are comprised of three series: Samoa, Clambeach, and Lanphere. The Samoa Series is found on the upland nearshore dunes, and consists of very deep, excessively drained, sandy soils with slopes ranging from 2 to 50 percent (Soil Survey Staff 2007). The A and O horizons are missing in areas where dunes have sparse dune mat vegetation or European beachgrass. In lower seasonally wet areas of the nearshore dunes (dune swales), the Clambeach series is present. These are also deep and poorly drained, composed of eolian and marine sand, but with shallower slopes from 0–2 percent, and with redoximorphic features (colors in the soil that indicate water is seasonally present at the level the features are found) and free water within 80 inches. The Lanphere Series is found on stabilized forested backdunes. They are deep, somewhat excessively drained, sandy soils formed in eolian sand. Slopes range from 2–75 percent (Soil Survey Staff 2007).

3.1.9. Humboldt Bay NWR Water Resources

There are four sizable coastal streams that empty into Humboldt Bay. Jacoby Creek and Freshwater Creek enter into North Bay, Elk River meets the bay near its entrance, and Salmon Creek enters the South Bay. These watersheds are all roughly 12 miles in length and support anadromous fish. Salmon Creek and Jacoby Creek have relatively small amounts of estuarine habitat, while Freshwater Creek and Elk River have somewhat larger estuaries. All four systems have been significantly altered by logging, development, and diking.

The Mad River Slough is one of four major channel systems carrying water to and from Arcata Bay (Thompson 1971). The slough runs north-south for ~3.4 miles from its confluence with the main body of Arcata Bay. The current extent of tidal influence within Mad River Slough and its tributary, Liscom Slough, is 480 acres. Prior to diking, the salt marshes of the slough were contiguous with those of the rest of Arcata Bay, and the slough was less of an isolated feature. Using present day Highway 255 as a division between the slough and the rest of the bay's historic salt marshes, the historic tidal extent of the slough was as much as 1,500 acres.

Mad River Slough collects runoff from the Arcata Bottoms, including periodic overflow from the Mad River. Perennial fresh groundwater flows, as well as one perennial stream (Iron Creek), enter Mad River Slough from the dune side of the slough. The slough comprises an interlacing collection of tidal flats, channels, and salt marshes. The slough contains a total of 150 acres of salt marsh, or 17 percent of the bay's total salt marshes (Pickart 2001).

Although the Mad River did historically flow directly into ancestral Humboldt Bay, the slough does not represent a historic channel (Thompson 1971). Much of the Arcata Bottoms represent deltaic deposits, and the slough is believed to be a natural trough formed between the edge of subsiding delta deposits and the more recent spit deposits. However, a canal was dug to connect the Mad River and Mad River Slough in 1854 in order to facilitate log rafting from the river to the bay. The higher velocity of the river required that a boom be constructed across the river, and during the 30 year history of the canal it was functional for only a few years due to repeated failing of the boom during flood events. The canal had a lasting impact on both the river and bay, however. Logjams caused alterations in the river bed that exacerbated flooding on the Arcata Bottoms, and to an unknown extent debris and silt were diverted into the slough and bay (Haynes 2003).

Jacoby Creek provides a freshwater source for thousands of waterbirds and cuts through the north end of the refuge's Jacoby Creek Unit. This unit includes one of the largest remaining salt marshes in Humboldt Bay. To the east, across the freeway, the City of Arcata has purchased additional lands adjacent to and including lower Jacoby Creek and is planning restoration work.

In the South Bay, three streams flow into Humboldt Bay NWR's Salmon Creek Unit: Willow Brook, Cattail Creek, and Salmon Creek. The former two are small (less than 1 mile long) perennial streams that drain the Tompkins Hill area and flow onto refuge lands. One additional small perennial stream flows off north Tompkins Hill through the White Slough Unit and into the bay. Two other small unnamed perennial creeks flow north off Table Bluff and into the Hookton Slough Unit.

Salmon Creek is the only sizeable perennial stream that flows into south Humboldt Bay. It is the main water course for the drainage which affects most south Humboldt Bay lowlands. Peak flows for Salmon Creek occur between November and March (PCFWWRA 2003), with low to barely perceptible flows during the rest of the year.

Salmon Creek historically flowed into the bay through a relatively large multi-channeled alluvial floodplain (delta) which included a dynamic transition of habitats from riparian to salt marsh, and from creek channel to tidal slough. Large woody debris (trees and/or logs that were washed down the creek during flood events) had a significant role in the historic delta ecology by jamming and causing the re-routing of flows, stabilizing banks, and creating and providing habitat diversity (Gregory et al. 2003).

The entire delta area was diked off for development in the late 1800s and early 1900s. During that time, and in later years, Salmon Creek was channelized and diverted to maximize drainage, spread silt, sub-irrigate agricultural grassland, and provide drinking water for livestock during the dry season (A. McBride pers. comm.). Large woody debris was also removed to the extent possible. During this same time period and later, the upper watershed was also heavily logged, roads built, and lands toward the bottom of the watershed converted from forest to pasture for livestock. These alterations significantly changed the natural topography, hydrology, and ecological function of the delta by reducing fish passage, impeding sediment and flood flows, and nearly eliminating tidal exchange and large woody debris from the delta. As a result, the lower stream channel filled with silt, adjacent roads were (and are) flooded multiple times each

winter, and flows reached the bay only through tidegates at different locations. Generally, tidegates were constructed to allow freshwater to flow into estuaries but prevent the upstream movement of estuarine waters (Giannico and Souder 2005).

The Salmon Creek Unit of the refuge includes most of the Salmon Creek delta. Since most of this area was acquired by the refuge in the 1980s, there have been substantial efforts made to restore the natural function of the creek to the extent possible. These efforts (past, present, and future) are adaptive in nature and include installation and modification of newly designed tidegates, channel restoration, reintroduction of large woody debris, fish screening, and monitoring of both the physical and biological changes taking place. The objectives are to significantly increase tidal exchange, which in turn will improve fish passage, movement of sediment and flood flows, water quality, and increase the total area and natural function of salt marsh and brackish marsh habitats. An outline and summary of these efforts can be found in the Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities (PCFWWRA 2003)

Humboldt Bay NWR Hydrology and Water Management

The Salmon Creek Unit is composed of a complex arrangement of dikes, diversion structures, ditches, ponds, water control structures, and tidegates. Each plays a role in creating a wide variety of habitat types while providing drainage for storm runoff.

Willow Brook collects water from the northern end of Tompkins Hill and then runs under the freeway onto the refuge through the north diversion and out into the bay through the White Slough tidegates.

Cattail Creek drains the southern Tompkins Hill area and also enters the refuge from the east after emerging from under Highway 101. It has a substantially smaller drainage area than Willow Brook. After entering the refuge, Cattail Creek currently flows in a ditch through the Middle Diversion and then eventually into Long Pond.

Long Pond, a former tidal slough, is now a large brackish pond that serves as a collection and discharge basin for much of the waters draining from the refuge. The pond receives flow from both Salmon and Cattail Creek. The water surface elevation of the pond is managed through a set of tidegates at the west end and a large water control structure at the east end (equipped with flashboards) that allows captured floodwater to be channeled into seasonal wetlands to the north.

Salmon Creek approaches Humboldt Bay from the southeast after crossing under bridges located on Tompkins Hill Road, Highway 101, Loleta Drive, and Hookton Road. Between Eel River Drive and the Humboldt Bay NWR the stream flows in an aggraded meandering channel flanked by agricultural grassland and a former dairy facility. Just as it enters the refuge, the stream channel makes a 90° turn and becomes linear, flowing west in a straight diked channel. At the end of this reach the stream passes uninterrupted through the First Diversion, which is no longer actively operated. Downstream of the First Diversion the stream flows through a meandering channel constructed by refuge staff and partners in 1993, eventually reaching the Salmon Creek tidegate and lower tidal estuary. A cooperative project begun in 2003 and completed in 2008 replaced and/or reworked all of the tidegates of lower Salmon Creek and added a new tidegate in the Salmon Creek overflow. The goals of the project were to improve fish passage and water quality, increase sediment transport and estuarine habitat and function, and allow flood flows to reach the bay in one tide cycle. Prior to adding the new tidegate and enlarging the one on Salmon Creek, flood events would overwhelm the drainage capacity of the tidegates, causing floodwaters to back up and sediment to fill the lower creek channels (a situation that worsens with each ensuing flood), which then impairs water quality and reduces habitat quality. The new structures are larger, which allows greater volume to escape each tide cycle, and are equipped with sluice gates which remain open to allow fish passage and upstream tidal flows during high tides, which will passively remove sediment built up on the creek bed and help cut the channel down to its natural elevation.

During high flow events, which typically occur several times each year, Salmon Creek overtops the First Diversion. These flood waters fill the diversion ditch that runs north and eventually drains via the Long Pond and White Slough tidegates. These flood or overbank events provide the water used to flood all the seasonal freshwater wetlands that occur on this unit of the refuge.

Humboldt Bay NWR Water Quality

There have been ongoing efforts to assess water quality in lower Salmon Creek over the last decade. In general, until 2007, the water quality in lower Salmon Creek could be characterized as fair to good during the winter rainy season and poor during the summer and early fall months. However, the late summer water quality has improved with the installation and replacement of new tidegates which have increased the movement of bay water up the creek.

Water quality data is summarized in a report by PCFWWRA (2003).

3.2. Humboldt Bay NWR Biological Resources

3.2.1. Humboldt Bay NWR Ecoregional Context

The California North Coast Ecoregion represents the southern extension of the temperate rainforests of the U.S. Pacific Northwest (TNC et al. 2005). This ecoregion is characterized by a series of mountain ranges that approximately parallel the coast. Elevations range from sea level to over 2,100 meters (7,000 feet) on the crest of the Yolla Bolly Mountains (TNC et al. 2005). Many small streams originate in the coastal mountain ranges, feeding larger rivers that flow towards the ocean creating estuaries as they merge with the Pacific Ocean. The cool, foggy coastal climate supports coastal redwood forests and the resident flora and fauna that depend on these forests.

The diverse topography supports a wide variety of plant community types. According to TNC et al. (2005), the lowland areas near the coast are dominated by redwood and Douglas-fir forests. Inland, the ecoregion is dominated by Douglas-fir/tanoak forest, Oregon oak woodland, annual grasslands, and mixed evergreen forests. Higher elevations contain montane mixed coniferous forests (white fir [*Abies concolor*], ponderosa pine [*Pinus ponderosa*], and Douglas-fir). The interior southeastern portion of the ecoregion is characterized by mixed chaparral, gray pine, and blue oak (*Quercus douglasii*) (TNC et al. 2005).

The immediate coast also provides microhabitats that favor plant communities not dominated by coastal redwood forest. Other important coastal systems in the region include grasslands, bald hills (prairies), coastal terrace prairies, dune communities, coastal estuaries with salt marsh, brackish marsh, and eelgrass beds (TNC et al. 2005). Coastal estuaries are of particular importance to bird, fish, wildlife, and plant production and diversity. Estuaries are fueled by emergent vegetation, algae, and detritus-based food webs (Rumrill 2002). Tidal basins accumulate sediments and the resident communities contribute to water quality in the bay (Rumrill 2002).

The ecologically important eelgrass beds in Humboldt Bay are the largest between Willapa Bay, Washington, and Baja California, Mexico. These extensive eelgrass beds provide cover for many species of marine and estuarine vertebrates and invertebrates, and food for hundreds of thousands of migrating shorebirds and waterfowl, especially Pacific brant (WHSRN 2007).

Humboldt Bay NWR Geographic/Ecosystem Setting

The refuge is located in and around Humboldt Bay near the cities of Arcata and Eureka. Humboldt Bay is located on a narrow coastal plain and is a natural land-locked harbor 0.5 to 4 miles wide and 14 miles long. Humboldt Bay consists of two tidal basins, designated as the Arcata Bay and the South Bay (USFWS 1997).

The Mad and Eel rivers bound Humboldt Bay on the north and south respectively. The countryside adjacent to the refuge is relatively flat with rolling terraces. The Humboldt Bay NWR contains many types of habitats including intertidal flats (mudflats and eelgrass beds), estuarine wetlands, palustrine wetlands, agricultural grasslands, riparian forest communities, dunemat/foredune grasslands, dune swales, dune riparian/swamp forest communities, and coniferous dune forest. The topography of the area immediately east of the coastal plain is characterized by steep hills and narrow valleys. Vegetation of these uplands consists of dense forests of redwood, Sitka spruce, and Douglas-fir.

The majority of land within the refuge boundary was tidally influenced. Vast expanses of wetlands around the bay, including lands within the Humboldt Bay NWR boundary, were historically diked to prevent tidal water exchange and to convert salt marsh to pasture to allow for cattle grazing and other agricultural practices. Many changes in the topography, hydrology, soils, and plant species composition have taken place since these lands were diked. Freshwater marsh was historically rare within the Humboldt Bay area, however, freshwater wetlands are an extremely valuable habitat type for a large variety of birds, and contribute to the abundance of wildlife found at the Humboldt Bay NWR specifically and around the bay generally. Other areas that provide freshwater marsh habitats include the Arcata Marsh and several of the CA Department of Fish and Game Wildlife Areas. Both estuarine (tidally Influenced) wetlands and freshwater wetlands have been reduced by over 90% throughout California.

3.2.2. Humboldt Bay NWR Units

The refuge consists of nine units located within Humboldt Bay (five units in South Bay and four units in North Bay) and two units to the west of the Mad River Slough (dune units) (Figure 5). The South Bay units include Table Bluff, South Bay, Hookton Slough, Salmon Creek, and White

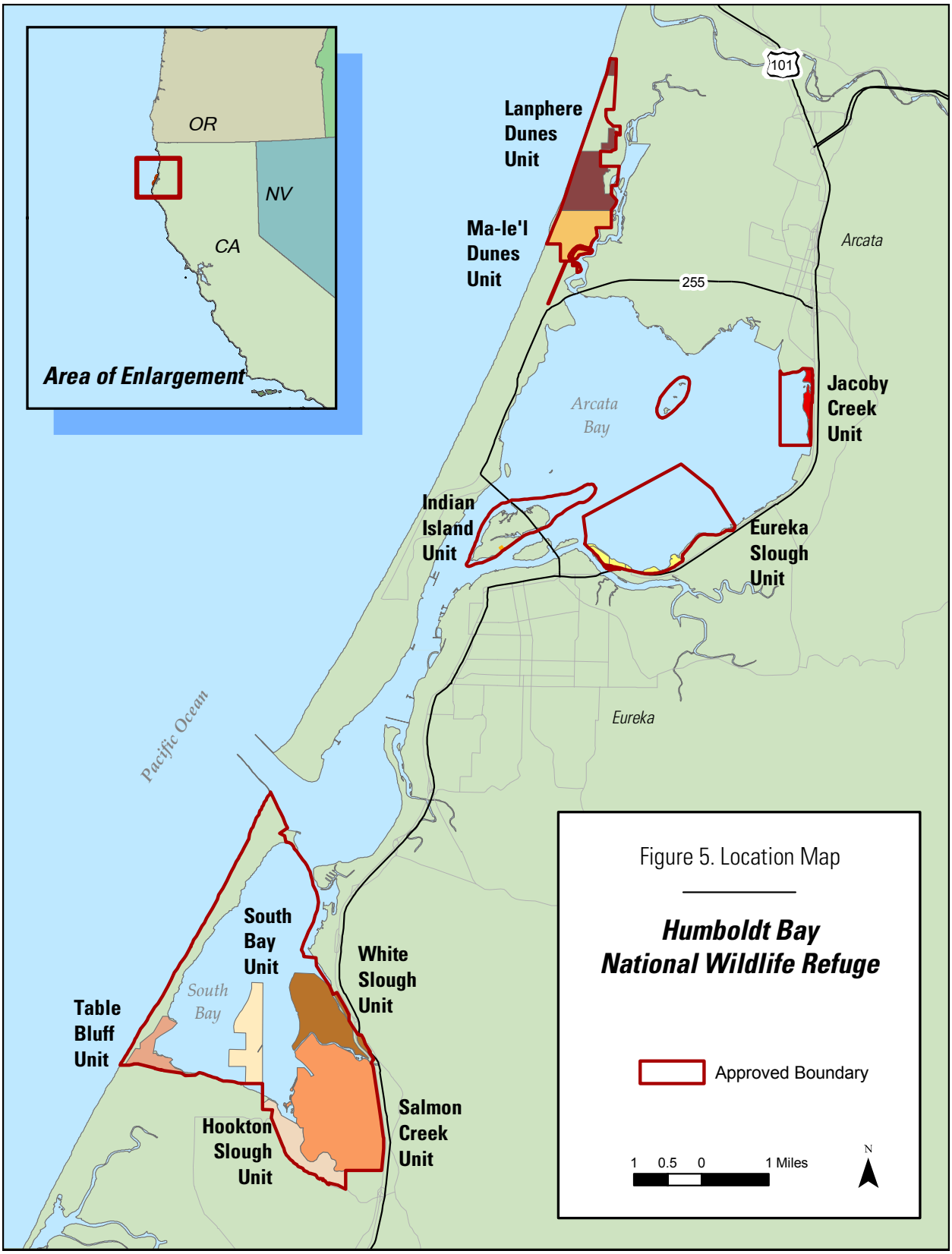


Figure 5. Refuge boundary and management units for Humboldt Bay NWR.

Slough, while the North Bay units include Indian Island, Eureka Slough, and Jacoby Creek. The Sand Islands in northern Humboldt Bay are within the Humboldt Bay NWR boundary, although no interest in the Island's lands have been acquired by the Service. The approved refuge boundary encompasses over 9,500 acres, of which ~ 3,379 are owned in fee title by the Service (Table 2).

South Bay Units

Table Bluff Unit. The Table Bluff Unit, comprising ~168 acres, is located in the southwest corner of Humboldt Bay (Figure 6). Former salt marsh on the site was diked around 1914 to create agricultural grasslands (Pickart 2005b). The Table Bluff Unit was added to the Humboldt Bay NWR in 1981. The pastures were of low quality and the long-term plans were to restore this tract to tidal exchange. Leaky tidegates had created a mosquito nuisance, and in the summer of 1984 the dike was breached in two places by the Service to alleviate the mosquito problem. The unit now includes a continuum of mudflat to dune habitats.

The Table Bluff Unit has unique wetland vegetation composition and patterns for Humboldt Bay, resulting from its history of diking and subsequent breaching (Pickart 2005b). The gradient of salt to freshwater is very well defined across the northern arm of the Table Bluff Unit, from palustrine dune wetlands on the west to estuarine salt marsh on the east. The presence of the Little Salmon Creek fault, responsible for the juxtaposition of the bluff and dune/estuary habitats, also contributes to the uniqueness of the site.

In 2004 the Table Bluff Unit was surveyed for rare plants and to classify its vegetation communities (Pickart 2005b). Seven wetland vegetation types were characterized and mapped. Cordgrass, salt marsh, and two of the three brackish marsh subtypes (salt rush and mixed brackish marsh) are estuarine wetlands, subjected to regular or irregular tidal inundation and occurring on primarily organic soils (although there is much intergrading of sand and peat), while freshwater/brackish marsh and agricultural grassland, shrub swale, and herbaceous swale are palustrine wetlands on primarily sandy dune substrates.

The Table Bluff Unit freshwater and brackish marsh communities include mixed brackish marsh dominated by salt rush (*Juncus leseurii*), silverweed, and spear-leaved saltbrush (*Atriplex triangularis*); salt rush marsh dominated by salt rush); and slough sedge marsh dominated by slough sedge (*Carex obnupta*) with seacoast angelica (*Angelica lucida*).

Two types of salt marsh exist on the Table Bluff Unit: those dominated by non-native dense-flowered cordgrass; and those co-dominated by native species. Native salt marsh is characterized by 100 percent cover, comprised of saltgrass (*Distichlis spicata*; 25–50 percent), pickleweed (*Salicornia virginica*; 25–50 percent), jaumea (*Jaumea carnosa*; 5–25 percent), minor Lyngbye's sedge (*Carex lyngbyei*), salt rush, sand spurrey (*Spergularia macrotheca*), and seaside arrow-grass (*Triglochin maritima*). This vegetation falls within the "mixed marsh" type described by Eicher (1987), characteristic of high elevation marshes.

South Bay Unit. The approved boundary of the South Bay Unit includes almost all the natural tidelands in South Bay but excludes the navigation channel and turning basin along the developed portion of the bay between King Salmon and Fields Landing. The acquired area is ~823 acres in size and consists of deeper channels which convey the tidal flows, mudflats that are seasonally covered with algae that provide crucial nutrients to the bay's food web, and eelgrass (*Zostera marina*) beds, which are a key habitat and the food for many marine invertebrates, fish species, and waterfowl, especially Pacific brant. The unit is tidally influenced and covered by water for some portion of every day.

Hookton Slough Unit. The Hookton Slough Unit is ~444 acres of low, diked, former tidelands and tidal slough (Figure 6). The dike greatly prohibits tidal exchange but it also protects low spots on the county-owned Hookton Road from flooding. Prior to acquisition by the Service, this area was managed as agricultural grassland for cattle grazing. Upon acquisition, grassland management ceased and the area has been allowed to revert to seasonal and semipermanently flooded wetlands. The unit is split by an interior dike that formerly provided landowners access to houses, barns, and the slough. It now provides the public access to facilities including a hiking trail, boat dock, and vault toilets. The wetlands on either side of the dike receive seasonal freshwater input from drainage off Table Bluff and perennial freshwater input from springs. Both sides also receive limited tidal input by fish-friendly tidegates installed between 2003 and 2007. The vegetation in this unit was mapped in 2006–2007. The wetlands east of the interior dike have transitioned to a fresh to brackish wetland gradient ranging from more brackish saltgrass to fresher cattail (*Typha latifolia*), marsh pennywort (*Hydocotyle ranunculoides*), and willow (*Salix hookeriana*). To the west of the dike, the lands were more aggressively drained and this area is more transitional, but also displays a fresh to brackish continuum.

Table 2. Habitat type and acreage by unit.

Habitat Type	Acreage by Unit									
	Lanphere Dunes	Ma-le'l Dunes	Jacoby Creek	Eureka Slough	White Slough	Salmon Creek	Hookton Slough	Table Bluff	South Bay	Total Acreage by Habitat Type
Beachgrass	3	7								**10**
Brackish marsh (Native)	3	7			35	42	84	14		**185**
Coniferous Forest	111	71								**182**
Dune mat with beachgrass								11		**11**
Dune mat	74	40								**114**
Dune swale	46	21						33		**100**
Freshwater marsh		2				218	50	10		**280**
Infrastructure						63				**63**
Tidal flats/slough channels/eelgrass							206	62	823	**1091**
Non-native Brackish marsh					12	339	12			**363**
Open sand	88	91								**179**
Open water (ponds, ditches)						30				**30**
Riparian forest/ Swamp	19	14			2	52	15	3		**105**
Salt marsh	9	37	73	86	11	36	26	35		**313**
Short-grass Pasture					10	270	51			**331**
Total Acreage By Unit	**353**	**295**	**73**	**86**	**70**	**1075**	**444**	**160**	**823**	**3379**

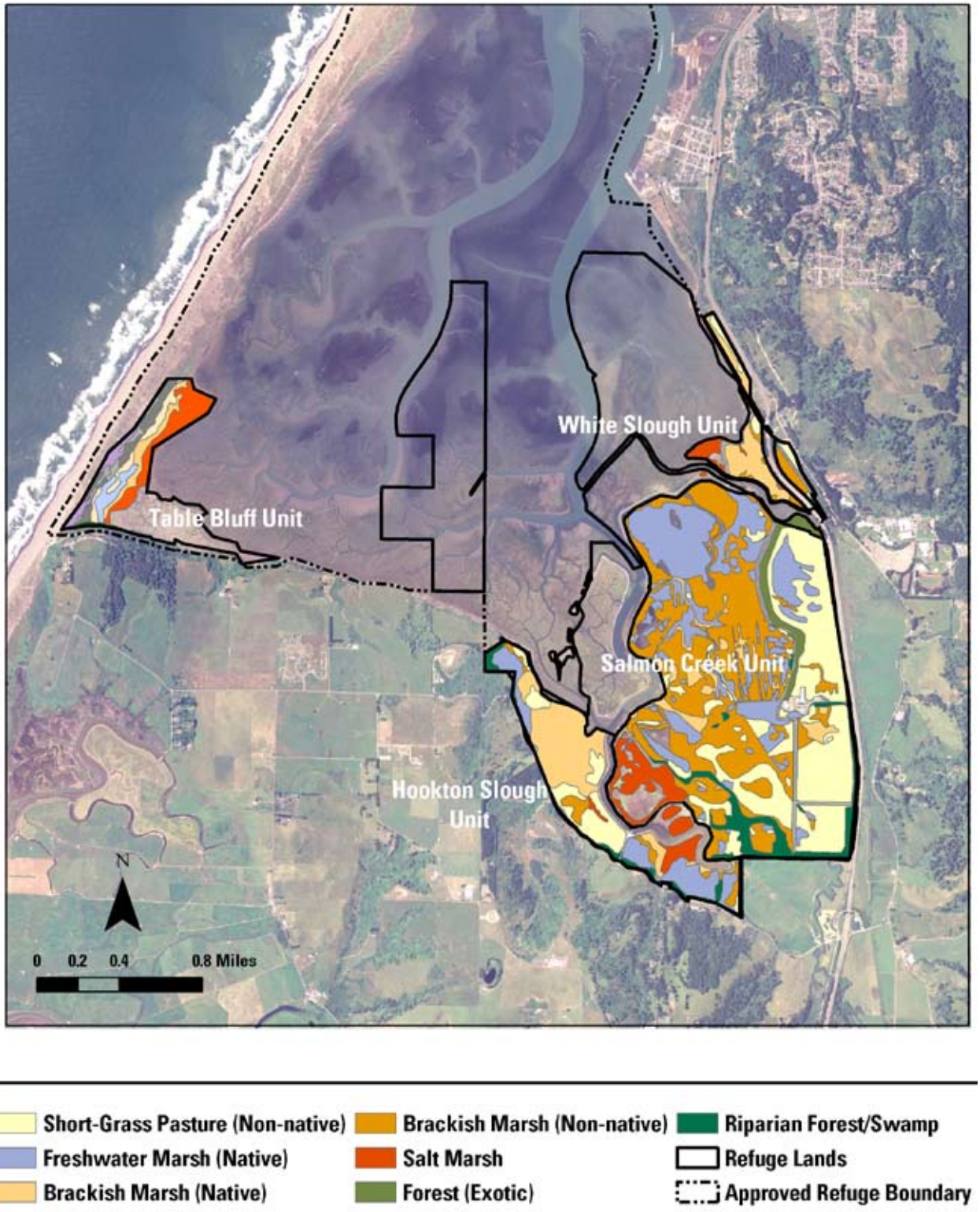


Figure 6. Terrestrial vegetation of White Slough, Salmon Creek, Hookton Slough, and Table Bluff units.

Although shortened by diking, Hookton Slough is tidal and could provide improved habitat for many estuarine species, including juvenile salmonids and the endangered tidewater goby, if it could be better reconnected to adjacent wetlands and have habitat complexity added in the form of large woody debris. There are also two salt marsh islands that remain in the upstream end of Hookton Slough. Teal Island, a 90 acre island of salt marsh that was diked in the mid-1900s, is now just the eroding remains of the dike surrounding a large tidal mudflat.

Salmon Creek Unit. The Salmon Creek Unit is composed of a modified arrangement of dikes, ponds, diversion structures, ditches, and tidegates (Figure 6). Each structure plays a role in creating a mixture of habitat types. This entire 1,075-acre unit consists of diked former tidelands that were converted to agricultural grasslands for cattle grazing from the late 1800s through the late 1980s. This also included a complex of ranching structures (houses, barns, silos, etc.) built on-site that were either converted to refuge use or demolished after the FWS purchased the ranch in 1988. The perimeter dike of this tract of land also protects Highway 101, refuge buildings and infrastructure, and some adjacent private lands between this unit and the Hookton Slough Unit from tidal influence.

Salmon Creek historically flowed through the middle of the Salmon Creek Unit and emptied into White Slough, but was diverted to Hookton Slough to maximize drainage, spread silt, and sub-irrigate agricultural grasslands. In 1993, refuge staff excavated a new serpentine channel for the lower end of Salmon Creek (from the first diversion structure to the Salmon Creek tidegate) and abandoned the straight-ditched channel. In addition, the Salmon Creek tidegate was modified to allow muted tidal wetland to develop and increase the passage of migrating salmonids. This muted condition extends to an area just beyond the Salmon Creek tidegate, an area known as the Salmon Creek Overflow. This area supports the largest pickleweed (*Salicornia*-dominated) marsh remaining in Humboldt Bay, and is one of the most important waterbird roosting and feeding areas on the Humboldt Bay NWR, likely because the area is tidally influenced and is flooded throughout the year with brackish water (Mini 2003).

Much of the east side of the Salmon Creek unit consists of improved agricultural grassland that is managed with a grazing and haying program accomplished through a cooperative agreement established with local ranchers. Grasslands are dominated by velvet grass (*Holcus lanatus*), Mediterranean ryegrass (*Lolium multiflorum*), and tall fescue (*Festuca arundinacea*), with lower areas covered with silverweed and spikerush (*Eleocharis macrostachya*). The Salmon Creek Unit provides important foraging and roosting habitat for Aleutian cackling geese, tundra swans, and other waterfowl, shorebirds, wading birds, and many other wildlife species.

White Slough Unit. The White Slough Unit totals ~70 acres in size and, like the other units, is diked former tidal marsh used for pasture (Figure 6). The management of this unit is constrained by its proximity to the railroad and Highway 101 (including the Tompkins Hill overpass) which bracket and split it into four different cells. There is a perennial spring upstream of this unit that contributes a small source of fresh water through the main cell and ultimately out to the bay. Brackish marsh constitutes the greatest acreage on the White Slough Unit. Vegetation types present include ~60 acres of brackish marsh dominated by salt grass, 10 acres of salt marsh dominated by cordgrass, one acre of freshwater riparian/swamp, and 6 acres of freshwater marsh/agricultural wetland. The dikes were in poor condition when the land was acquired by the refuge and have not been maintained because this area was always expected to ultimately be allowed to revert to salt marsh.

North Bay Units

Indian Island Unit. Indian Island, completely within the approved refuge boundary, is located in central Humboldt Bay. It contains ~205 acres of salt marsh, the largest contiguous stand of salt marsh remaining in the bay (Pickart et al. 2006). This tract of land was split by Highway 255 in the 1970s. A three-acre grove of mostly non-native trees (*Cupressus macrocarpa* and *Eucalyptus globulus*) contains a rookery (nesting habitat for several species of egrets and herons) that has been recognized by ornithologists, tribes, agencies, and bird enthusiasts for decades (Pickart et al. 2006). The rookery area is currently owned by the City of Eureka and the entire island is designated as an environmentally sensitive habitat area by the City of Eureka's General Plan.

Indian Island is an important cultural resource for the Wiyot Tribe, Blue Lake Rancheria, and Bear River Band of Rohnerville Rancheria, and was the site of a massacre, at the hands of EuroAmerican settlers, in 1860. The northern portion of the island was purchased by the Table Bluff Reservation in 2000. The North Coast Indian Development Council, working closely with the Wiyot Tribe, the City of Eureka, and the State Coastal Conservancy, is currently preparing a resource enhancement plan for the northernmost 60 acres of the island.

Refuge fee title ownership on the unit currently consists of two relatively small tracts, together totaling less than 2 acres in size.

Eureka Slough Unit. The Eureka Slough Unit is ~86 acres in size and preserves the relatively small remnant of the slough's historic salt marsh occurring west of Highway 101 (Figure 7). The marsh is dominated almost entirely by invasive cordgrass.

Jacoby Creek Unit. The Jacoby Creek Unit is ~73 acres in size and is located on the eastern shore of north Humboldt Bay (Figure 7). There is a significant amount of high elevation, native salt marsh vegetation, classified locally as mixed marsh (Pickart 2005a).

Salt marsh vegetation on the Jacoby Creek Unit consists of jaumea, saltgrass, pickleweed, seaside arrow-grass, arrow-grass (*T. concinnum*), coastal gum-plant (*Grindelia stricta* var. *stricta*), and western marsh-rosemary (*Limonium californicum*). Along the edges of the Jacoby Creek channel are higher areas supporting coastal tufted hair-grass (*Deschampsia caespitosa*), and along the creek itself is Lyngbye's sedge. Non-native invasive dense-flowered cordgrass occurs mostly in very dense discrete stands, which appear to be correlated well with lower elevations and tidal creeks (Pickart 2005a). The large cordgrass stands at the western edge of the marsh probably colonized relatively recent sediment accretions, rather than displacing historic salt marsh.

The high elevation salt marshes of Jacoby Creek Unit provide habitat for the two rare salt marsh species Point Reyes bird's-beak and Humboldt Bay owl's-clover. A previous 1999–2000 mapping of these two species show large populations were present at that time. Although no subsequent mapping or monitoring has been done, qualitative observations indicate that these populations are still extant (Pickart 2005a).

Humboldt
Wallflo

Dune Units

Ma-le'l and Lanphere Dunes Units. To the northwest of Humboldt Bay, adjacent to the Mad River Slough, are the Lanphere Dunes Unit and Ma-le'l Dunes Unit. The dune units are located on the upper North Spit of Humboldt Bay (Figure 7). These units contain ~648 acres consisting mainly of coastal dune and salt marsh habitats. The Lanphere Dunes Unit contains arguably the most pristine remaining dune system in the western U.S. This unit contains one of only a few remaining areas of the globally endangered foredune grassland community.

The biodiversity and resource values of the dune units have been well documented. At the local level (through the Humboldt County Coastal Plan) and at the eco-regional level (through The Nature Conservancy) the dunes have been identified as a high priority for conservation. At the national level a northern dune unit site is part of a dune system that was nominated for Natural National Landmark status. The dune units are also significant as stopover sites for neo-tropical migrants.

The dune mat plant community provides habitat for two federally listed plant species, Humboldt Bay wallflower and beach layia, and the open sand dunes provide potential nesting habitat for the threatened snowy plover (*Charadrius alexandrinus*). In addition to dune mat and foredune grassland, the nearshore dunes support seasonal dune wetlands (dune swales). Between the nearshore and stabilized forested dunes is a large sand sheet. The older stabilized dunes are colonized by red alder (*Alnus rubra*) riparian forest, and maritime forest of beach pine (*Pinus contorta* ssp. *contorta*), Sitka spruce, and grand fir (*Abies grandis*) (Pickart and Barbour 2007). East of the forest are estuarine salt marsh, brackish marsh, mudflats, and eelgrass beds.

The interspersion of freshwater wetlands, uplands, and estuary is responsible for the wealth of diversity found within a relatively small area of these units (see Figure 7). The nearshore freshwater wetlands, known as dune swales, are seasonal and depend on winter rainfall that raises the water table. A few permanent marshes in the backdunes provide water for wildlife year-round. Some swales are dominated by Hooker's willow thickets, which are important as habitat and forage for migrating bird species, as well as resident mammals and amphibians (Sendak 2008).

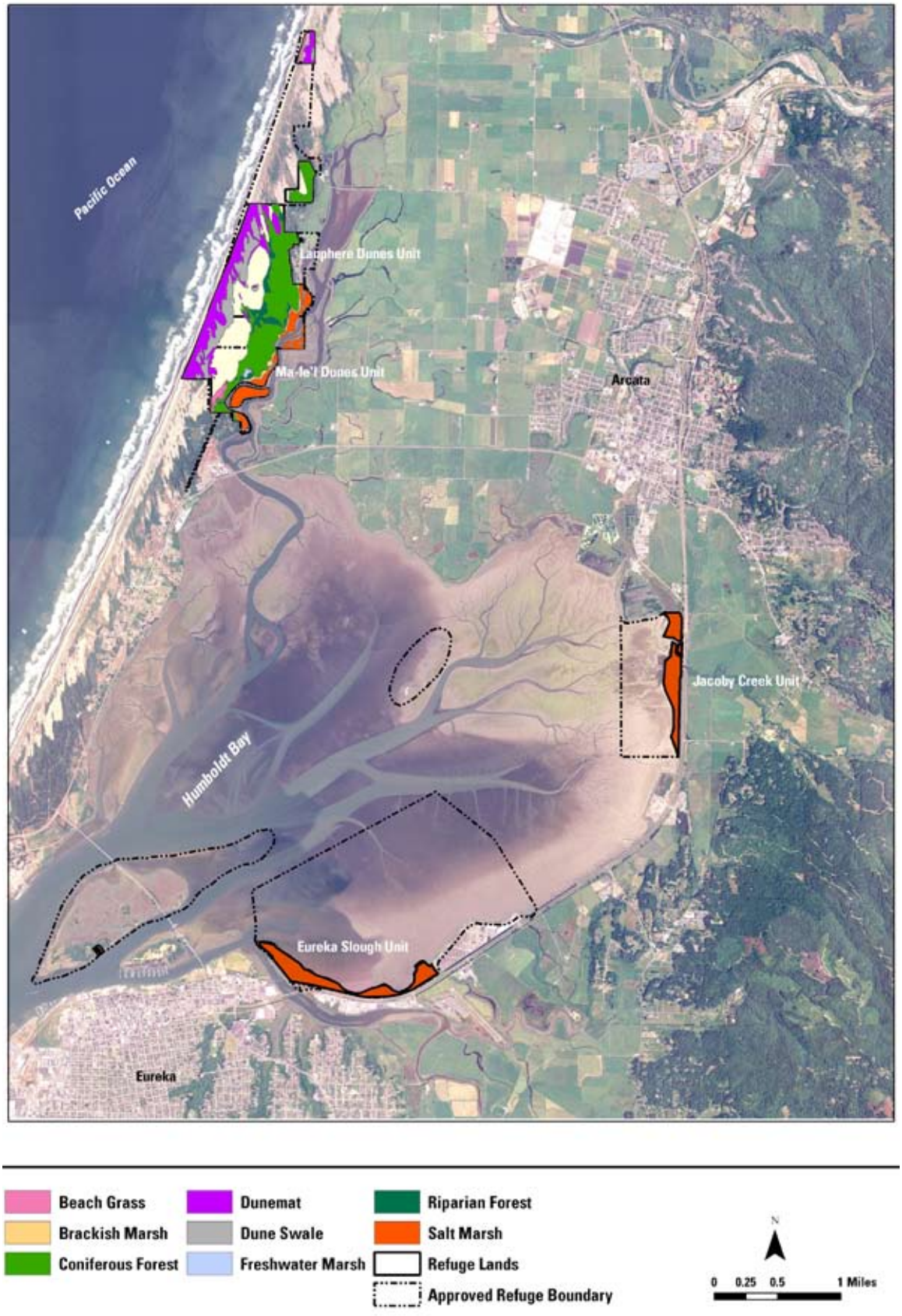


Figure 7. Terrestrial vegetation of Lanphere Dunes, Ma-le'l Dunes, Jacoby Creek, and Eureka Slough units.

3.2.3 Humboldt Bay NWR Plant Communities and Habitats

Due to the rapidly changing nature of the National Vegetation Classification, the following summary of vegetation types relies on broader habitat and physiognomic distinctions. Vegetation sampling was carried out between 2005 and 2007 on the refuge, and alliance/association level classification and description are still being finalized. Plant taxonomy for California is also undergoing major revisions. All plant nomenclature follows the *Jepson Manual* (Hickman 1993). Vegetation and habitat types are divided into three categories below: estuarine, palustrine wetland, and upland. A species list for vascular plants can be found in Appendix J.

Eelgrass Photo: © Jeff Robinson

Estuarine Plant Communities and Habitats

Eelgrass Beds. Humboldt Bay has the largest eelgrass beds on the west coast, north of bays in Baja Mexico (PCJV 2004). Eelgrass beds are among the most productive habitats in an estuarine ecosystem. They provide habitat for marine animals and are a substrate for epiphytes and epifauna (Cooke 1997).

Eelgrass (*Zostera marina*) is considered an important constituent of estuarine ecology, providing trophic support, improving water clarity, and functioning as refugia and nurseries (Shaughnessy et al. in press). Eelgrass in Humboldt Bay has been shown to structure the size of some invertebrates such as Dungeness crab (*Cancer magister*) (Williamson 2006).

The non-native eelgrass *Zostera japonica* was identified in Humboldt Bay in 2003, and manual removal efforts were begun that year by U.C. Sea Grant. Monitoring for new infestations continue as eradication proceeds, and a relatively large occurrence was located in the Eel River estuary in 2008 (Kirsten Ramey pers. comm.). *Zostera japonica* introduction impacts have been documented elsewhere, including alterations of physical habitat and the richness and densities of resident fauna (Posey 1988); and changes to water column-benthos nutrient fluxes (Larned 2003) .

Intertidal Mud Flats (not mapped). Intertidal habitats are the most widespread habitat in Humboldt Bay, and are very productive in terms of the abundance and diversity of species they support. The intertidal zone contains a large variety of the phytoplankton and zooplankton that form the basis of food webs that support fish, mollusks, crustaceans, other invertebrates, birds, and mammals. This habitat supports abundant micro and macro algae growth and eelgrass at higher elevations.

Macroscopic algal beds form as ephemeral communities on the intertidal mud flats. Two important species on the high intertidal flats are *Enteromorpha* sp. and *Ulva* sp. Algal beds are difficult to map because they are both ephemeral and spatially unstable. However, they are considered an important source of primary productivity for the estuary (Barnhart et al. 1992).

Brackish Marsh (*tidally influenced*). Brackish and estuarine marshes in the Salmon Creek area are behind dikes and may not represent natural (pre-diked) brackish marsh vegetation. Native dominants include seacoast bulrush (*Scirpus maritimus*), coastal tufted hair-grass (*Deschampsia caespitosa*), saltgrass, and salt marsh sand spurrey (*Spergularia marina*). Newly disturbed (excavated or disked) areas become seasonally dominated by invasive creeping saltbush or brass buttons (*Cotula coronopifolia*).

In the dune units and at the Table Bluff unit, brackish marsh occurs in its natural state as a linear strip of vegetation between the upland dunes and the salt marsh (although species composition at Table Bluff has been altered by past diking, now breached). These brackish marshes are irregularly flooded estuarine intertidal marshes. Dominant species include salt rush, seaside arrow-grass, hard-stemmed tule (*Scirpus acutus*) and Lyngbye's sedge.

Salt Marsh. The undiked salt marshes of the refuge are found in Hookton and White Slough in South Bay, and Mad River and Eureka sloughs and at the mouth of Jacoby Creek in North Bay. Island marshes are characterized by the highest tidal elevations and support the most diverse salt marsh plant assemblages. This community, classified as "Mixed Marsh" by Eicher (1987), is co-dominated by salt grass, pickleweed and jaumea with associated species arrow-grass, marsh rosemary, salt marsh plantain (*Plantago maritima*), dodder (*Cuscuta salina*), and sand spurrey. The rare Point Reyes bird's beak and Humboldt Bay owl's clover are found in some of the largest densities bay-wide on salt marsh islands on refuge units.

Invasive cordgrass now dominates most of Humboldt Bay's salt marshes. In medium elevation marshes it forms a monotype and displaces native species. This type was classified by Eicher (1987) as *Spartina* marsh. Experimental eradication efforts have cleared *Spartina densiflora* from most of the salt marshes in the Lanphere and Ma-le'l Units.

Salt Marsh Behind Dikes. Seasonally flooded salt marshes form with estuarine influence from leaking tidegates or frequent dike overtopping. This community is dominated by pickleweed but also present are salt grass and invasive dense-flowered cordgrass.

Palustrine Wetland Plant Communities and Habitats

Open Water/Ponds. Open water habitats are those areas where water is permanent and generally too deep to support emergent vegetation. Emergent vegetation often forms a ring of vegetation around open water habitats. Floating and submergent vegetation may also be present, including pondweeds (*Potamogeton pectinatus*), mosquito fern (*Azolla* spp.) and duckweed (*Lemna* spp.). In brackish areas, such as drainage channel bottoms, wigeon-grass (*Ruppia maritima*) may be present.

Shortgrass Pasture (*non-native*). Most of the refuge's seasonal freshwater wetland areas were formerly salt marsh until they were diked and converted to agricultural use. Vegetation currently occurring in these areas is dominated by Mediterranean ryegrass (*Lolium multiflorum*), and common velvetgrass, with localized dominance by tall fescue, and bird's-foot trefoil (*Lotus corniculatus*). Associated species include silverweed, creeping bentgrass (*Agrostis stolonifera*), and white clover (*Trifolium repens*) (Pickart 2006). Weedy species such as bullthistle (*Cirsium vulgare*), Canada thistle (*Cirsium arvense*), bristly oxtongue (*Picris echioides*), and lesser hawkbit (*Leontodon taraxacoides*) are also found in the agricultural grassland.

Freshwater and Brackish Marsh. Freshwater to slightly brackish marshes occur on Salmon Creek, Table Bluff, Hookton Slough, White Slough, Lanphere Dunes, and Ma-le'l Dunes units. These habitats vary greatly in size, but are either spring-fed or seasonally-flooded and highly productive for wildlife food. Emergent vegetation in these marshes, including cattails and bulrush, can range from mostly open water to almost 100 percent cover. These marshes are generally at least seasonally brackish due to the high salinity of underlying soils and/or salt spray. However, they differ from estuarine brackish marshes in having no current tidal influence.

Native freshwater marshes on the Humboldt Bay NWR are dominated by one or more of the following species: water parsley (*Oenanthe sarmentosa*), marsh pennywort (*Hydrocotyle ranunculoides*), salt rush, small-fruited bulrush (*Scirpus microcarpus*), cattail, silverweed, common spikerush, short-awn foxtail (*Alopecurus aequalis*), or pondweed.

The invasive species creeping bentgrass is abundant to dominant in fresh to brackish marshes in south bay units (Pickart 2006). Other invasive species that require monitoring and control in freshwater /brackish marsh include large bird's-foot trefoil (*Lotus uliginosus*), woodland groundsel (*Senecio sylvaticus*), reed canarygrass (*Phalaris arundinacea*), fireweed (*Erechtites glomerata*), bristly ox-tongue, spiny sow thistle (*Sonchus asper*), and Harding grass (*Phalaris aquatica*) (Pickart 2006).

Riparian Swamp Habitat. Riparian swamp habitat communities are seasonally flooded, wooded palustrine wetlands dominated by coastal willow or red alder, with an understory including California blackberry (*Rubus ursinus*), salmonberry (*Rubus spectabilis*), small-fruited bulrush (*Scirpus microcarpus*), coastal wood fern (*Dryopteris arguta*), and coast hedge-nettle (*Stachys chamissonis*). Associated species include red elderberry (*Sambucus racemosa*), poison oak (*Toxicodendron diversilobum*), wax myrtle (*Myrica californica*), and cascara (*Rhamnus purshianus*).

Non-native invasive plant species that require monitoring and control in freshwater swamp/ riparian forest habitat include; English ivy, poison hemlock (*Conium maculatum*), reed canarygrass, periwinkle (*Vinca major*), eucapyptus (*Eucalyptus globulus*), and Himalayan blackberry.

Dune Swales. Dune swales, which occur on all dune units, are seasonal freshwater marshes and shrub swamps. Common dominants are slough sedge, spike rush, silverweed, Hooker's willow, and beach pine. Transitional areas between swales and dune mat can be quite extensive due to annual varation in flooding and saturation extent. While classified as seasonal wetlands, they include many facultative dune mat species (Pickart and Barbour 2007). The dominant species is Brewer's rush (*Juncus breweri*). Invasive species in dune swales include rabbit's-foot grass (*Polypogon monspeliensis*), loosestrife (*Lythrum hyssopifola*), pennyroyal (*Mentha pulegium*) and yellow glandweed (*Parentucellia viscosa*).

Upland Plant Communities and Habitats

Foredune Grassland (not differentiated from dune mat in maps). This endangered community occurs only on dunes of the Pacific coast of North America. The characteristic species of this community is the native dune grass *Leymus mollis,* but large-flowered sand dune blue grass (*Poa macrantha*) can be common to dominant and associated species include a number of forbs such as yellow sand-verbena (*Abronia latifolia*), beach pea (*Lathyrus littoralis*), seaside daisy (*Erigeron glaucus*), coast buckwheat (*Eriogonum latifolium*), and beach morning-glory *Calystegia soldanella* (Pickart 2008). Foredune grasslands are so-called because *Leymus mollis* is generally confined to the upper beach and the first rise, or "foredune." Typically, foredune grassland is found on relatively high-energy sandy coastlines on ocean beaches.

Until the introduction and spread of the invasive European beachgrass, *Leymus mollis* was the dominant grass of northern California's foredunes. Over the past century, European beachgrass displaced native dune grass over much of our coastline. The Lanphere Dunes is one of only a few remaining healthy populations of native beachgrass south of Alaska (Pickart and Barbour 2007).

*Dune Mat. D*une mat floristically intergrades with foredune grassland, which is described above. The boundary between them is transitional, occurring near the crest of the primary foredune if a continuous foredune ridge occurs Behind the foredune the dune mat community occurs on dune ridges aligned parallel to the northwest prevailing wind. Native dune mat communities are diverse with variable localized dominant species. Common and abundant species include dune goldenrod (*Solidago spathulata*), large-flowered sand-dune blue grass, beach-bur (*Ambrosia chamissonis*), beach pea, coast buckwheat, coastal sagewort (*Artemisia pycnocephala*), yellow sand verbena, common yarrow (*Achillea millefolium*), beach strawberry (*Fragaria chiloensis*), and seaside daisy (Pickart and Barbour 2007).

Dune mat communities support two ESA-listed endangered plant species; Humboldt Bay wallflower and beach layia; two CNPS List 1B (rare, threatened or endangered in California and elsewhere) species; dark-eyed gilia (*Gilia millefoliata*) and pink sand verbena; and a CNPS list 4 species (plants with limited distribution), American glehnia (*Glehnia littoralis* ssp. *leiocarpa*).

Dune mat, like foredune grassland, has been significantly threatened by non-native European beachgrass. In addition, non-native species such as iceplant, yellow bush lupine, and several invasive annual grasses including ripgut brome (*Bromus diandrus*), rattlesnake grass (*Briza maxima*), barren fescue (*Vulpia bromoides*), and European hairgrass (*Aira* spp.) also impact the native plant communities and require active management.

Dune Swale Photo: Andrea Pickart

Dune Mat Photo: Andrea Pickart

The dune mat communities on the Lanphere Dunes and Ma-le'l Dunes units harbor rare biotic soil crusts, also called cryptogamic crusts. The dominant non-vascular plant in local biotic soils crusts are the mosses *Didymodon vineali* and *Homalothecium arenarium* (Glavich 2000). Associated lichens include *Leptogium intermedium* and *Cladonia pyxidata*.

Coniferous Dune Forest. Coniferous dune forest communities occur on the Lanphere Dunes and Ma-le'l Dunes units east of the large sheet of moving dunes, on relatively older and stabilized portions of the dune units. The coniferous dune forest is a lush productive environment harboring over 300 species of fungi, lichen, and mosses. The forest canopy is dominated by Sitka spruce and beach pine, with grand fir, Douglas-fir, and madrone (*Arbutus menziesii*) subdominant. The forest understory occurs as two distinct phases. A dense shrub understory is dominated by evergreen huckleberry (*Vaccinium ovatum*), silk tasel (*Garrya elliptica*), and salal (*Gaultheria shallon*), while more open pine-dominated stands have a low carpet of bearberry (*Arctostaphylos uva-ursi*) with reindeer lichen (*Cladina portentosa* ssp. *pacifica*). Other common understory species include twinberry (*Lonicera involucrata*), false lily-of-the-valley (*Maianthemum dilitatum*), yerba buena (*Satureja douglasii*), vanilla grass (*Hierochloe occidentalis*), sword fern (*Polystichium minitum*), leather fern (*Polypodon scouleri*), and the orchids rattlesnake plantain (*Goodyera oblongifolia*), elegant rein orchid (*Piperia elegans*), and rein orchid (*Piperia tranversa*) (Leppig and Pickart 2005). A variety of nonvascular plants are found in the forest both on the forest floor and the canopy, including broom moss (*Dicranum scoparium*), cat-tail moss (*Isothecium myosuroides*), beaked moss (*Kindbergia oregona* and *K. praelonga*), flat-leaved liverwort (*Radula complanata*), and net lichen (*Ramalina menziesii*) (Pickart and Barbour 2007).

Open Sand. This habitat consists of areas of moving sand. The few vegetated areas consist of small hummocks of early successional species such as yellow sand verbena and sea rocket (*Cakile maritima*). The ESA threatened and California Species of Concern snowy plover may eventually breed in open sand areas of the dune units, but is not known to at this time.

Non-Native Dune Communities. Portions of the Table Bluff Unit support invasive European beachgrass, yellow bush lupine, and iceplant. Restoration of these communities to dune mat is needed, following techniques used at the northern dune units. These types are mapped as European beachgrass or dune mat/beachgrass in Alternative maps due to their localized nature.

Yellow Sand Verbena

Upland Dikes. Upland dikes surround much of the Salmon Creek, White Slough, Table Bluff, and Hookton Slough units. They are dominated by weedy grasses, and in some places by the native shrub coyote bush (*Baccharis pilularis*). Dike tops are regularly mowed in spring and summer. Perimeter dikes around the Hookton Slough and Salmon Creek Units are mostly armored on the bay side with some type of rip-rap (generally old broken concrete or medium to large quarry rock). All other dikes on the refuge are earthen and serve as roads and/or trails.

Non-Native Exotic Forests (not mapped). Approximately 20 acres of the Salmon Creek Unit is almost entirely dominated by non-native blue gum eucalyptus. There is little understory diversity in this habitat, due to competition by gum trees and the allelopathic effect of their leaves. Gum trees are also highly flammable (USFWS 2004).

3.2.4. Overview of Humboldt Bay NWR Fish and Wildlife

The Humboldt Bay NWR and surrounding environments provide important habitats for fish, wildlife and plants.

The primary reason the refuge was originally established was because of the area's importance as stopover habitat for migratory birds.

Humboldt Bay is considered an internationally significant area for migratory birds due to the sheer number of birds that depend on it in the fall, winter, and spring. Important bird groups that depend on the bay include waterfowl, shorebirds, waterbirds, raptors, and passerines. Many of the birds using the bay area frequent lands within the existing refuge boundary on a daily basis.

Many species of birds have evolved complex migratory behavior, resulting in annual visitation to different parts of their ranges. The vast majority of bird species found on the Humboldt Bay NWR utilize refuge habitats during particular seasons to fulfill needs during migration (see Appendix F). A much smaller number of bird species use various refuge habitats for the breeding season or are year-round residents. Humboldt Bay's immense habitat value for birds is due, in part, to its proximity to a diverse array of nearby habitats including tidal marsh (Mad River and Eel River estuaries), restored freshwater marsh (HBNWR, CDFG Wildlife Areas, Arcata Marsh), eelgrass beds, wet agricultural grasslands, willow thickets, and coastal dunes (Evens and Tait 2005).

More than 50 different species of mammals and a wide variety of reptiles and amphibians are known to utilize Humboldt Bay habitats. Mammal species commonly found in bay ecosystems include river otter (*Lontra canadensis*), black-tailed deer, long-tailed weasel (*Mustela frenata*), and gray fox (*Urocyon cinereoargenteus*). Species much less commonly seen include black bear (*Ursus americanus*), mountain lion (*Felis concolor*), ringtail (*Bassariscus astutus*), and porcupine (*Erethizon dorsatum*). The dune forests typically have no mammals larger than the gray fox, although occasional deer stray into the forest.

The diversity of habitats around the bay support many amphibians and reptiles, including a variety of frogs (red-legged and tree), salamanders, and snakes.

In total, the bay provides habitat for ~95 species of fish, 41 of which contribute to sport or commercial fisheries or have contributed to those fisheries in the past. Salmon Creek provides a passage corridor or habitat for various life stages of steelhead, Coho salmon, Chinook salmon, and coastal cutthroat trout (*Oncorhynchus clarki clarki*), which are all Federal and/or State listed species. Tidewater goby, another federally listed species of fish, use the edges of the bay, particularly brackish areas with little to no current.

Benthic invertebrate communities in marshes and the bay, are dominated by gastropods, crustaceans, and polychaetes (Barnhart et al. 1992). Intertidal flats support eelgrass beds that provide cover and contribute to the invertebrate food source and are important spawning and feeding areas for sport and commercial species.

Invertebrates are abundant and diverse in the dunes system. Gordon (1984) identified 43 species of bees from six families at the Lanphere Dunes Unit. This unique assemblage of solitary nesting bees, including silver bees (*Habropoda miserabilis*) and leaf cutter bees (*Megachile wheeleri*), serve as crucial pollinators for dune plants (Nyoka 2004).

Dune-forest ecotone.
Photo: Andrea Pickart

3.2.5. Humboldt Bay NWR Wildlife

Migratory and Resident Birds

Fall migration begins as early as July for some shorebirds, while the peak of waterfowl migrants reaching the Humboldt Bay area is September through November. Wintering and spring staging birds are at their greatest numbers from November to April. Dozens of species of waterbirds use the bay from July through April, with most beginning to migrate back to their northern breeding grounds by sometime in April.

Over 260 different bird species have been documented throughout the vicinity of the bay (Harris 1996, Ralph et al. 1998). Nelson (1989) estimated ~four million bird use-days annually for the South Humboldt Bay alone. On a typical winter or spring day, it is not unusual for more than 100,000 birds to use the bay as a feeding or resting site. According to WHSRN (2007), over 230 species of birds have been found within the refuge including over 31 species of waterfowl numbering ~70,000 throughout the winter. The migratory and over-wintering shorebird population generally exceeds 100,000 birds from 34 species. Among the birds heavily dependent upon the bay and associated seasonal wetlands are willet, marbled godwit, dunlin, least (*Calidris minutilla*) and western sandpiper, Pacific brant, Aleutian cackling geese, tundra swans, American wigeon (*Anas americana*), greater scaup (*Aythya marila*), bufflehead (*Bucephala albeola*), surf scoter (*Melanitta perspicillata*), green-winged teal (*Anas crecca*), mallard (*Anas platyrhynchos*), northern pintail (*Anas acuta*), great (*Casmerodius albus*) and snowy (*Egretta thula*) egret, great blue heron (*Ardea herodias*), and black-crowned night heron (*Nycticorax nycticorax*). Humboldt Bay is the northernmost wintering area on the Pacific coast for significant numbers of long-billed curlews, marbled godwits, and willets. Over a million shorebirds migrate through the Humboldt Bay area each year (WHSRN 2007).

The bay area is also a very important area for hundreds of passerine bird species, especially the dune and riparian habitats, which provide important food resources during migration (Ralph et al. 1998). In the dunes, passerine bird use and nesting is concentrated in the forest, with lesser use of the swales. During winter and migration periods the dune ridges are also frequented by red-tailed hawks (*Buteo jamaicensis*), short-eared owls (*Asio flammeus*), white-tailed kites (*Elanus leucurus*), and other raptors, because of the many rodents that occur there and provide a primary source of prey. The upper beach is an important feeding habitat for migratory and resident shorebirds such as the threatened western snowy plover (*Charadrius alexandrinus*) and sanderlings (*Calidris alba*). In addition, recently de-listed species, such as the bald eagle, peregrine falcon, and Aleutian cackling geese, utilize refuge and bay habitats.

Waterfowl

The Humboldt Bay watershed is considered the most important wintering waterfowl habitat between San Francisco Bay and the Columbia River (PCJV 2004). Many species of waterfowl use habitats on Humboldt Bay NWR, particularly for resting and foraging over winter and spring during their annual migration through the bay area. Seasonally common waterfowl that use refuge/bay wetlands and agricultural grasslands during migration include northern pintail, American wigeon, green-winged teal, Pacific brant, Aleutian cackling geese, tundra swan, white-winged scoter (*Melanitta fusca*), surf scoter, and red-breasted merganser (*Mergus serrator*). Several waterfowl species also nest on the refuge including western Canada geese, mallard, cinnamon teal (*Anas cyanoptera*), and gadwall (*Anas strepera*).

Pacific Brant

Pacific brant are small dark geese that migrate long distances to their primary wintering areas in coastal Mexico which are typically characterized by an abundance of sea grasses, (especially eelgrass, *Zostera maritima*) and certain marine algae (Reed et al. 1998). Eelgrass is the principal forage for Pacific brant and other herbivorous waterfowl. Each spring, eelgrass beds in Humboldt Bay attract the largest flocks of Pacific brant along the Pacific coast as the birds stopover during their migration from southern wintering sites to breeding grounds in the Arctic (Evens and Tait 2005). Humboldt Bay NWR is the southernmost in a chain of national wildlife refuges in the United States that provide habitat for most of the world's population of Pacific brant. It is estimated that over 40 percent of the Pacific Flyway population of Pacific brant use Humboldt Bay as a migratory stopover in the spring, primarily to utilize eelgrass resources (PCJV 2004). The bay's extensive eelgrass beds make it the most important Pacific brant wintering and migration site in California. The primary wintering areas for these geese is now the coastal lagoons in Baja and Pacific coastal Mexico. Peak counts of spring staging Pacific brant in Humboldt Bay were 20,000–40,000 from 1950–1977, declined to 10,000–15,000 in the 1980s, and has increased to 20,000–25,000 in the late 1990s (PFC 2002). It is not uncommon for more than 10,000 Pacific brant to be found on the South Bay alone from late February through mid-April (PCJV 2004).

Cackling Geese and Western Canada Geese
In 2004 the formerly broad Canada goose species was divided by the American Ornithologists Union into a group of large-bodied interior and southern range breeding subspecies, and a group of small-bodied tundra breeding subspecies. The members of the large-bodied group are still known as Canada geese (*Branta canadensis*), while the small-bodied group was given the name cackling geese (*Branta hutchinsii*) (Sibley 2007). Both Aleutian cackling geese and cackling geese (*Branta hutchinsii minima*), a separate small-bodied species that breeds on the Yukon-Kuskokwim Delta in Alaska and winters primarily in the Willamette Valley of Oregon, as well as the large-bodied western Canada geese, use the agricultural grasslands and freshwater wetlands on the Humboldt Bay NWR.

Aleutian Cackling Goose
The original decline of the Aleutian cackling goose primarily resulted from the introduction of Arctic foxes (*Alopex lagopus*) and, to a lesser extent, red foxes (*Vulpes vulpes*) during the late 1800 and early 1900s to the Aleutian Islands for the purpose of developing a fur industry. Hunting throughout its range in the Pacific Flyway, especially on the migration and wintering range in California, as well as loss and alteration of habitat on its migration and wintering range, also contributed to the Aleutian cackling goose subspecies' decline (USFWS 2001).

The formerly named Aleutian Canada goose (now called the Aleutian cackling goose) was first designated as an endangered species in the United States on March 11, 1967, under the Endangered Species Preservation Act of 1966 (*see Abundance of Aleutian Cacling Geese; Preliminary Results*). Over time, conservation initiatives from the Aleutian Canada Goose Recovery Program were instituted. These included removal of foxes from nesting sites, closing of Canada/cackling goose wintering and migration areas to hunting, translocation of wild geese caught in the Aleutians to other islands where foxes had been removed, and habitat conservation (PCJV 2004). As a result of such management actions, the Aleutian goose population began a steady recovery and the subspecies was reclassified as threatened on December 12, 1990. The goose was officially removed from the list of ESA-listed threatened and endangered species on March 20, 2001.

Aleutian geese typically arrive in California in mid-October each year. The majority of the population currently bypasses the north coast and goes right to their primary wintering areas in the Central Valley. However, since 2002, there has been a relatively small (~1500-5000) number of geese that spend fall and winter on the north coast. In about late December the geese wintering in the Central Valley begin moving north, and by mid-February most of the Aleutian goose population is located in northwestern California until they depart for the Aleutian Islands in mid-April.

As the goose population grew (Figure 8, Table 3) so did their impact on grasslands in Del Norte County. Beginning in 2001, the geese began frequenting

Aleutian cackling geese. Photo: © Red Jioras

Humboldt County more often, likely as a result of a combination of hazing in Del Norte County and continued population growth. As of 2004, Humboldt County began receiving the majority of Aleutian goose use on the northwest coast from January through April. A working group of landowners, biologists, and others have been meeting since 2002 in efforts to manage this situation. It has been and likely will continue to be a contentious problem until managers can find a way to bring the population closer to the Pacific Flyway management goal of 60,000. A sustainable harvest of the geese is now allowed under CDFG regulations. Beginning in spring 2007, CDFG allowed a late season (~2 weeks in late February and early March) on private lands only with the intent to "push" geese off private and onto public lands.

Western Canada Goose

These large geese are native to the Great Basin but were not historically found on the coast. However, CDFG, with assistance from the Northcoast Waterfowlers, relocated several hundred birds from the Reno, NV, area during the mid-1980s. Those birds have become local nesters and year-round residents with a current population of ~3000. Approximately 50–75 pairs nest on refuge lands each spring (which are closed to hunting at that time).

Tundra Swans

Tundra swans are abundant in the Pacific flyway. Tundra swans are a relatively long-lived species that form monogamous pairs. Each year's young remain with their parents until their arrival back on the, arctic wetland breeding grounds the following year (Limpert and Earnst 1994).

The majority of tundra swans in the flyway winter in the Central Valley but ~1000 winter (November–February) on the northcoast with primary use areas being the Smith River bottoms and Lake Earl Wildlfie Area in Del Norte County, and the Eel River bottoms and the refuge's Salmon Creek Unit in Humboldt County. Tundra swans graze agricultural grassland and forage for submerged aquatic vegetation, tubers, and some mollusks in ponds (Limpert and Earnest 1994).

Shorebirds

Many species of shorebirds use Humboldt Bay NWR habitats during migration and for overwintering. Humboldt Bay's particular importance to shorebirds is indicated by its designation as a Western Hemisphere Shorebird Reserve Network (WSHRN) site (WHSRN 2007). The mission of WSHRN is to conserve shorebird species and their habitats across the Americas through a network of key sites.

Marine waters, intertidal flats, seasonal wetlands, beaches, marshes, and agricultural grasslands are all used by shorebirds, primarily for foraging. Common species of shorebirds found in the Humboldt Bay area include marbled godwits, willets, long-billed curlews, whimbrels (*Numenius phaeopus*), western and least sandpipers, dunlin, long (*Limnodromus scolopaceus*) and short-billed (*Limnodromus griseus*) dowitchers, greater (*Tringa melanoleuca*) and lesser (*Tringa flavipes*) yellowlegs, common snipe (*Gallinago gallinago*), ruddy (*Arenaria interpres*) and black (*Arenaria melanocephala*) turnstones, several plover species, spotted sandpipers (*Actitis macularia*), and killdeer (*Charadrius vociferus*). In fact, surveys from the early 90s reveal that the bay supports 5-8 percent of the Pacific Flyway population of marbled godwits, 4-5 percent of dunlin, and 3-4 percent of willet. More rare species include semi-palmated (*Calidris pusilla*), buff-breasted (*Tryngites subruficollis*), pectoral (*Calidris melanotos*), and stilt (*Calidris himantopus*)sandpipers; ruff (*Philomachus pugnax*) and golden plovers (*Pluvialis fulva*).

Few species of shorebird breed on the refuge; those that have include killdeer, black-necked stilt (*Himantopus mexicanus*), and American avocet.

Long-billed curlew. Photo: © Red Jioras

Abundance of Aleutian Cackling Geese: Preliminary Results 2007–2008

Todd A. Sanders, U. S. Fish and Wildlife Service, Division of Migratory Bird Management; 18 June 2008

Aleutian cackling geese (*Branta hutchinsii leucopareia*) were listed as an endangered population in 1967, downgraded to threatened status in 1990 and were removed from protection under the endangered species act in 2001. Accurate determination of population status continues to be a priority for management agencies because of the population's past listing as endangered, the species status as a game bird, and because population expansion has resulted in depredation complaints. Breeding population inventories have never been considered a practical means of monitoring population status because of their remote and widely distributed breeding areas. Direct counts in winter were sufficient to monitor their status when the population was small and concentrated in a few local areas. However, as the population has grown and distribution expanded, challenges associated with direct counts have lead managers to indirect methods (mark-resight) of estimating population abundance of this important goose population. An estimate of abundance of Aleutian cackling geese was derived by expanding an estimate of the abundance of marked birds by the ratio of total birds to marked birds. For estimation of abundance of marked birds, a closed robust design model was used, using only sighting data from a primary sample period of 1 January–31 March annually with 2 secondary sample periods of 1 January–14 February, primarily in the San Joaquin Valley region, and 15 February–31 March, primarily in the California-Oregon Coast region. For estimation of the ratio of total birds to marked birds, I used ratio estimates from a single annual sample period 15 February–31 March in the California-Oregon Coast region. Abundance of this species has increased exponentially from 790 in 1973 to 114,000 (95% CI = 100,000–128,000) in 2007 (Figure 8, Table 3).

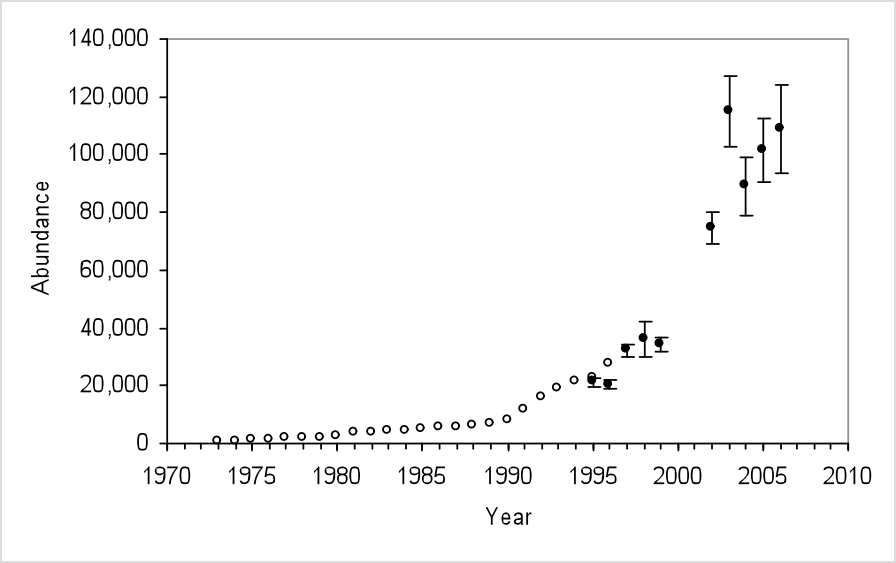


Figure 8. Abundance (point estimate and 95 percent confidence interval) of Aleutian cackling geese from direct counts (1973–1995) and from estimates of marked bird abundance based on a closed robust design model for the San Joaquin Valley and California-Oregon Coast regions combined and expanded by estimates of the ratio of total geese to marked geese in the California North Coast region (1996–2007). There is no estimate for 2000 and 2001 because of insufficient data.

Table 3. Abundance (point estimate and lower [L] and upper [U] 95% confidence intervals [ci]) of Aleutian cackling geese from direct counts (1973–1995) and from estimates of marked bird abundance based on a closed robust design model for the San Joaquin Valley and California-Oregon Coast regions combined and expanded by estimates of the ratio of total geese to marked geese in the California North Coast region (1996–2007). There are no estimates for 2000 and 2001 because of insufficient data.

Year	N	SE	L95%ci	U95%ci	Method
1973	790				Direct count
1974	900				Direct count
1975	1,280				Direct count
1976	1,500				Direct count
1977	1,590				Direct count
1978	1,740				Direct count
1979	2,000				Direct count
1980	2,700				Direct count
1981	3,500				Direct count
1982	3,800				Direct count
1983	4,200				Direct count
1984	4,300				Direct count
1985	5,000				Direct count
1986	5,400				Direct count
1987	5,800				Direct count
1988	6,300				Direct count
1989	7,000				Direct count
1990	7,680				Direct count
1991	11,680				Direct count
1992	15,700				Direct count
1993	19,150				Direct count
1994	21,420				Direct count
1995	22,800				Mark-resight
1996	27,600				Mark-resight
1995	21,280	777	19,757	22,804	Mark-resight
1996	20,227	756	18,744	21,709	Mark-resight
1997	32,271	1,064	30,185	34,357	Mark-resight
1998	35,825	3,138	29,676	41,975	Mark-resight
1999	34,274	1,362	31,604	36,944	Mark-resight
2000					
2001					
2002	74,655	2,854	69,062	80,249	Mark-resight
2003	114,985	6,261	102,714	127,257	Mark-resight
2004	89,042	5,048	79,148	98,936	Mark-resight
2005	101,589	5,714	90,390	112,789	Mark-resight
2006	108,854	7,747	93,670	124,039	Mark-resight
2007	113,963	7,371	99,516	128,411	Mark-resight

Waterbirds

Waterbirds is a generic term that refers to a large group of species that tend to obtain most of their food from water-associated habitats. Birds that dive and forage the marine edges of the Humboldt Bay NWR include common (*Gavia immer*), Pacific (*Gavia pacifica*), and red-throated (*Gavia stellata*) loons; brown pelican (*Pelecanus occidentalis*); double-crested cormorants (*Phalacrocorax auritus*); Clark's (*Aechmophorus clarkii*), western (*Aechmophorus occidentalis*), horned (*Podiceps auritus*), eared (*Podiceps nigricollis*), and red-necked (*Podiceps grisegena*) grebe.

Other waterbirds are best described as wading birds that feed primarily by wading in or standing still in fresh or brackish waters to strike at small fish and other prey. Many wading birds that breed on or near Humboldt Bay NWR primarily use freshwater and brackish marsh, seasonal wetlands, and riparian forest habitat. These include great blue heron; American bittern (*Botaurus lentiginosus*); great, snowy, and cattle (*Bubulcus ibis*) egret; green heron (*Butorides virescens*), and black-crowned night-heron.

Raptors

Raptors are birds of prey, including owls (Order Strigiformes), but most are in the Order Falconiformes which includes osprey (*Pandion haliaetus*), kites, eagles, hawks, and falcons. On Humboldt Bay NWR, raptors feed primarily on a variety of birds and small mammals. Forest habitats on the refuge are primarily used by raptors such as Cooper's (*Accipiter cooperii*), sharp-shinned (*Accipiter striatus*), and red-shouldered (*Buteo lineatus*) hawks. Other raptors such as northern harrier (*Circus cyaneus*); white-tailed kite; rough-legged (*Buteo lagopus*), red-tailed, and Swainson's hawk (*Buteo swainsoni*); peregrine falcon; merlin (*Falco columbarius*); American kestrel (*Falco sparverius*); short-eared, long-eared (*Asio otus*), burrowing (*Speotyto cunicularia*), great horned (*Bubo virginianus*), and barn owls (*Tyto alba*) primarily use more open habitats such as grasslands, dunes, and marshes for hunting. Osprey and bald eagle both nest near the refuge with osprey being an obligate fish-eating (piscivorous) bird, while eagles will eat both fish and waterfowl, as well as occasionally scavenging.

Passerines

Over 150 passerine bird species have been sighted in the Humboldt Bay area (Harris 1996, Ralph et al. 1998), many of which use refuge habitats such as grasslands, dune swales, marshes, and coniferous, dune forest, and. riparian/swamp. Riparian swamp In particular Is a favored habitat of migrating birds (Evens and Tait 2005).

Osprey. Photo: © Ron LeValley

The majority of these are migrants, but there are many breeding birds as well. Key species groups include swallows, sparrows, wrens, flycatchers, and warblers.

There have been banding sites set up and run at both the Lanphere Dunes Unit (since the 1980s) and the Salmon Creek Unit (since 2002) by the Humboldt Bay Bird Observatory (Ralph et al. 1998). These sites are part of the Monitoring Avian Productivity and Survivorship (MAPS) program (Figure 9). The program was started by the Institute for Bird Populations in 1989 "to assess and monitor the vital rates and population dynamics of over 120 species of North American landbirds in order to provide critical conservation and management information on their populations." The MAPS network now includes over 500 stations in North America and has captured and banded millions of birds. MAPS biologists use ultra fine nets, called mist nets which are about 2 meters high and 10 meters long, stretched between two poles to capture birds. A MAPS station typically utilizes 10 nets, which are open for 6 hours beginning at sunrise. Each station is run once every 10 day period between May 1st and August 8th. Birds

Figure 9. Monitoring Avian Productivity and Survivorship (MAPS) on Salmon Creek restoration area.

captured during this period are more likely to be resident and breeding at the station site. Some stations, such as at Salmon Creek and Lanphere Dunes, capture birds earlier and/or later in the year in order to capture birds during migration. Data collected on each bird captured includes its band number, species, amount of fat, and molt patterns. Biologists also attempt to determine the bird's sex and age based on its plumage, breeding condition, and other characteristics.

Birds that use the area but are not captured are also systematically surveyed via a method called area searching.

Mammals

A wide variety of mammals use Humboldt Bay NWR aquatic and terrestrial habitats. Marine mammals such as harbor seal (*Phoca vitulina*), harbor porpoise (*Phocoena phocoena*) and California sea lion (*Zalophus californianus*) use bay habitats as well as near shore habitats. Harbor seals bear and rear their pups on exposed tidal flats, and sea lions occasionally use haulout sites near the shoreline for resting. River otters use the sloughs and associated riparian forest for foraging and den building.

The diversity of refuge habitats provide cover and forage for larger mammals including black-tailed deer, bobcat (*Lynx rufus*), mountain lion, gray fox, and porcupine (*Erethizon dorsatum*). Smaller mammals include the dusky-footed woodrat (*Neotoma fuscipes*), white-footed deer mouse (*Peromyscus maniculatus*), Pacific jumping mouse (*Zapus trinotatus*), California harvest mouse (*Reithrodontomys megalotis*), Trowbridge shrew (*Sorex trowbridgii*), vagrant shrew (*Sorex vagrans*), shrew mole (*Neurotrichus gibbsii*), California vole (*Microtus californicus*), and the rare white-footed vole (*Arborimus albipes*). Botta's pocket gopher (*Homomys bottae aticeps*) is very common and important on dunes. Bats include the big brown bat (*Esptesicus fuscus bernardinus*) and Yuma myotis (*Myotis yumanensis saturatus*). Open grassland and (seasonal) marsh habitats are preferred by black-tailed jackrabbit (*Lepus californicus*), brush rabbit (*Sylvilagus bachmani*), striped (*Mephitus mephitus*) and western spotted (*Spilogale gracilis*) skunk, long-tailed weasel (*Mustela frenata*), and American mink (*Mustela vison*), while also being utilized by some mammals mentioned above. The most adaptable and cosmopolitan mammals such as coyote (*Canis latrans*), gray fox, Virginia opossum (*Didelphis virgiana*), and raccoon (*Procyon lotor*) use a wide variety of habitats and food sources.

River otter Photo: © Red Jioras

Anadromous Fish

The local anadromous salmonids have similar life histories. They begin their lives in streams and, after passing through larval stages, move out to the marine environment to mature. Finally returning to freshwater streams to deposit and fertilize eggs, they begin the cycle again. Fish trapping done on the Salmon Creek Unit in the late 1980s in cooperation with the Humboldt Fish Action Council and College of the Redwoods found that Salmon Creek supported remnant runs of steelhead, Coho, Chinook, and cutthroat trout. Chinook salmon utilize the main channels of larger rivers and some use of smaller tributaries. They are typically present in low-gradient area streams (1–2 percent grade) from October to January (HBWAC, RCAA 2005). Steelhead, an anadromous form of rainbow trout, utilize tributary channels with less than 8 percent grade, and may use stable side channels as well. Steelhead are typically present in area streams from winter through spring. Coho salmon utilize accessible reaches of streams, especially side channels with small gradients for breeding. Coho are typically present in area streams from November to January. Populations of Chinook salmon, steelhead, and Coho salmon, which migrate through Salmon Creek, are all listed as threatened species under the ESA. Since at least 2002, CDFG has been assessing salmonid populations at multiple locations in tributaries around the bay, including Salmon Creek. This work indicates that currently lower Salmon Creek is not receiving significant use by outmigrating salmonids.

Coastal cutthroat trout are listed as a California Species of Special Concern. Coastal cutthroat trout utilize small streams and headwaters, usually above those used by steelhead (HBWAC, RCAA 2005). Coastal cutthroats are weakly anadromous, being more tied to freshwater than other anadromous salmonids in California (Moyle 2002). Their preferred habitat is low-gradient coastal streams and estuaries (perhaps due to exclusion from other habitats by the more aggressive Coho and steelhead in pools and deeper water (Moyle 2002). They feed on invertebrates and small fish, becoming increasingly piscivorous with age. Coastal cutthroats first spawn at 2–4 years old, and may return to freshwater up to five times to overwinter and spawn (Moyle 2002). Cutthroats use off-channel habitats and intermittent tributaries and sloughs. Cutthroats are typically present from late winter through spring (HBWAC, RCAA 2005).

The tidewater goby is an ESA-listed endangered species. Tidewater goby proposed critical habitat includes most of the southern Humboldt Bay NWR units (USFWS 2006b). The entire life history of the goby can be completed on the refuge. Tidewater gobies are known to migrate upstream in tributaries up to 0.6 mile from estuaries. Sub-adult and adult gobies migrate upstream in tributaries in summer and fall for reproduction. Nesting burrows are dug in coarse, sandy substrate. They primarily feed on small benthic crustaceans and aquatic insects. Individuals typically live for 1 year (Moyle 2002).

The Pacific lamprey (*Lampetra tridentata*) is also anadromous and is likely to be found in the streams of Humboldt Bay, but is in the Family Petromyzontidae and unrelated to salmonids. According to Moyle (2002), adult Pacific lamprey spawn in streams generally from early March to late June. Adults typically die after spawning, and the embryos hatch in about 10 days. The ammocoetes (juvenille lampreys) burrow into sand or mud and live as filter feeders for 5–7 years. After the filter feeding life stage, lampreys become predatory and move downstream to the marine environment where they live for a maximum of 3–4 years (Moyle 2002).

Marine fish

Hundreds of species of marine fish live in Humboldt Bay (Barnhart et al. 1992) (see Appendix K). Many marine fish may use nearshore areas adjacent to Humboldt Bay and estuarine/slough areas within the bay for a portion of their lifecycle. Several species are caught and or harvested for their commercial or sport value, while most others are relatively little known members of the bay, nearshore fauna and ecologic cycle(s).

Amphibians and Reptiles

Amphibians that occur in the local area include the western toad (*Bufo boreas*), pacific tree frog (*Hyla regilla*), northern red-legged frog (*Rana aurora aurora*), rough-skinned newt (*Taricha granulose*), northwestern salamander (*Ambystoma gracile*), Oregon ensatina (*Ensatina eschscholtzii oregonensis*), and Pacific giant salamander (*Dicamptodon ensatus*). These amphibians are associated with the various freshwater wetland habitats on the Humboldt Bay NWR, and breed in permanent freshwater areas near Salmon Creek and on dune units.

Snakes also make use of grassland, riparian forest, marsh, and dune habitats on the Humboldt Bay NWR including several species of garter (*Thamnophis* spp.) snakes and the gopher snake (*Pituophis catenifer*). Lizards that make use of these habitats include northern alligator lizard (*Elgaria coerulea*), western skink (*Eumeces skiltonianus*), and western fence lizard (*Sceloporus occidentalis*).

Management considerations for the long term persistence of the herpetofauna of the Humboldt Bay National Wildlife Refuge need to consider both breeding and upland habitats. Most amphibians breed in the freshwater wetlands and canal system on the main management unit of the refuge.

Most research focusing on management of amphibians has recently been conducted on northern red-legged frogs, due to their limited range in relation to other amphibian species found on the Humboldt Bay NWR. The northern red-legged frog uses freshwater habitat for breeding, which occurs locally on the refuge from mid-December to the end of March, when males and females congregate at breeding sites to deposit egg masses. Larvae hatch out of egg masses 2 to 4 weeks after oviposition, depending on water temperature, and the larvae are free swimming herbivores that go through metamorphosis starting in June to August. Wetlands where breeding occurs but hydroperiods last only until May might be insufficient in successfully recruiting new individuals into a population, so management should consider maintaining wetlands that have longer hydroperiods that will allow for completion of metamorphosis. Post-metamorphic frogs disperse from wetlands and move to upland habitats in alder forest adjacent to wetlands, although some individuals stay year round near wetlands. After two years post-metamorphosis, males become sexually mature and females become sexually mature after three years.

Pacific Tree Frog Photo: Shannon Smith

Recent surveys conducted in "Cattail Creek" from November 2006 until April 2007 revealed an effective population size of 237 females utilizing this ~500 meter reach of the canal as based on detection of egg masses (Bettaso et al. 2008). Population estimates of metamorphic northern red-legged frogs were 829 animals for Pond 1 and 851 animals for Pond 5 during abnormal frog surveys in 2004 (Bettaso 2004). Sendak (2008) found that northern red-legged frog abundance was greater in the smaller, permanent pond habitats out in the dune ecosystem, along with movement of adults to the breeding ponds greatest during the breeding season. Adult movements away from breeding ponds can be up to 4.8 kilometers to appropriate non-breeding habitats (Hayes et al. 2007) demonstrating the importance of maintaining upland habitats as part of management of this species.

Management of both freshwater breeding sites and adjacent upland habitats will likely maintain a robust effective population size of northern red-legged frogs and these same habitats would be utilized by the other pond breeding amphibians of the refuge. Proper management of the adjacent uplands will facilitate habitats that the reptile assemblage of the refuge would occupy. If restoration projects are to reduce freshwater breeding habitats (e.g. areas that are freshwater now but historically salt marsh), mitigation by construction of additional freshwater habitats could be managed on the refuge property. For restoration of currently occupied habitats, pre-construction and post-construction surveys should be initiated to understand the cost-benefits of restoration projects to the currently healthy population of breeding amphibians on the refuge.

Invertebrates

A wide variety of invertebrates inhabit wetlands and shorelines associated with Humboldt Bay NWR for at least a portion of their lifecycle. Barnhart et al. (1992) and Boyd et al. (2002) provide lists of marine and intertidal invertebrate species known to inhabit Humboldt Bay. In total there is thought to be in excess of 360 species invertebrates inhabiting the bay as well as the associated intertidal mudflats, marshes, and dunes (Hull 2002).

Two types of invertebrates, the Dungeness crab (*Cancer magister*) and Pacific oysters (*Crassostrea gigas*), have the highest respective commercial value to fisheries and aquaculture in Humboldt Bay. Limited sport harvest of Dungeness crab is also permitted by the CDFG, but is insignificant compared to the commercial harvest. Dungeness crabs prefer sandy and sand-mud substrates, but can be found on almost any substrate type. They live in the intertidal zone to a depth of 750 feet, but are not abundant beyond 300 feet (CDFG 2004b). Pacific oysters have been grown in the intertidal zones of Humboldt Bay (primarily the north Bay) for over 60 years using a variety of methods (Rumrill and Poulton 2004).

Many invertebrates also inhabit the bay's surrounding marine environment. Red rock crab (*Cancer productus*) are also commercially and recreationally harvested in large numbers in the area surrounding Humboldt Bay (CDFG 2004b). Rock crabs are both predators and scavengers. They feed on a variety of other invertebrates and provide a source of food to many predators (CDFG 2004b).

California's coastal dunes have been recognized for their unique and endangered terrestrial invertebrate (insect) fauna (Powell 1978). The nearshore dunes are populated by numerous beetles including darkling beetles (*Coelus ciliatus, Eleodes scabrosus*), carrion beetles (*Nicrophorus defodens*), blister beetles (Family Meloidae), and June beetles (*Polyphlla decemlineata, Phyllophaga* sp). Oregon tiger beetles (*Cicindela oregana*) are found in the spring around flooded dune swales. Pallid-winged grasshoppers (*Trimerotropis pallidipenis*) are ubiquitous in the dune mat during the late summer, while spur-throated grasshoppers (*Melanoplus* sp.) are common in herbaceous dune swales. Jumping spiders (*Habronottis amicus*) are found on the open sand, along with termites that colonize buried trees. Broad-headed bugs (*Alydus pluto*) are conspicuous when feeding on beach pea seeds with their piercing mouth parts. One of the most ubiquitous insects on the ground in the near-shore dunes are mound-building thatch ants (F*ormica obscuripes*) considered an "ecosystem engineer"

for their disproportionate effect on the ecosystem (Crutsinger and Sanders 2005). Their mounds, constructed of pieces of vegetation, can reach a height of 4 feet.

The dunes are also home to 40 species of bees (Gordon 1984), including a unique assemblage of solitary nesting bees such as the silver bee (*Hapbropoda miserabilis*) and leaf cutter bee (*Megachile wheeleri*). Many of these species are specialized on certain dune plants and serve as crucial pollinators (Nyoka 2004). Others require specialized nesting substrate present only on the dunes (Gordon 2000).

3.2.6. Humboldt Bay NWR Special Status Species

Federal Endangered Species Act Listed Species at the Refuge

An endangered species is an animal or plant species in danger of extinction throughout all or a significant portion of its range. A threatened species is an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Various ESA-listed threatened and endangered species found seasonally or permanently on the Humboldt Bay NWR use a wide diversity of the available habitats. Two endangered plant species, Humboldt Bay wallflower and beach layia, are members of the dune mat community on the Lanphere and Ma-le'l dune units. Salmon Creek provides habitat for juvenile ESA-listed threatened steelhead, Coho and Chinook salmon, as well as passage for migrating adults of these species. Endangered tidewater gobies may migrate upstream in tributaries up to 0.6 mile from estuaries. Sub-adult and adult gobies migrate upstream in summer and fall to reproduce in tributaries (USFWS 2006a).

Birds of Conservation Concern

A 1988 amendment to the Fish and Wildlife Conservation Act mandates the U.S. Fish and Wildlife Service (USFWS) to "…identify species, subspecies, and populations of all migratory non-game birds that, without additional conservation actions, are likely to become candidates for listing under the Endangered Species Act of 1973." Bird species meeting this criteria are referred to as Birds of Conservation Concern (BCC). Further, the Service is required to update the list every 5 years. Species that occur in Humboldt Bay that are listed within the "Birds of Conservation Concern 2008" (USFWS 2008b) list are identified in Appendix L. Many BCCs migrate through the Humboldt Bay NWR area seasonally, including tricolored blackbirds (*Agelaius tricolor*), burrowing owls, ferruginous hawk (*Buteo regalis*), Swainson's hawk, black swift (*Cypseloides niger*), prairie falcon (*Falco mexicanus*), loggerhead shrike (*Lanius ludovicianus*), Lewis' woodpecker (*Melanerpes lewis*), and Caspian tern (*Sterna caspia*). Two BCCs are commonly found on the refuge: the olive-sided flycatcher is known to breed in Douglas-fir trees growing in stabilized dune coniferous forest habitat on the dune units and long-billed curlews are found on wetlands from fall through spring.

California State Endangered Species Act Listed Species

The California Endangered Species Act (CESA) listed endangered willow flycatcher (*Empidonax traillii*) and the threatened bank swallow (*Riparia riparia*) may use habitat on the Humboldt Bay NWR during their annual migrations. The CESA endangered bald eagle uses Humboldt Bay NWR habitat for hunting on the refuge.

California State Species of Special Concern

California Species of Special Concern (SSC) is a designation that the CDFG can give to vertebrate species because of declining population levels, limited ranges, and/or continuing threats that may make the listed species vulnerable to extinction. A single amphibian SSC, the northern red-legged frog, uses wetland habitats on the Humboldt Bay NWR. Fish SSC that use Humboldt Bay NWR habitat include green sturgeon (*Acipenser medirostris*), tidewater goby, coast cutthroat trout, Coho salmon (southern Oregon/northern California ESU), steelhead (northern California ESU), Chinook salmon (California coastal ESU), longfin smelt (*Spirinchus thaleichthys*), and eulachon (*Thaleichthys pacificus*). Bird SSC species that use the Humboldt Bay NWR include osprey, merlin, prairie falcon, ferruginous hawk, Swainson's hawk, Cooper's hawk, sharp-shinned hawk, northern harrier, long-eared owl, burrowing owl, short-eared owl, Barrow's goldeneye (*Bucephala islandica*), common loon, California gull (*Larus californicus*), black tern (*Chlidonias niger*), double-crested cormorant, long-billed curlew, western snowy plover, tricolored blackbird, Vaux's swift (*Chaetura vauxi*), black swift (*Cypseloides niger*), yellow-breasted chat (*Icteria virens*), yellow warbler, (*Dendroica petechia*) loggerhead shrike and purple martin (*Progne subis*).

Other Special Status Species

Two globally endangered lichens are found in the forest of the dunes units, *Bryoria spiralifera* and *B. pseudocapillaris* (Glavich 2003). Both are arboreal and are commonly found at the edges of the coniferous forest. These two lichens are endemic to the California and Oregon coastlines and listed

Population status of the endangered Humboldt Bay wallflower (*Erysimum menziesii ssp. eurekense*)

Humboldt Bay wallflower (*Erysimum menziesii* ssp. *eurekense*) is a federally and State-listed endangered plant in the Brassicaceae. The subspecies is restricted to coastal dunes in the Humboldt Bay region, and is one of three endangered subspecies of Menzies' wallflower (*Erysimum menziesii*). The semelparous life history (it is a short-lived perennial with only one reproduction event) of *Erysimum* is distinctive among dune plants. Many years of research on the Humboldt Bay wallflower have shown that it requires a semi-stable substrate with openings of bare sand to thrive, and is particularly vulnerable to invasions by stabilizing vegetation.

Over the past two decades, management for this subspecies has been carried out on Humboldt Bay NWR and other public lands on the North Spit of Humboldt Bay. Management has consisted primarily of removal of invasive species to allow for maintenance of underlying disturbance-generating processes. A sampling program for the entire North Spit population was carried out in 1988 (Sawyer and André 1990), and repeated in 1997 (Pickart et al. 2000) and 2006 (USFWS unpublished data), allowing for a unique opportunity to track the health of this plant over two decades of active management. Although the 2006 results are still preliminary, we present them (Figure 10) to illustrate the positive response of this plant to management. Between 1988 and 2006, the North Spit population of wallflowers has increased from 20,657 (+1,172 SE) to 55,605 (+7,020 SE). As is visible on the chart, the Lanphere Dunes subpopulation accounts for the greatest increase, and now represents nearly 50 percent of the total population. This subpopulation was the most intensively managed over this period, with removal of virtually all invasive species occurring in wallflower habitat (yellow bush lupine, European beachgrass, iceplant, and annual grasses) as well as the intentional movement of seeds from occupied to unoccupied habitat areas between 1997 and 2006.

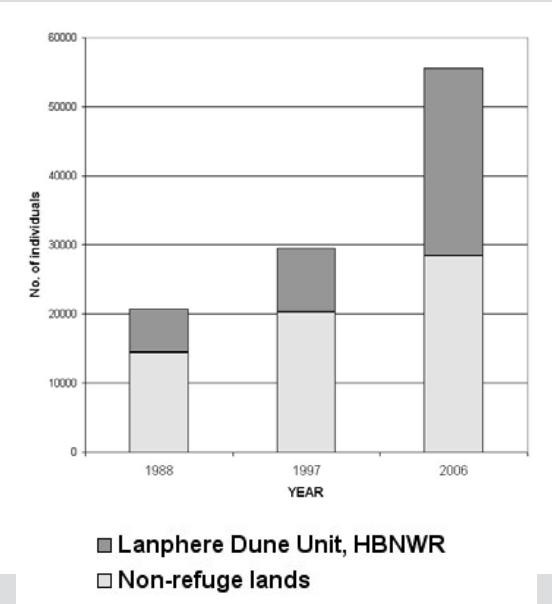


Figure 10. Population status of Humboldt Bay wallflower.

Of the three endangered subspecies, *Erysimum menziesii* ssp. *eurekense* is considered the closest to achieving recovery (USFWS 2008a). However, additional protection of privately held habitat, and additional off-refuge habitat restoration is still needed.

under the Department of Agriculture/Department of Interior's InterAgency Special Status/Sensitive Species Program (http://www.fs.fed.us/r6/sfpnw/issssp/).

Non-native Wildlife
Beginning in 2000, the CDFG conducted the most thorough aquatic organism sampling program recently undertaken in Humboldt Bay (Boyd et al. 2002). During this survey of marine species, researchers collected and identified 95 species that are possibly non-indigenous to Humboldt Bay. These were representatives from diverse groups of organisms ranging from vascular plants to fish. The majority of non-indigenous species found were in various invertebrate groups, including polychaetes (24 species), amphipods (20 species), and bryozoa (8 species) (Boyd et al. 2002).

Non-native wildlife found on the other refuge units includes starlings, house sparrows (*Passer domesticus*), feral cats (*Felis domesticus*), and Norway rats (*Rattus norvegicus*).

3.3. Humboldt Bay NWR Visitor Services

3.3.1. Overview of Humboldt Bay NWR Visitor Services

Recreational uses occur throughout Humboldt Bay, but are most common in the North and South Bay areas. Some of the most common are recreational bird watching, fishing, boating, clamming, hunting, and hiking (Hull 2002).

Bird watching is one of America's fastest growing recreational pastimes (USFWS 1997), and the Humboldt Bay area is a birding destination due to both the diversity of birds and the number of great spots to view them. Godwit Days has grown into a very successful week-long community birding event that brings in hundreds of birding enthusiasts each spring.

Recreational boating (primarily kayaks and canoes) has also increased dramatically both nationally and locally. There are several businesses that rent boats for use on and around the bay, as well as a local kayaking club. Boaters have access from many locations around the bay including Woodley Island, Arcata Marsh, Fields Landing boat launch, and the refuge at Hookton Slough (non-motorized only). A water trails plan for the bay has recently been developed in order to inform people of some of the best locations, as well as provide information on safety, potential impacts to wildlife and habitats and considerations of tides and weather.

Sport fishing continues to be a popular pastime in and around Humboldt Bay. Most of the fishing around the South Bay occurs on the South Jetty and at Buhne's Point. The South Bay also contains large clam beds, including gaper (*Tresus capax*), and Washington (*Tresus nuttallii*) and littleneck clams (*Protothaca staminea*). Several thousand clamming-days occur in good years. Sport fishermen, including clammers, spend over $400,000 annually on licenses alone in Humboldt County.

Another popular traditional use on and around the bay is waterfowl hunting. Humboldt Bay has been well known for generations as one of the best places on the west coast of the United States to hunt Pacific brant. The recent increase in both Aleutian cackling and western Canada geese around the bay, in addition to other waterfowl, provides increased opportunities for hunters. Estimated use by hunters around the bay exceeds 7,500 use-days annually. Like other recreational pursuits, hunters add significantly to the local economy through purchase of local goods and services. In addition, a percentage of required licenses and stamps purchased by hunters and fishers are used to pay for State and Federal conservation programs and acquire lands for public use.

Aesthetics of Humboldt Bay NWR Area
The southern units of Humboldt Bay NWR can be partially viewed from Highway 101. The refuge is enclosed by Tompkins Hill on the east and Table Bluff to the south. The views of these areas from the refuge are currently pastoral in nature, but increasing development on both ridges is a concern from the standpoint of a refuge visitor's aesthetic experience. Hopefully, in decades to come, refuge visitors will still have the sense of being in a rural area rather than semi-urban.

Once on the refuge, open agricultural grasslands and seasonal wetlands allow visitors to glimpse shorebirds, wading birds, geese, raptors, deer, and occasionally gray foxes, skunks, and/or otters. The southern portion of the Salmon Creek Unit appears as a deciduous riparian forest bordering Highway 101. Once visitors enter the Humboldt Bay NWR southern units they find several trails that can provide immediate viewing opportunities for a variety of wildlife, primarily birds and deer. Interpretive displays around the visitor center and along the trails provide visitors with basic information about the species and habitats present on these units. The refuge has two interpretive trails in South Bay, one each at the Hookton Slough and Salmon Creek Units. Peak viewing season from these trails is September through March for most species of waterbirds and raptors. On the

Humboldt Bay NWR, Pacific brant and migratory shorebird viewing peaks from mid-March to late April. Summer visitors will see many gulls, terns, cormorants, and pelicans, as well as resident egrets and herons. Waterfowl, raptors, and harbor seals are visible throughout the year.

The entrance to Humboldt Bay's northern dune units is generally lined by willow swamp and coniferous dune forest and appears as a pristine natural forest along a country road. Those who take a guided tour of the dunes experience a continuum of pristine dune habitats from coniferous forest, to dune mat, moving dunes, swales, foredune grasslands, beaches, and finally the Pacific Ocean. In the near future there will be a new trail open to the public at the Ma-le'l Dunes Unit adjacent to the Mad River Slough. The dunes offer spectacular panoramic views to the east and west all year long, but spring time is the best for birds and summer for viewing the prolific floral displays in the dune mat plant communities.

3.3.2. Humboldt Bay NWR Visitor Services

Public visitation of the Humboldt Bay NWR has steadily increased since 1988 when the refuge acquired the Salmon Creek Unit.

In spring 2002, the Richard J. Guadagno Headquarters and Visitor Center was dedicated and offered an obvious destination for visitors. Prior to 2002, the Humboldt Bay NWR headquarters and residence was an old ranchhouse at the end of a gravel road. Visitation increased dramatically shortly after the construction of the visitor center and paving of the entrance road.

As visitation increased, the older established trails had to be re-routed to minimize wildlife disturbance while providing the public with the opportunity to view a representative sample of wildlife and habitats on the refuge units. Increased public exposure and ongoing habitat improvement projects resulted in requests by the public to open the Salmon Creek Unit on weekends.

In response to the growing demand, and with volunteer assistance, the Salmon Creek Unit was opened on Saturdays in 2003. Due to the continued, increasing demand for weekend access to the refuge, hours were again expanded in 2005 making the Salmon Creek Unit open to the public seven days a week from 8 a.m. to 5 p.m.

Currently, with the assistance of two Friends groups and volunteers, Humboldt Bay NWR makes a variety of visitor services accessible to the public. The total number of visitors averages 15,000 to 17,000 per year, conservatively. Wildlife observation, environmental education/interpretation, and waterfowl hunting are currently the principal public uses of the refuge. The Visitor Center has interpretive exhibits and staff or volunteers available to provide information daily from 8:00 a.m. to 5:00 p.m., excluding Federal holidays. The Hookton Slough Unit is open daily from sunrise to sunset. Only day-use activities are allowed on refuge units.

Kayaking on Hookton Slough
Photo: Shannon Smith

Painting waterbird silhouettes. Photo: Shannon Smith

The southern units of Humboldt Bay NWR include two self-guided trails and a sheltered viewing area for wildlife observation. One trail is open seven days a week during daylight hours (Hookton Slough Trail), and one is open daily from 8 a.m. to 5 p.m. (Shorebird Loop Trail). The Hookton Slough Trail follows a tidal slough one and a half miles out along the south edge of the bay. The three mile round trip trail passes along grasslands, freshwater marsh, mudflats, and open water. Visitors can see herons and egrets, as well as shorebirds, waterfowl, and harbor seals. The 1.75-mile Shorebird Loop Trail passes near some of the refuge's best shorebird viewing areas. The trail affords a good overview of the diverse seasonal wetlands; an optional side trail goes to the refuge's photoblind. Interpretive panels along the way illustrate wildlife resources and habitat management practices on Humboldt Bay NWR. Visitors often see shorebirds, waterfowl, songbirds, raptors, tree frogs, deer, and river otters.

Seasonal waterfowl hunting is currently allowed on all refuge units except Hookton Slough and the dune units. The managed hunt area with the Salmon Creek Unit supported over 1000 hunter use-days during the 2007-08 waterfowl season. Humboldt Bay and tidal sloughs are open to fishing year-round. Areas separated from the bay by land, such as creeks and flooded areas behind dikes, are closed to fishing. The Hookton Slough Trail is open to shore fishing; access to other areas is by boat. The Hookton Slough Unit has a non-motorized boat launch.

The northern Lanphere Dunes Unit of Humboldt Bay NWR is accessible only by permit or guided tour to minimize disturbance of sensitive species and dune habitats. Visitation to the Lanphere Dunes Unit is estimated at 2500–3500 people per year. The recently acquired Ma-le'l Dunes Unit is currently closed to public access, but will be open to daily walk-on use by 2009. Volunteers for Friends of the Dunes (FOD), a nonprofit organization whose mission is "to conserve the natural diversity of coastal environments through community-supported education and stewardship programs at multiple locations around the bay," lead monthly walks, restoration events, and conduct environmental education activities on the Dunes Units.

The Humboldt Bay NWR tries to mitigate for, or minimize, disturbance impacts caused by public use through a variety of methods. Areas of some refuge units remain closed to the general public to provide inviolate sanctuary areas for wildlife. Trails have been re-routed and/or enhanced to provide closer views of wildlife and their habitats, while providing a distance buffer for wildlife. Certain uses, such as hunting and the refuge trails, are largely compartmentalized to reduce wildlife disturbance, as well as to provide safe high quality experiences for visitors. The Humboldt Bay NWR also limits the level, intensity, frequency, and time of day of public uses to minimize wildlife disturbance.

Environmental Education and Interpretation

The Humboldt Bay NWR has continually offered environmental education and interpretation, at some level, and provided off-site outreach since the establishment of the Salmon Creek Unit in 1988. Groups regularly utilizing refuge units for environmental education range from kindergarten through 12th grade, and university level students.

The Redwood Region Audubon Society led monthly bird walks on the Hookton Slough Unit for many years. In recent years, they have changed the location of their walks to the Salmon Creek Unit.

With the addition of the Lanphere Dunes Unit in 1998, the refuge gained the valuable support of the FOD. The FOD still conducts portions of their Bay to Dunes curriculum, restoration activities, monthly guided docent walks, and volunteer coordination on the Dunes Units.

In 2002, the refuge expanded its relationship with the FOD to include limited environmental education and volunteer coordination on the southern units of the Humboldt Bay NWR. The FOD received a Nature of Learning Grant which helped to expand their Bay to Dunes environmental education curriculum to include trips to the Salmon Creek

Unit. In recent years, environmental education and interpretation activities on the South Bay Units have been coordinated by the newly formed Friends of Humboldt Bay NWR, whose mission is to assist the refuge and staff in all functions.

Since 2005, the refuge has contracted with the California Waterfowl Association (CWA) to hire a temporary Visitor Services Assistant, who manages the Visitor Services Program.

The lack of a full-time, dedicated staff person has hindered the Complex's ability to provide consistent environmental education, interpretation, volunteer coordination, and outreach. However, in 2008 the refuge received funding for a permanent position to be shared with the Arcata Fish and Wildlife Office to accomplish Visitor Services and Outreach goals for the FWS mission on the north coast. When filled, the shared position will be stationed at the Salmon Creek Unit of the Humboldt Bay NWR.

The Humboldt Bay NWR conducted a Visitor Services Review in November 2006. This review gathered invaluable background material and helped to inform the Draft Visitor Services Plan (Appendix B).

3.4. Humboldt Bay NWR Cultural Resources

3.4.1. Humboldt Bay NWR Prehistoric Archaeology

In aboriginal times, Humboldt Bay was home to the Wiyot people, an Algic speaking group that fished and hunted on the California coast from Little River to the Eel River (Fredrickson 1984).

Prehistoric Use of Humboldt Bay and Surrounding Area

Numbering somewhere between 1000 and 3300 in aboriginal times (Cook 1976), the Wiyot boasted one of the highest aboriginal population densities in California, about seven people per square mile. The Wiyot were known for their elaborate ceremonial system. The White Deerskin Dance, in addition to its more esoteric functions, connect unrelated families living many miles apart as friends and allies (Kroeber 1925). Highly valued obsidian blades were displayed at the dances. The obsidian was obtained from as far as 300 miles away (Hughes 1978). The blades were sacred and important markers of wealth and social rank. Loud (1918) recorded numerous villages and campsites around the perimeter of South Humboldt Bay. Some of these archaeological and historic aboriginal sites lie within and immediately adjacent to the Humboldt Bay NWR.

In North Humboldt Bay, Loud (1918) recorded two large sites on Indian Island (Gunther Island), which is within the approved Humboldt Bay NWR boundary. The sites are surrounded by tidal salt marsh. Loud excavated one site, which he described as the most important site in Wiyot territory. Later, Elsasser and Heizer (1964) described artifacts excavated from another site that contained a large deeply stratified shell midden filled with numerous artifacts, burials, food remains, hearths and house floors. From archaeological evidence this site was occupied from about A.D. 500 to 1860, when the aboriginal occupants were massacred by American settlers (Fredrickson 1984, Loud 1918). Beyond this limited information, the archaeology of Humboldt Bay remains virtually unknown. Elsasser (1978), Fredrickson (1984), and Eidsness (1988) all have written on the archaeology and prehistory of areas adjacent to Humboldt Bay on the northern California coast.

Loud also recorded sites in the dunes of North Spit, south of the Humboldt Bay NWR dune units. Albert James, prior Chairman of the Wiyot Tribe, was consulted (by telephone) about Native American use of South Humboldt Bay (Raymond 1990). Aside from the ethnogeographic information compiled by Loud, James said that his father remembers when the Wiyot would fish the lower reaches of Salmon Creek within the current boundary of Humboldt Bay NWR. However, sediment accumulation, channeling, and diking of the creek would have destroyed the integrity of the fish station. James indicated that a fish camp was established annually where the creek issued from the canyon into the flats of the bay. This location is upstream of the Humboldt Bay NWR boundary.

What is now the Humboldt Bay NWR was part of the historic Wiyot Ancestral Territories. Three contemporary entities represent the historic Wiyot Ancestral Territories located around Humboldt Bay: the Wiyot Tribe (which consists of Wiyot only), the Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria , which are composed of Wiyot and several other tribal groups. There are currently over 600 Wiyot Tribal citizens and ~50 reside on the 88 acre Table Bluff Reservation, 16 miles south of the City of Eureka (Wiyot Tribe 2007) and adjacent to the Humboldt Bay NWR.

Prehistoric Cultural Resources

Since Loud's initial investigations of Humboldt Bay cultural resources in 1918, two cultural resource investigations have been conducted in the South Humboldt Bay area. Benson et al. (1977) surveyed Hookton Road as part of a larger investigation in the Eureka area. He re-recorded two of Loud's sites. Hayes (1983) surveyed a 0.6-acre corridor at

the head of Hookton Slough for the U.S. Fish and Wildlife Service. The Hayes' survey area falls within the current Humboldt Bay NWR boundary. Despite the excavation of 40 probe pits, no cultural resources were encountered by Hayes. The negative results can likely be attributed to the fact that the survey area occurs within the tidal/marsh zone of Humboldt Bay. This area, which was swept twice daily by tidewater, probably would not preserve cultural resources. Since settlement by ranchers, dikes have caused large amounts of sediment from Salmon Creek to accumulate and bury the historic natural surface.

A survey for cultural resources was conducted at Humboldt Bay NWR in 1990 (USFWS 1990). Findings indicate that no significant cultural resources were observed within the southern Humboldt Bay NWR units. It is possible that middens and other archaeological resources may be located within the Humboldt Bay NWR.

The Lanphere and Ma-le'l Dunes Unit have been surveyed repeatedly, most recently in 2003 (Angeloff et al. 2004). These units contain prehistoric archeological sites, historic era resources, and isolated artifacts.

3.4.2. Humboldt Bay NWR EuroAmerican Settlement

In 1806 an American, Captain Jonathan Winship, and 100 Aleuts were sent to the California coast by the Russian governor in Alaska. Winship discovered Humboldt Bay but neither he nor other seamen re-entered the bay until 1850. Wandering gold seekers settled the area in the 1850s. Hostilities between settlers and natives climaxed on February 25, 1860, with the Indian Island massacre (Loud 1918). Settlement and dredging of the tidelands and marshes of Humboldt Bay began in the 19l0s. There are no listed National Register sites in or near the refuge (Gerike 1988).

EuroAmerican Settlement in Humboldt Bay
The southern units of Humboldt Bay NWR are composed of land once owned and developed by ranchers who began to settle the South Bay area in the late 1800s and early 1900s (USFWS 1990). Ranchers built a dike around the entire salt marsh zone of the South Bay, effectively eliminating daily tidal exchange in the marsh. Other dikes and channels were constructed to control and spread Salmon Creek and other unnamed brooks. The tidal marshlands of the South Bay steadily dried out. The marsh and soils, deprived of the daily sweep of tidewater and flushed with fresh water and silt from Salmon Creek, eventually supported agricultural grasses. The grasses quickly spread and fed hundreds of cattle. Ranching facilities were built in the area in the 1920s, which were removed, improved, or maintained through the present.

Large areas of the Hookton Slough, Salmon Creek, and White Slough Units have subsided as a result of land reclamation. Lacking tidewater, aeration increased, organic matter decomposed, and soil compacted. Elimination of salt marsh plants has stopped the annual accumulation of organic matter and peaty soil formation from senescing salt marsh plants. Cattle have also contributed to subsidence and soil compaction by their weight on soils as they forage. This resulted in a situation where at certain locations the substrate inside the dike on these units is anywhere from 1–4 feet lower than the tidal mudflat on the bay side of the dike.

However, in the southern part of the Salmon Creek Unit along Salmon Creek, sediment has accumulated to a depth of 3 to 4 feet as a result of historic modifications of the channel and the resulting overbank flooding. The channeling of Salmon Creek into a network of canals has forced sedimentation here instead of onto the tidal flats of the bay. Since the area has been diked off from the daily influence of tides, the soil has changed from tidal marsh series to a Weott series (Soil Survey Staff 2007).

3.5. Humboldt Bay NWR Social and Economic Conditions

3.5.1. Overview of Humboldt Bay NWR Social and Economic Regional

Since the 1850s, great demands have been placed on the Humboldt Bay region for timber, livestock, and agricultural products. Although these activities have provided economic benefits, they have also affected some of the region's other natural resources (USFWS 1997).

Humboldt County has historically been a very productive timber region (TNC et al. 2005). However, over the past 20 years the timber industry in California has undergone a major downturn, economically impacting the industry as well as the local community (TNC et al. 2005). One important factor in the industry's downturn is a reduction in supply due to prior intensive harvest. In addition, an inconsistent domestic housing market, declining Asian markets in the 1990s, an increasing foreign lumber supply with relatively lower cost from Canada, Brazil, Chile, and Russia, and regulatory constrictions for protected species have had negative impacts (TNC et al. 2005). Nonetheless, as of 2005, Humboldt County timber production was over 390

million board feet, equivalent to 22.6 percent of California's total production (CDOF 2007).

As of 2000, approximately 1,220 people were employed in agriculture in Humboldt County (CDOF 2007). Agricultural products, such as livestock and livestock products, as well as plant products, had a value of over $124 million (in year 2000 $) for Humboldt County (Table 4). Dairy and beef cattle are primary products. The illegal production of marijuana has occurred for decades and is acknowledged by literally everyone in the county as a substantial economic driver but obviously there are not reliable figures regarding production, employment, or societal costs of this particular crop.

Commercial and sport fishing have been a consistent part of the local economy for decades, but have recently fallen on hard times due to declining fisheries populations and increasingly complicated management and regulation (Table 5). For the first time in over 150 years, in summer 2008 there was not a commercial or sport ocean salmon fishing season allowed, due primarily to an unprecedented downturn in the Sacramento River Chinook salmon population.

Commercial oyster culture has a relatively long history on Humboldt Bay and provides much of the west coast supply of oysters as well as business and jobs within the local community.

The majority of non-agricultural employment in Humboldt County is in a few sectors including State and local government; trade, transportation and utilities; educational and health services; and leisure and hospitality (Table 6).

Table 4. Value of agricultural commodities produced in Humboldt County for 2005.

Commodity	Value $ Million
Nursery Products	$43.50
Milk, Market	$29.10
Cattle and Calves	$19.90
Milk, Manufactured	$12.90
Biomas, Energy	$5.60
Pasture, Range	$4.70
Livestock	$3.70
Pasture, Irrigated	$3.10
Silage	$0.90
Vegetables	$0.90
Total Value	$124.30

from www.dof.ca.gov

3.5.2. Humboldt Bay NWR Management Economics

The current Complex staff consists of six full-time employees and one term-funded position. All seven employees are permanently stationed at Humboldt Bay NWR. The Complex's total operational budget for fiscal year (FY) 2008 was ~$1M, including ~$362K for maintenance.

Table 5. Eureka commercial fish harvest through 2005.

Year	Millions of Pounds of Fish	Millions of Dollars
1981	35	13.5
1982	36	12.4
1983	21.9	7
1984	22.5	8.6
1985	28.5	10.7
1986	19.4	8.3
1987	28.5	12.6
1988	27	12
1989	21.2	8.4
1990	24.4	12.8
1991	20	8
1992	21.2	10.1
1993	18.3	9.1
1994	18.4	13
1995	15.1	10.3
1996	18	12.3
1997	19.7	12.7
1998	12.8	9
1999	12.1	9.7
2000	13.7	7.7
2001	9.5	5.7
2002	16.4	7.2
2003	16.4	12.8
2004	19.4	13.1
2005	14.9	7

from: http://www.st.nmfs.gov/st1/commercial/landings/lport_hist.html

National Wildlife Refuges contribute funds to local counties through revenue sharing programs that are intended to cover unrealized tax revenues for either lands purchased in fee title or lands reserved from the public domain. For fiscal year 2007, Humboldt County received payment in the amount of ~$15K from the Federal government under this revenue sharing program.

3.5.3. Humboldt Bay NWR Regional Land Use

Humboldt County and Bay Area Land Use
Humboldt County is comprised of ~2,286,400 acres. The county has nearly 132,000 residents with the vast majority of people living in the larger cities around Humboldt Bay of Eureka (27,208), Arcata (17,244), and Fortuna (11,207) (CDOF 2007). Today, the area surrounding Humboldt Bay is a mixture of developed urban areas, agricultural lands, forest lands, and publicly owned natural areas (Table 7). According to the California Department of Finance, as of 2001, 27.7 percent (634,000 acres) of Humboldt County was farmland. In 2002 there were 993 farms in Humboldt County.

As is the case with all development, including that around Humboldt Bay, there have been consequences to the local environment. Some of the regional environmental impacts from decades of development, logging, and agriculture include: sedimentation and aggraded stream and slough channels, degraded water quality and the reduction or loss of wetlands and other native habitats, and the fish, wildlife, and plants those lands support.

Humans drastically altered lands around Humboldt Bay beginning in 1850. From 1850–1870, much of the shrubs and trees (riparian plant communities) were cleared from the bottoms around the bay. From 1880–1910, the majority of the salt marshes were diked and converted to agricultural grasslands. The higher areas of Arcata Bottoms, Jacoby Creek, Freshwater Creek, Elk River, Salmon Creek, and parts of Humboldt Hill were cleared and converted for hay production and agricultural grassland. Land use changes between 1871 and 1948 resulted in an approximate six-fold increase in agriculture lands with a corresponding loss in salt marsh. Currently, about 970 acres of salt marsh remain around the bay.

Currently, according to the National Wetland Inventory, there are ~10,200 acres of palustrine wetland (former tidelands) around Humboldt Bay, the majority of which is grazed or farmed. Most of the farmed or grazed wetlands are adjacent to the North Bay in the Arcata Bottoms and Eureka-Arcata agricultural grasslands. In recent decades there has been an increased interest in identifying opportunities and implementing actions to reclaim and preserve portions of historic bay ecosystems (Monroe 1973). Additionally, public interest is increasing for more wildlands and wildlife viewing

Table 6. Non-agricultural sector employment in Humboldt County as of 2006.

Humboldt County Non-Agricultural Sector in 2006	Number Employed in Sector	Percent of Total Employed in Sector
State and Local Government	13,050	26.8
Trade, Transportation and Utilities	9,867	20.2
Educational and Health Services	5,775	11.8
Leisure and Hospitality	5,250	10.8
Manufacturing	3,383	6.9
Professional and Business Services	3,158	6.5
Construction	2,533	5.2
Financial Activities	2,033	4.2
Other Services	1,833	3.8
Federal Government	792	1.6
Information	717	1.5
Natural Resources and Mining	383	0.8
Total	48,775	100

from www.dof.ca.gov

Table 7. Current land use in Humboldt Bay area as of 2001 (adapted from Hull 2002).

Use	Acres	Percentage
Agriculture	17,760	62.8%
Natural Resources	4,315	15.3%
Commercial/Industrial	2,596	9.2%
Residential/Rancheria	1,979	7.0%
Public	1,156	4.1%
Timberland	348	1.2%
Railroad	39	0.1%

from www.dof.ca.gov

opportunities (USFWS 1997), mirroring national trends that rank wildlife viewing as the most popular outdoor recreational activity (OIF 2006).

3.5.4. Humboldt Bay NWR Land Use

The Humboldt Bay area is the major population and industrial center along the California coast north of San Francisco (Table 5). The cities of Eureka and Arcata, and the small communities of Fairhaven, Manila, Samoa, King Salmon, and Fields Landing, lie along the shores of the bay. Several other communities, including Trinidad, McKinleyville, Loleta, Ferndale, and Fortuna, are within a broad service area. Arcata is the site of HSU, which currently has an enrollment of ~7,500 students. The College of the Redwoods, a two-year college with an enrollment of about 5,000 full-time and part-time students, is located a few miles south of Eureka, and right across Highway 101 from the refuge.

The South Humboldt Bay area, though strongly influenced by the urban and industrial nature of Eureka and the mid-bay, is still largely rural. Land uses along the east side of South Bay include log storage and deep-water docking facilities, a marina, power plant, two small residential areas (King Salmon and Field's Landing), the College of the Redwoods, and improved agricultural grassland. Table Bluff, which separates South Bay from the Eel River bottoms, supports the Wiyot Rancheria, as well as agricultural operations and rural residences.

3.5.5. Humboldt Bay and Surrounding Area Demographics

Humboldt County is home to 131,595 residents as of 2007 (CDOF 2007). The two largest cities near Humboldt Bay NWR, Eureka and Arcata, have populations of 27,208 and 17,244 respectively (CDOF 2007). According to the U.S. census of 2000, 51,238 households, and 30,640 families reside in Humboldt County. The population density was 35 per square mile in 2000. There were 55,912 housing units at an average density of 16 per square mile. The racial makeup of the county was 84.7 percent white, 0.9 percent black or African American, 5.7 percent Native American, 1.7 percent Asian, 0.2 percent Pacific Islander, 2.5 percent from other races, 6.5 percent Hispanic or Latino of any race, and 4.4 percent identified themselves as from two or more races.

As of 2000, there were 51,238 households in Humboldt County. The average household size was 2.4 people and the average family size was 3 people. The median age was 36 years.

3.5.6. Humboldt Bay NWR Local Economy and Employment

As of the 2000 U.S. census, the median income for a household in Humboldt County was $31,226, and the median income for a family was $39,370. The per capita income for the county was $17,203. About 12.9 percent of families and 19.5 percent of the population were below the poverty line. Although somewhat higher, Humboldt County's recent unemployment rates tend to closely follow the state's pattern (EDD 2007). As of May, 2007 the median home price in Humboldt County was $314,000 (Eschker et al. 2007).

Economic development of the Humboldt Bay region is primarily limited by its remote location (Barnhart et al. 1992). The economic base is dependent upon natural resource related industries including timber and wood products, fisheries, agriculture (primarily dairy products), and tourism (Barnhart et al. 1992). Commercial maritime activities associated with shipping and fishing operates from Fields Landing, King Salmon, and Eureka (Hull 2002). Major export products include wood chips, paper pulp, and logs and lumber, while logs, wood chips and fuel are the major imports to local port facilitates (Hull 2002).

Lumber-based manufacturing generates about 55 percent of total Humboldt County manufacturing employment. Overall manufacturing is down 40.8 percent from 10 years prior throughout the county. Lumber-based manufacturing has declined sharply since its recent peak in 2005 (Eschker et al. 2007).

The ecosystems in and near Humboldt Bay have historically supported the largest commercial fishery of all California ports north of Los Angeles. While commercial fisheries vary in complex cycles, there has been a general downward trend in the annual harvest reported for the port at Eureka, CA, from well over 20 million pounds of fish harvested per year in the 1980s to well below 20 million pounds of fish harvested per year since the early 1990s (NOAA Fisheries Service 2007). Annual harvests of Dungeness crab off of Eureka, CA, are the largest in the state. Between the fishing seasons of 1982–1983 and 2001–2002, the annual harvest of Dungeness crab in northern California ranged from 1.9–13.1 million pounds, and averaged 6.9 million pounds per year (CDFG 2004b). Although declining in importance, commercial fisheries continue to be a significant source of resource-driven economic benefits.

During the period 2001–2005, Humboldt County's industry employment declined overall by 900 jobs. While the county experienced job losses in

manufacturing, educational and health services; professional and business services; financial activities; and other services as well as growth in other industries offset some of the decline (EDD 2007). As of 2005, some of the largest industries in Humboldt County included government (26.8 percent); trade, transportation, and utilities (19.8 percent); education and health services (11.5 percent); leisure and hospitality (10.5 percent); manufacturing (7.7 percent); professional and business services (6.7 percent); and construction (4.8 percent) (EDD 2007).

3.6. Overview of Castle Rock NWR

3.6.1. Castle Rock NWR Geographic/Ecosystem Setting

Castle Rock is the largest, most structurally diverse island on the California coast north of Southeast Farallon Island. It is unique among the more than 1,000 offshore rocks and islands in the state in that it has so many types of habitat on one large island within an extremely productive region of the Pacific Ocean. Castle Rock NWR's habitat features include relatively deep topsoil, vegetated terraces, sheer rock cliffs, talus slopes, as well as protected sandy beach and reef habitat. These features allow it to host more than 100,000 breeding seabirds of 11 species, as well as provide haulout grounds for pinnipeds and a secure night roost for Aleutian cackling geese.

Castle Rock NWR supports one of the largest populations of nocturnal cavity-nesting seabirds in California and one of the most important colonies of common murres on the Pacific coast (Carter et al. 1992, USFWS 2005). It is one of only five sites in the California Current System that supports more than 100,000 nesting seabirds. One species of shorebird, the black oystercatcher, also nests at Castle Rock NWR. The island is important to non-breeding seabirds as well. It serves as a communal roost for thousands of brown pelicans during migration, and has become one of the most important resting sites for State and federally listed species on the northern California coast.

Four species of pinnipeds occur regularly at Castle Rock NWR and its associated reef. Two seals, the elephant seal and harbor seal, breed there. The island represents the northernmost colonial site in the Pacific Ocean where elephant seals regularly and successfully breed. In addition, Castle Rock NWR is part of one of the largest haul-outs for California sea lion in northern California, and a key haulout for a local breeding population of the federally endangered Steller sea lion.

Castle Rock NWR is fringed by a lush intertidal zone and surrounded by waters rich with marine resources. This intertidal zone and near shore habitat provide rich feeding grounds for seabirds and pinnipeds that also use the island.

3.6.2. Castle Rock NWR Physical Geography and Climate

The coastal habitats of Del Norte County have a Mediterranean climate, characterized by moderate temperatures and heavy precipitation with many foggy days throughout the year (HC 2001). The area receives over 50 inches of precipitation annually, with the majority occurring from October through April (WRCC 2007). Table 8 displays the average monthly and annual precipitation data for Crescent City (WRCC 2007). Prevailing winds during spring and summer are from the north and northwest (WRCC 2007). Winter storms can bring winds, generally from the south or southwest, sometimes exceeding 55–75 miles per hour.

Ocean Climate and the California Current System

The California Current System, which extends from Baja Mexico to British Columbia, is a complex and extremely productive system of currents, counter currents, undercurrents and other oceanographic processes, such as upwelling, that supports millions of breeding and seasonally migrating seabirds. Surface flow along the northwest California coast (north of Point Conception) is generally northward during winter, but during the spring there is a dramatic reversal, or "spring transition," as the current shifts to predominantly southward. Upwelling of cold, nutrient-rich waters along the coast is greatest in spring and summer, coincident with seabird breeding seasons. Contours of the coastline, ocean floor topography and weather all contribute to spatial and temporal variability in the system, such as variable upwelling. Murres, gulls and shearwaters are the most abundant seabirds in the California Current System.

Large Scale Oceanic and Climate Processes

El Niño, La Niña, the Southern Oscillation, and currents are linked via changes in global pressure systems of the southwestern Pacific Ocean (Southern Oscillation). The connection of El Niño and La Niña with the Southern Oscillation has led to the acronyms, ENSO (El Niño Southern Oscillation) and LNSO (La Niña Southern Oscillation). Declines and increases in zooplankton, squid, and fish populations that compose the food webs of most seabirds in the Pacific Ocean can be linked directly to a variety of physical oceanographic changes that occur during ENSO events. Periodic El Niño ocean

warming conditions occur every 4–7 years. During El Niño, biological productivity in the upper water column declines markedly, with resulting negative effects on survival and reproduction of seabirds. The inverse of El Niño is La Niña, a periodic condition that results in ocean cooling. During La Niña, enhanced upwelling has positive effects on food web development and seabird productivity.

Seabird responses can vary in relation to the intensity and timing of each El Niño. Life history and demographic parameters affected by El Niño and La Niña include reproductive success, adult mortality, mortality of hatch-year birds, colony attendance, and breeding effort. Starvation is the likely cause of increased mortality of young and adults, but direct evidence of this mechanism is often lacking. El Niño has been linked to the population dynamics of seabirds, suggesting an important natural mechanism for understanding seabird population changes. In contrast, strong La Niña years may result in the production of exceptionally large cohorts which can sustain seabird populations for decades.

Pacific Decadal Oscillation

In addition to ENSO/LNSO there are other natural oceanic climatic cycles that occur on time scales of decades or centuries. In the North Pacific, one of these long cycle marine climate shifts is called the Pacific Decadal Oscillation (PDO). The PDO can be thought of as an El Niño-like event that operates on a time scale of decades, with a 50–60 year periodicity of warm and cold phases.

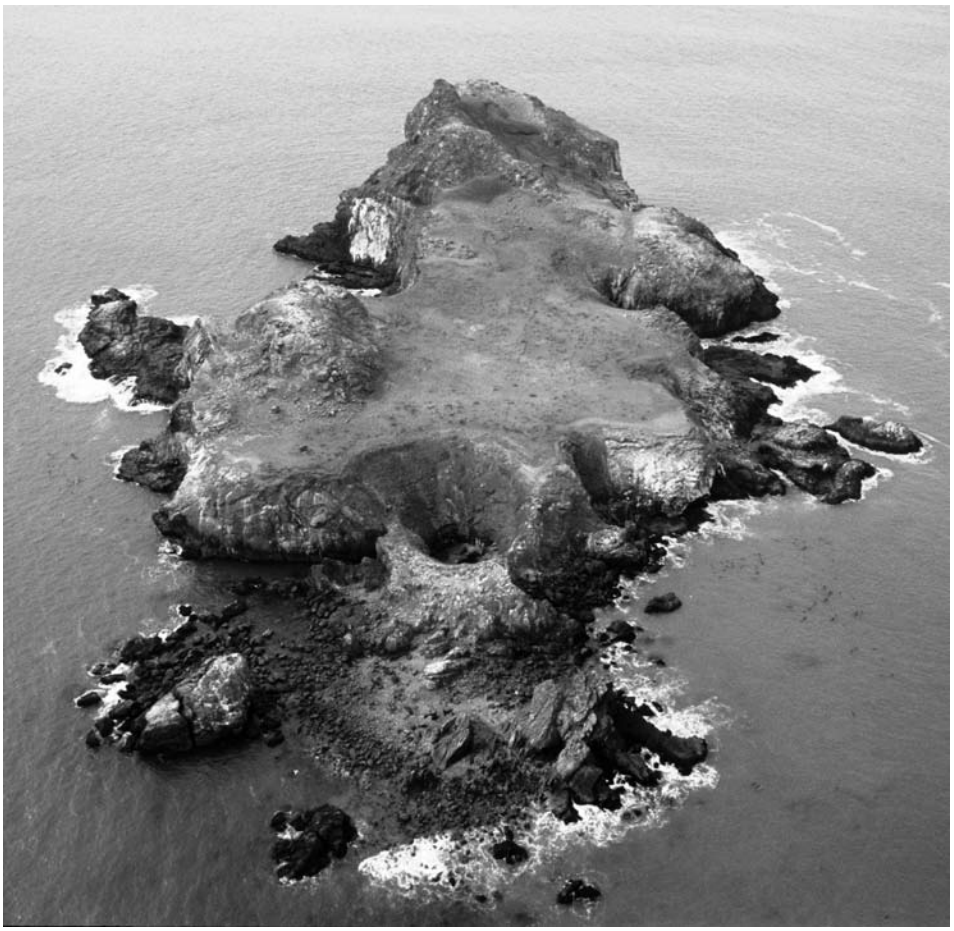
Biological communities have historically responded to PDO-related ocean warming and cooling in the Pacific Ocean. There have been few studies of the effects of long-term ocean climate shifts on seabirds. In California and Hawaii, some seabirds showed long-term declines in productivity, while others did not after the PDO shifted from a cool to a warm phase in 1976–1977. However, after a hypothesized shift back to a cool era in 1998–1999, colony data from the Farallon Islands NWR clearly demonstrated an increase in productivity for six species of seabird.

Functional relationships between seabird life history parameters, demographic traits, and environmental conditions have rarely been documented, yet knowledge of such relationships is critical to understanding the causes of seabird population fluctuations in relation to climate variability and change. Developing an understanding of the relative effects of anthropogenic and natural factors on ocean warming at multiple temporal scales remains a serious conservation challenge.

Table 8. Monthly and annual precipitation data for Crescent City, CA (near Castle Rock NWR), from 1948 through 2007 (adapted from WRCC 2007).

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Average Max. Temperature (F)	54.0	55.7	56.9	59.1	62.0	64.9	66.9	67.4	67.7	64.2	58.4	54.8	61.0
Average Min. Temperature (F)	39.6	40.5	41.0	42.5	45.3	48.3	50.6	50.9	49.1	46.2	42.8	40.2	44.7
Average Total Precipitation (in.)	11.68	9.90	8.97	5.40	3.49	1.60	0.45	0.61	1.86	5.24	9.86	11.61	70.66
Average Total SnowFall (in.)	0.4	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.7
Average Snow Depth (in.)	0	0	0	0	0	0	0	0	0	0	0	0	0

Period of Record : 1/ 1/1893 to 12/31/2007
Percent of possible observations for period of record.
Max. Temp.: 95.2% Min. Temp.: 95.1% Precipitation: 97.4% Snowfall: 99.7% Snow Depth: 99.7%
Source of data: http://www.wrcc.dri.edu/summary/Climsmnca.html



Castle Rock seen from overhead. Aerial photograph taken on 25 February 2006 by D. Jaques from a U.S. Coast Guard helicopter.

3.6.3. Castle Rock NWR Climate Change and Sea Level Rise

Castle Rock NWR is a 14-acre island, which offers essentially no opportunity for geographic migration by terrestrial plant communities. If the ambient climate becomes intolerable for a resident plant species, then local extirpation of that plant species is very likely.

Much of the productivity of the California's open coastal habitat is directly or indirectly related to upwelling caused as currents and winds move water offshore (Hunt 1995). Upwelling is a wind-driven process in which colder, nutrient-rich waters from the depths are brought to surface waters where plankton utilize the nutrients for growth, fueling increased productivity in higher trophic levels. If historic changes in the upwelling, and resulting productivity of the California Current System, occur and are amplified by global climate change, then impacts to seabird and marine mammal food sources could be substantial. Little evidence is available to accurately predict changes to the California Current System over time as the climate warms. However, fluctuations in upwelling can produce major impacts on biological productivity. Impacts on productivity, correlated with reduced upwelling, include large-scale seabird deaths recently observed along the coasts of California and Oregon (CSG 2007).

3.6.4. Castle Rock NWR Geology, Hydrology, and Soils

Castle Rock NWR is located within the geographic boundary of the Coast Range of northern California. The Coast Range geological province is located along the coastal portion of the Klamath ecoregion from Sonoma County to the Oregon border. It includes the entire watershed of most of the smaller coastal streams, as well as portions of the Smith River and Klamath River hydrobasin. It consists of

a system of north and northwest trending mountain ridges and valleys formed by folding and faulting. The geologic history of this province is complex. The exposed stratigraphy suggests long periods of marine deposition, plutonic intrusion (igneous rocks that solidify below the earth's surface), and intermittent volcanic activity and orogeny (mountain building from plate tectonics) (Cooperrider and Garrett 1998). The predominant formation in the Coast Ranges is the Franciscan Complex of Upper Jurassic (~160 to 136 million years ago) and Lower Cretaceous (beginning ~136 million years ago) age. Franciscan Complex rocks include graywacke, metagraywacke, argillite, greenstone, chert, blueschist, and associated ultramafic rocks and serpentine. Over millennia, these rocks have undergone periods of intense folding, faulting, and deformation associated with the complex process of tectonic plate movement. The rivers of this province mostly run south/north or north/south paralleling the underlying rock formations and fault lines.

Castle Rock is associated with the Smith River Plain and emerged marine terrace (Osborne 1972, USFWS 1978). The plain covers an area of about 60 square miles and is composed of geologic formations from the Jurassic age to recent times. Castle Rock is of the Franciscan Formation. It has a base of pillow basalt which extends 200 feet high on the west end. The east end of the island is largely greywacke and shale. The south and west aspects of the island are largely barren cliffs. The northwest portion of the island slopes downward to the water at a 30 degree angle. There is soil on the northern and eastern slopes of the island. A rocky yellow-sandy subsoil exists on the relatively flat portions of the island. This soil layer is reportedly up to 25 feet deep and is the product of late Pleistocene era deposits. The topsoil above this has been described as a dark organic humus layer 6–12 inches deep (Osborne 1972).

There are faults in the island running north-south which have been eroded by waves forming large caves on the southern side. Near the east side of the island, one of these faults has collapsed forming an open "pit" 100 feet in diameter and connected to the sea by a cave.

3.6.5. Castle Rock NWR Minerals

There are no known mineral deposits on Castle Rock NWR. Prior to the purchase by the Nature Conservancy in 1979, speculators were contemplating guano mining and rock quarrying on the island.

3.6.6. Castle Rock NWR Paleontological Resources

No known paleo-faunal remains occur within the approved refuge boundaries of Castle Rock NWR.

3.6.7. Castle Rock NWR Water Resources

There are no permanent water resources on Castle Rock NWR. Plant communities survive on water supplied through precipitation and fog.

3.6.8. Castle Rock NWR Hazardous Materials

No area within the Castle Rock NWR is listed as a hazardous waste site by the U.S. Environmental Protection Agency.

3.7. Castle Rock NWR Biological Resources

3.7.1. Castle Rock NWR Ecoregional Context

The California North Coast Ecoregion represents the southern extension of the temperate rain forests of the U.S. Pacific Northwest (TNC et al. 2005). The cool, foggy coastal climate supports coastal redwood forests and the resident flora and fauna that depend on these forests.

3.7.2. Castle Rock NWR Fish and Wildlife

Castle Rock NWR, and portions of the surrounding environment, is an important stopover for migratory birds, as well as important breeding habitat for resident birds.

In addition to providing breeding habitat for many species of birds, Castle Rock NWR and the surrounding sea rocks and reefs offer haulout sites for resident and migratory pinnipeds, including species of seal and sea lion. Given the sensitivity of Castle Rock's bird nesting habitat, no formal surveys for resident terrestrial mammals, reptiles, or amphibians have been completed so information about such groups is historic, speculative or anecdotal.

3.7.3. Castle Rock NWR Plant Communities

Osborne (1972) developed a rough map of the major cover types (Figure 11), and listed the most common plant species on Castle Rock based on island visits in 1970. John Sawyer visited the island in 1984 and developed a plant list (modified in Appendix J: Plant list for HBNWRC). Both investigators described

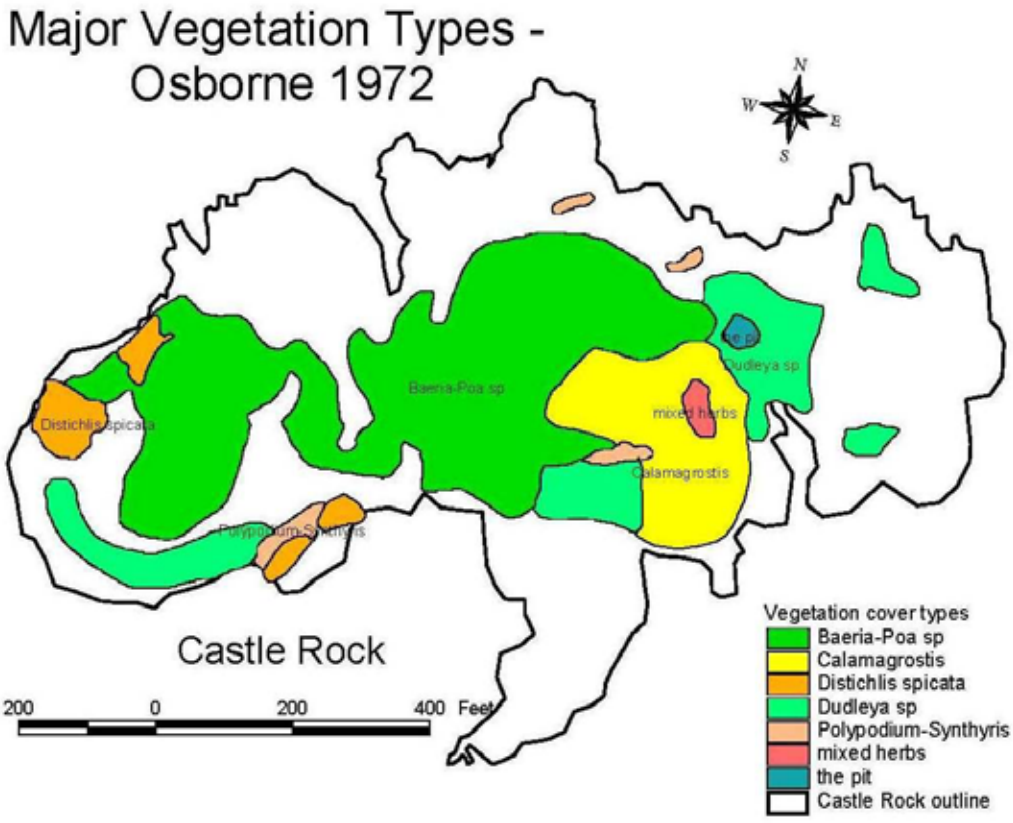


Figure 11. Historic vegetative cover map of Castle Rock. (Note: Baeria has been renamed Lasthenia.) Figure adapted from Osborne (1972) and converted into ArcView format by D. Jaques.

apparent trends in plant community composition and soil erosion.

In the early 1970s, Osborne (1972) found two primary plant cover types on the eastern flat (meadow) and northern slopes, an area dominated by maritime goldfields (*Lasthenia maritima*), annual blue grass (*Poa annua*), sand spurrey, and lesser swine cress (*Coronopus didymus*), and an area covered with a dense growth of Pacific reedgrass (*Calamagrostis nutkaensis*) and a host of mixed herbs. In 1984, Sawyer noted that the meadow was covered with sand spurrey and goldfields. Clumps of Pacific reedgrass on the plains in areas with deeper soils were intermixed with other coastal scrub plants, such as coast angelica (*Angelica hendersonii*), rush, and sedge.

Plants growing in rocky areas during the surveys included bluff lettuce (*Dudleya farinosa*), brome (*Bromus* sp.), seaside daisy, and leather leaf fern (*Polypodium scouleri*). The protected portion of the north side of the island supported miner's lettuce (*Claytonia perfoliata*, syn. *Montia perfoliata*), snow queen (*Synthris reniformis*), and leather leaf fern, with a few pockets of salt grass.

Changes in Castle Rock NWR Plant Communities

Over the last century, the area covered with reedgrass has receded and been replaced with goldfields and sand spurrey. The cause of the decrease in reedgrass has been attributed to the increase in the Brandt's cormorant breeding population on Castle Rock (Osborne 1972). Osborne observed cormorants using reedgrass almost exclusively for nesting material when it was readily available. He also suggested that Canada geese might be having some impacts on vegetative changes at Castle Rock. At that time, only up to 600 geese were using the island for roosting and grazing (compared to up to 20-25,000 currently). Sawyer (1984) stated that the loss of reedgrass was indicative of a more extensive problem of heavy erosion of the habitat overall.

In recent years, thousands of roosting Aleutian cackling geese and breeding seabirds have appeared to impact the short-term status of vegetation at Castle Rock NWR, with long-term impacts likely. The geese cause a general browning of the spring vegetation due to trampling, foraging, and intensive fecal output. The vegetation greens up and grows

back lushly by the peak incubation time of most seabirds. Breeding seabirds, and lack of summer rain, cause a second death of vegetative growth due to use of island plants for nest material, trampling, and effects of guano. By mid to late summer, the island appears more white and brown than green. Temporary vegetation loss is likely to affect long-term soil erosion on the island (Osborne 1972, Sawyer 1984, Jaques and Strong 2001), particularly during the rainy season. Accelerated soil erosion could have long-term negative impacts on burrow-nesting seabird habitat.

There has been no recent assessment of the ratio of native versus non-native plant communities at Castle Rock NWR. The USFWS Seabird Conservation Plan (2005) states that non-native plants can displace native plants and may limit or degrade seabird nesting habitat. Non-native plants may have shallow root systems that do not stabilize the soil as well as native vegetation and consequently effect burrow stability.

3.7.4. Castle Rock NWR Seabirds

Castle Rock NWR provides habitat for one of the largest, most diverse, and densely populated seabird breeding colonies in the California Current System (Tables 9 and 10). It is one of only five sites in the California Current System that supports more than 100,000 nesting seabirds. Castle Rock NWR is known as the second largest seabird colony south of Alaska, after Southeast Farallon Island. This ranking is based on population levels that include rough historical estimates for nocturnal cavity nesting seabirds, whose status is currently unknown. Common murres comprise the majority of the breeding seabird population at both Castle Rock NWR and SEFI. Due to annual variability in murre breeding effort between the two sites, Castle Rock NWR may be the largest seabird colony south of Alaska in some years.

The relative importance of Castle Rock NWR on a statewide and regional scale has been established by large-scale inventories. Two statewide surveys of all breeding species have been conducted in California, in 1975–1980 (Sowls et al. 1980) and in 1989–1991 (Carter et al. 1992). The last statewide inventories of all species in Oregon and Washington were conducted in 1988 and 1978–1982, respectively (Speich and Wahl 1989, USFWS in prep). More recently, large-scale inventories have focused on aerial surveys of only murres and cormorants.

Castle Rock NWR was the second largest seabird colony in California, following closely behind the Farallon Islands NWR during the last statewide survey. The total breeding population estimate

Table 9. Complete seabird breeding population estimates on Castle Rock, 1970 to 1989.

	Estimated Number of Nesting Birds		
Species	**1970 (a)**	**1979-80 (b)**	**1989 (c)**
Fork-tailed Storm-petrel	<200	100	100
Leach's Storm-petrel	5,000	5,000	1,646
Brandt's Cormorant	1,758	2,200	2,490
Pelagic Cormorant	100	340	392
Black Oystercatcher	2	6	4
Western Gull	1,200	1,350	1,370
Common Murre	80,000	126,000	108,318
Pigeon Guillemot	250	800	360
Cassin's Auklet	3,600	3,600	5,638
Rhinoceros Auklet	150	200	1,034
Tufted Puffin	50	100	82
TOTAL	**92,310**	**140,596**	**121,434**

Data from Osborne (1972) (a), Sowls et al. (1980) (b), and Carter et al. (1992) (c).

at Castle Rock NWR was 122,000 birds in 1989, compared to about 128,000 at SEFI (Carter et al. 1992). In 2004, the Castle Rock NWR murre estimate alone was over 138,000 birds (Capitolo et al. 2006). Castle Rock supports about 8,600 breeding birds per acre, compared to about 1,300 birds per acre at SEFI. Eleven species of seabirds breed at Castle Rock NWR, which represents all of the island breeding seabird species in California north of Point Reyes. Five are surface nesters: the common murre; Brandt's, pelagic, and double-crested cormorants; and western gull. The remaining six species are cavity nesters: fork-tailed and Leach's storm-petrels; Cassin's and rhinoceros auklets; pigeon guillemot; and tufted puffin. One species of shorebird, the black oystercatcher, also breeds on the island. Castle Rock NWR is the site of the largest common murre colony in California (Capitolo et al. 2006) and supported substantial portions of the California total of six species during the last

statewide survey: fork-tailed storm petrel (24 percent), leach's storm-petrel (19 percent), common murre (31 percent), Cassin's auklet (10 percent), rhinoceros auklet (58 percent), and tufted puffin (30 percent) (Carter et al. 1992).

3.7.5. Castle Rock NWR Nesting Seabirds

Fork-tailed Storm-petrel

The fork-tailed storm-petrel is widely distributed throughout the North Pacific. It is separated into two subspecies; *Oceanodroma furcata plumbea* breeds along the west coast of North America from southern Alaska to northern California (Osborne 1972, Harrison 1983). There are about 5,000 breeding birds on the west coast of the U.S., excluding Alaska, with an estimated 400 pairs in California (USFWS 2005). The fork-tailed storm-petrel is a pelagic seabird that feeds primarily offshore, near the continental shelf break in summer, and further offshore in the non-breeding season (Briggs et al. 1987). Its diet consists of planktonic crustaceans, and fish and animal detritus from the ocean surface (Boersma and Silva 2001). It breeds colonially in crevices and burrows on rocky islands, and is nocturnally active at breeding colonies (Boersma et al. 1980).

Castle Rock NWR is near the southern limit of the fork-tailed storm petrel species range and, according to very limited historic information, appears to be the second largest fork-tailed storm-petrel colony in California (Carter et al. 1992). The fork-tailed storm petrel breeding population at Castle Rock NWR has never been scientifically assessed due to inherent survey difficulties. Their presence on Castle Rock NWR has been established through mist-netting as well as auditory cues. In 1970 (16 May), Osborne captured two FTSPs, and suggested that the total population was probably fewer than 100 pairs. The next mist-netting effort took place in 1989 (Sept. 12–13), when six fork-tailed storm petrels were captured in a mist-net located in the "saddle" of the meadow. FTSPs also were heard calling near the east end of the island on 21–22 August. Until new information is collected, the only definitive statement that can be made is that they were present in the early 90s.

The fork-tailed storm petrel is one of the earliest breeding seabirds in northern California. First landfall at Little River Rock was February 25 (Harris 1974). Egg dates range from March 22 to June 18 (Clay 1925, Dawson 1923, Harris 1974). Local chick records range from June 11 to August 9 (Osborne 1972).

Leach's Storm-petrel

The Leach's storm-petrel is one of the most widely distributed procellariform (in the order Procellariiformes, or tube-nosed seabirds) species in the northern hemisphere. They breed from Japan to Guadalupe, Mexico, in the Pacific, and also in the Atlantic (Huntington et al. 1996). The subspecies in northern California is *Oceanodroma leucorhoa leucorhoa.* The population estimate for the U.S. west coast, excluding Alaska, is nearly 500,000 birds, with about 90 percent of these breeding in Oregon. The number of storm petrel colonies in California north of Cape Mendocino was reduced from 11

Table 10. Population estimates for surface nesting and diurnal cavity nesting species at Castle Rock, 1979-1999.

	Estimated Number of Nesting Birds				
Species	**1997 (a)**	**1998 (a)**	**1999 (a)**	**2003 (b)**	**2004 (b,c)**
Common Murre	75,246	51,138	97,996	104,381	138,104
Pigeon Guillemot	288	269	260	nd	324
Tufted Puffin	12	6	24	nd	9
Brandt's Cormorant	1,638	1,380	1,208	2,068	3,122
Double-crested Cormorant	44	58	80	272	116
Pelagic Cormorant	372	80	308	nd	534
Western Gull	nd	662	698	nd	nd
TOTAL	77,600	53,593	100,574	106,721	142,209

from Jaques and Strong (2001) (a), Capitolo et al. 2006 (b), and Jaques (2004) (c). The murre estimate is the raw count times a correction factor of 1.67; the cormorant estimate is derived from the number of nests directly counted times 2.

historic sites to five known sites by 1969 (Harris 1974). There is evidence of a continued decline of this species in California (Carter et al. 1992). The Leach's storm petrel is a pelagic seabird that is most abundant seaward of the continental shelf, and closer to shore during the breeding season. Its diet includes plankton and small nekton, concentrated at the surface. These petrels nest in burrows or crevices. They feed during the day and move to and from breeding colonies only at night.

Leach's storm petrels arrive at northern California breeding colonies and begin courtship activities early in the spring. The earliest landfall detected in the region was 12 February (Osborne 1972). Harris (1974) found courtship and intensive burrow construction from March to May. Eggs have been reported from 7 May to 24 July (Clay, unpubl.). Small numbers of birds may be found at northern California colonies as late as October (Osborne 1972).

Leach's storm petrels at Castle Rock have been strongly associated with reed grass vegetation on the east end of the island. Osborne (1972) estimated 2,500 pairs of Leach's storm petrels nesting under the grass, and found their burrows nowhere else on Castle Rock NWR. That vegetation now appears to be extirpated from the island. The vegetation on Castle Rock NWR is directly affected by surface-nesting seabirds and non-breeding Aleutian cackling geese.

Double-crested Cormorant

The double-crested cormorant on the Pacific coast is one of five subspecies recognized in North America. The breeding range of this subspecies extends from Mexico to Canada. Post-breeding dispersal occurs along the Pacific coast, but major migratory movements have not been described. The continental population has been estimated at about two million birds (USFWS 2003b). Since the 1970s, numbers of this species have increased significantly in many regions of North America. Many negative impacts have been associated with this increase, prompting legal and illegal actions to control numbers in various places of the U.S. (Wires et al. 2001).

On the California coast the total number of double-crested cormorants nests in 2001–2003 was about 6,500 at 42 colonies (~940 (1975-80), 4,300 (1989-91), and 6,160 (2001-03); Capitolo et al. 2004b). Most of the increase in northern California between 1990 and 2003 was due to two new colonies in Arcata/Humboldt Bay (Teal Island and Arcata Bay Sand Island) This nest count was 48 percent higher than in 1989–1991 and almost six times higher than in 1975–1980. One of the three largest colonies in northern California is located just north of Castle Rock at Prince Island.

The double-crested cormorant uses a variety of nest habitat types. It constructs nests of vegetation in trees, islands, and a variety of artificial structures. It is known to denude vegetation and have negative effects on habitats shared with other species. Double-crested cormorants nest earlier than other coastal cormorants (Ainley and Boekelheide 1990, Carter et al. 1992). Egg laying may begin as early as late March in northern California; hatching takes place from late April to mid-August (Sowls et al. 1980).

Double-crested cormorants were first documented nesting at Castle Rock in 1997 (Jaques and Strong 2001). The colony increased from 29 nests in 1997 to an estimated 136 nests in 2003 (Capitolo et al. 2004b).

In 1997, double-crested cormorants were observed building nests in tall vegetation at the southeastern rim of the island (Jaques and Strong 2001). After 1997 it was not possible to see all nests from shore. Large chicks were observed creching in the nesting area in mid to late July each year from 1997–1999.

Since at least 2001, double-crested cormorant nesting has moved from exclusively at the eastern rim of Castle Rock NWR to various regions, including the western peak of the island (P. Capitolo, UCSC, pers. comm.). Capitolo et al. (2004b) reported that it is difficult to distinguish double-crested cormorant nests from those of Brandt's cormorant in the aerial photographs of Castle Rock because few stick nests were obvious there. Jaques (2004) observed that cormorants use vegetation from the island itself to build nests, and that there was no tall vegetative growth remaining on the eastern rim by 2004.

Double-crested cormorant productivity and chronology is relatively immune to variability in ocean conditions compared to other cormorants (see Capitolo et al. 2004a). The double-crested cormorant was one of only two seabird species breeding on Castle Rock NWR that did not demonstrate a negative response to ENSO conditions in 1998 (Jaques and Strong 2001). There was no apparent effect of the 2003 ENSO on this species' breeding status in California (Capitolo et al. 2004a). The consistent increase in the double-crested cormorant population in northern California likely reflects the fact that double-crested cormorants forage opportunistically in estuaries and fresh water bodies, as well as coastal waters of the region

(Ainely and Boekelheide 1990, Carter et al. 2001, Jaques and Strong 2001, Capitolo et al. 2004a).

Brandt's Cormorant

The Brandt's cormorant breeds only along the west coast of North America. Approximately 75 percent of the population breeds in California and Oregon. Some small colonies have occurred as far north as Alaska, and others exist as far south as southern Baja California. Post-breeding dispersal takes place out of central California, but no consistent movement pattern or direction has been established (Briggs et al. 1987). The total population has been estimated at more than 100,000 birds (USFWS 2005). A statewide nest count in California in 2001–2003 totaled 27,000 nests at 97 active colonies. These data indicated a 29 percent decline in the population between 1989–1991 and 2001–2004, but were similar to numbers reported in 1975–1980 (Capitolo et al. 2004a).

Brandt's cormorants nest in colonies on islands or cliffs with relatively flat ledges (Wallace and Wallace 1998). Nests are made of terrestrial plants or seaweed collected from the land or sea, or stolen from other nests. Nest building in northern California generally begins in April, and eggs are laid in May (Osborne 1972, Carter et al. 1992). Breeding chronology may be related to the onset of upwelling at different locations (Boekelheide et al. 1990). Nesting can be significantly depressed during ENSO and post-ENSO years; the degree of response has been related to intensity and timing of warm events. Brandt's cormorants will abandon nest sites en masse if food supplies decline midseason (Boekelheide et al. 1990).

Castle Rock NWR supported the third largest colony of Brandt's Cormorant in California during the last series of statewide surveys in 2003 (Capitolo et al. 2004a). This was a decrease of about 9 percent since the 1989 survey. The statewide population reportedly declined 25 percent from 1989 to 2003. In 2004, the numbers of Brandt's cormorant nests at Castle Rock increased. There were 1,561 nests present (Capitolo et al. 2006), which was the greatest number of nests ever recorded at the island.

Jaques and Strong (2001) reported much lower Brandt's cormorant nest counts at Castle Rock in 1997–1999 (604–819 nests), but breeding during much of that period was strongly affected by ENSO conditions. Major nest abandonment occurred in 1998. Nest counts at Castle Rock in 1970 and 1980 totaled 879 and 1,100, respectively (Osborne 1972, Sowls et al. 1980). These data probably reflect fluctuation in the population related to oceanographic variability and availability of prey (Capitolo et al. 2004). No major disturbances or oil spill impacts have been documented for this breeding population.

Brandt's cormorants roost on Castle Rock NWR in March, and begin forming colonies as early as the first week of April. Roosting Aleutian geese and Brandt's cormorants overlap during this period, but Jaques (2004) found no evidence of direct interference between geese and cormorants.

Brandt's cormorants use vegetation growing on Castle Rock to build nests (Osborne 1972, Jaques and Strong 2001, Jaques 2004). Historically, Brandt's cormorants preferred Pacific reedgrass, but as it is no longer available they use maritime goldfields and other plants. A major loss of protective vegetation and soil was reported at Castle Rock NWR in the early 1970s by Osborne (1972), who believed that the primary cause of the habitat degradation was removal of vegetation by nesting Brandt's cormorants.

Pelagic Cormorant

The pelagic cormorant breeds from northern Baja California to the Bering Sea, and south in the Northwest Pacific to Japan (Hobson 1997). The subspecies *Phalacrocorax pelagicus resplenens* breeds from Baja to British Columbia. About 29,000 birds, more than 40 percent of the global population, breed in Washington, Oregon, and California (USFWS 2005). Pelagic cormorants nest on cliff ledges on islands and mainland shores, and occasionally use artificial structures (Carter et al. 1992, Hobson 1997). Pelagic cormorants are very sensitive to changes in oceanographic conditions, such as ENSO events, and breeding effort and success can vary greatly on an annual basis (Ainley and Boekelheide 1990). Food supply also influences laying dates and variations in hatching and fledging dates in California (Boekelheide et al. 1990). Pelagic cormorants are extremely vulnerable to human disturbance at breeding areas (Verbeek 1982, Siegel-Causey and Litvinenko 1993).

Pelagic cormorants breed on cliff ledges all around the shoreline of Castle Rock NWR. Breeding activity has increased greatly since 1970 when only about 50 nests were reported (Osborne 1972). A record 267 nests was found during the most recent survey in 2004, indicating a breeding population of 534 birds (Jaques 2004 unpublished data). The breeding population ranged between 300-400 birds during 5 surveys conducted from 1979 to 1999, with the exception of 1998 (Sowls et al. 1980, Carter et al. 1992, Jaques and Strong 2001). In 1998, only 25 nests were built, probably due to ENSO conditions that year (Jaques and Strong 2001).

Western Gull

The western gull is endemic to the west coast of North America, and breeds from central Baja California to southern Washington (Pierotti and Annett 1995). There are two subspecies, with *Larus occidentalis occidentalis* occurring on the outer Pacific coast. The total subspecies population has been estimated at 80,000 to 126,000 breeding birds (USFWS 2005), including about 62,000 in California (Carter et al. 1992). Numbers have increased in California since the early 1900s (Pierroti and Annett 1995). The statewide survey in 1989–1991 indicated that the population has continued to grow since 1975–80 (Carter et al. 1992). Most California western gulls breed on the Channel Islands and Southeast Farallon Island NWR. Their relatively small population size and limited range make them a vulnerable species worthy of regional management concern (Pierotti and Annette 1995, USFWS 2005).

Castle Rock NWR supports the largest western gull colony in California north of the Farallon Islands, and represented 2 percent of the statewide breeding population with 1,370 breeding birds in 1989 (Carter et al. 1992). This was a slight increase over 1970 and 1979–1980.

Common Murre

The common murre is one of the most abundant seabirds in the Northern Hemisphere, with a breeding population of 13 to 21 million birds (Ainley et al. 2002). It is also one of the most intensively studied avian species in the world. Five subspecies are recognized; *Uria aalge californica* breeds from British Columbia to central California. Common murre breeding populations in California have been monitored more thoroughly than any other coastal nesting seabird in the state. Common murres in central California have been depressed due to gill net fisheries, oil spills, and ENSO events (Carter et al. 2001). The most recent surveys of sample colonies indicate that the common murre population in northern California is currently experiencing a general long-term population increase (Capitolo et al. 2006).

Castle Rock NWR supports the largest common murre breeding colony in the state of California. These birds comprise about 90 percent of the total seabird population. Recent aerial survey data suggest that the population has fluctuated since 1989, but has not declined over the longer term. Murre numbers at Castle Rock NWR and other northern California colonies were low during 1997–1999, a period of anomalous ocean conditions (Jaques and Strong 2001, Capitolo et al. 2004). Murres counts were comparable to 1989 numbers during 2001 and 2003 (Capitolo et al. 2006). The most recent raw count in 2004 was significantly greater than any counts over the past few decades (Capitolo et al. 2006), indicating a healthy, possibly growing, breeding population of murres on Castle Rock NWR. Adjusting the raw count of birds by a standard correction factor (Carter et al. 2001) results in an estimate of over 138,000 murres present in 2004.

Murres reside at Castle Rock NWR throughout the winter, beginning by mid-November, but residence patterns have not been methodically evaluated. Pre-breeding season presence at the colony was monitored in 2004 in conjunction with observations of roosting Aleutian geese (Jaques 2004). Murres were present at dawn each morning in March and April and overlapped with thousands of geese departing the roost.

Pigeon Guillemot

The pigeon guillemot is endemic to the North Pacific and occurs from Alaska to southern California (Ewins et al. 1993). There are five recognized subspecies; *Cepphus columba eureka* breeds in Oregon and California. The California breeding population was estimated at about 15,500 nesting birds at 235 colonies during the most recent statewide survey in 1989 (Carter et al. 1992). Pigeon guillemot are a diurnally active, cavity-nesting species (Ewins et al. 1993).

The statewide pigeon guillemot population appeared to be stable from about 1979 to 1989, however, estimates for Del Norte and Humboldt County had decreased by about 40 percent over the 10 year period (Carter et al. 1992). Competition for nest sites and an expanding rhinoceros auklet population may cause declines in pigeon guillemot numbers where nest sites are limited (Ainley and Boekelheide 1990).

Castle Rock NWR supports the largest pigeon guillemot colony in northern California and has accounted for 2 percent of the statewide population (Carter et al. 1992). Pigeon guillemot nest in rock crevices as well as burrows in the soil at Castle Rock NWR. The greatest concentration of birds occurs in the talus slope on the east end of the island.

Cassin's Auklet

The Cassin's auklet breeds from the Aleutian Islands in Alaska south to Baja California. During the non-breeding season, these alcids (birds in the Family Alcidae) spend most of their time at sea, often seaward of the continental shelf (Manuwal and Thoresen 1993). Individuals may visit the breeding colony in any month at southerly breeding colonies. They feed primarily on small crustaceans, as well

as squid and fish. Cassin's auklets nest in shallow burrows, small rock crevices, or under trees on the ground. They move to and from nest sites at night to avoid predation. There are two subspecies; the northerly population, *Ptychoramphus aleuticus aleuticus,* occurs in the California Current System. The core of the population breeds in British Columbia. Population declines have been reported in Canada and California. Introduction of predators and changes in food supply are cited as major causes of population change. The species will accept artificial nest boxes, which have been used as a research tool.

The presence of Cassin's auklets at Castle Rock NWR was first noted by Clay in 1934. Thoreson found a juvenile Cassin's auklet in a burrow in late August, 1958 (Thoreson 1964). Thoreson placed 25 artificial burrows constructed of wood on Castle Rock in October 1958, and returned on 26 April 1959 to find that none of the boxes were occupied. An inspection of five burrows on the same date found two Cassin's auklets incubating eggs. Thoreson discontinued further investigations on Castle Rock due to hazardous landing conditions on the island and because "none of the auklet burrows was sufficiently shallow to observe without great disturbance and certain desertion by the birds."

Rhinoceros Auklet

The rhinoceros auklet breeds in the North Pacific from the Channel Islands in southern California up through the Aleutian Islands and south to Japan (Gaston and Dechesne 1996). The North American population is roughly estimated at about one million birds. About 73 percent of this population breeds in British Columbia. The species was historically extirpated from Oregon and California; recolonization of islands in the region began in the 1960s and 1970s. The most recent estimate for California was about 1,800 birds at 32 colonies (Carter et al. 1992). Rhinoceros auklets move south after breeding, and the majority of the eastern Pacific nesting population appears to winter in central and southern California (Briggs et al. 1987).

Tufted Puffin

Tufted puffins have historically bred from the Channel Islands in southern California along the Pacific coast to the Aleutian Islands and down to Japan (Piatt and Kitaysky 2002). The world breeding population is estimated at nearly three million birds, about 80 percent of which nest in North America. Puffins were historically far more abundant in California than they are now (Ainley and Lewis 1974, Ainely and Boekelheide 1990, McChesney et al. 1995). The California population is estimated at less than 300 breeding birds (Carter et al. 1992), compared to about 5,000 in Oregon and 22,000 in Washington (Piatt and Kitaysky 2002). Tufted puffin numbers are declining throughout the coasts of California, Oregon, Washington, and British Columbia, but increasing in Alaska. Causes for recent declines have not been determined. However, tens of thousands were killed in offshore fishing nets from the 1950s to 1990s (DeGange and Day 1991). An unknown level of fisheries bycatch continues off of Alaska, Russia, and Japan (DeGange et al. 1993). Tufted puffins winter offshore throughout the North Pacific. Winter and spring population peaks offshore in California were estimated at 10,000 to 20,000 birds (Briggs et al. 1987).

The tufted puffin is a diurnally active cavity nester. Nests are typically excavated in deep vegetated soil on steep slopes or plateaus, but birds will use rocky crevices for nesting when available (Piatt and Kitaysky 2002). Populations are monitored by direct counts of birds, as well as burrow/plot counts.

Castle Rock NWR supported an estimated 50 percent of the California tufted puffin population in 1979–80 (Sowls et al. 1980). This refuge was thought to be the largest tufted puffin colony in California in 1989–1991, with an estimated 82 breeding birds (Carter et al. 1992). The sporadic record of direct counts for tufted puffins at Castle Rock indicates a gradual decline since at least 1970. In 1970, up to 56 puffins were counted (Osborne 1972), compared to a peak count of 24 birds in 1999 (Jaques and Strong 2001) and 9 birds in 2004 (Jaques 2004). The trend suggests that the species may soon become extirpated as a breeding bird at Castle Rock NWR.

Changes in prey conditions, competition with rhinoceros auklets (Ainley et al 1994, McChesney et al. 1995), and habitat degradation due to soil erosion have been cited as possible causes for tufted puffin population suppression in central California and Oregon. These factors may be relevant at Castle Rock NWR as well. Rhinoceros auklet numbers at Castle Rock NWR increased greatly from 1979–1989 (Carter et al. 1992). In addition, western gulls interfere with tufted puffins at Castle Rock NWR (Jaques and Strong 2001). Large gulls are one of the primary problems for puffins in other areas (Nettleship 1972, Vermeer 1979). Tufted puffins rely on vegetation to help shield them from diurnal interference and piracy from gulls. Changes in vegetation cover and height have occurred at Castle Rock NWR due to geese, surface-nesting seabirds, and sea lions. Soil erosion in burrow-nesting areas has occurred in denuded areas. Thus, other native species may be degrading the quality of the habitat for tufted puffins, and indirectly exacerbating problems with western gulls.

Tufted puffins arrived at Castle Rock during the first week of April in 2004 (Jaques 2004). The birds occupy nest habitat about 1 week after arriving (Piatt and Kitaysky 2002). Eggs are expected to be laid at Castle Rock by early to mid-May, and the incubation period is estimated at about 42–43 days based on other studies (Boone 1986, Ainley and Boekelheide 1990). Hatching is expected in late June. The average nestling period is 48 days (Piatt and Kitaysky 2002), with fledging from Castle Rock expected in August.

3.7.6. Castle Rock NWR Other Bird Species

Aleutian Cackling Goose
Aleutian cackling geese use Castle Rock NWR as a night roost and minor foraging area during migration and staging in the Crescent City area. Woolington documented use patterns at Castle Rock from fall 1975 to spring 1977. These studies revealed that the entire known Western Aleutian Islands population staged in the Crescent City area during late March to early April prior to migration to Alaska, with Castle Rock their primary night roost. The Service's proposal to acquire Castle Rock in 1978 was, in part, motivated by knowledge of its critical importance to the goose (USFWS 1978).

Goose-use of the Crescent City area, including Castle Rock NWR, declined as the population increased in Humboldt Bay and southern Oregon (Bachman and Nelson 2005). Peak counts of 27,570 and 27,200 birds were recorded roosting on Castle Rock in March 1999 and 2000, respectively (Strong and Jaques 1999, Lyon 2000). In comparison, the peak count in 2004 was about 20,000 birds (Jaques 2004).

American Black Oystercatcher
The American black oystercatcher is a traditional breeding species at Castle Rock NWR, and is present in the nearby Point St. George area for much of the year. Black oystercatchers were first noted at Castle Rock in 1934 by Fraser (Osborne 1972). These birds nest in small numbers on the rocky shores of the island. The number of nesting pair ranged from 2–3 in surveys conducted from 1979–1998 (Sowls et al. 1980, Carter et al. 1992, Jaques and Strong 2001).

Peregrine Falcon
The peregrine falcon is a common visitor and historic breeder at Castle Rock NWR. Breeding was first documented by Clay in May 1934. The nest site was described as located on the top edge of a steep, grassy slope against a sheer overhanging rock wall on the east slope of the island. A three-week-old chick was present at the eyrie. A peregrine falcon nest with petrel wings around it was documented by Talmage in 1940 (Osborne 1972). Aerial courtship has been seen over Castle Rock in recent years (Jaques and Strong 2001), but breeding has not been documented.

Peregrine falcons forage from various high perches on Castle Rock, and have been noted to chase pigeon guillemots and flush common murres during the breeding season (Jaques and Strong 2001). They can be seen at Castle Rock NWR during all times of year, but seem to be less common during summer (Jaques 2004) when they presumably retreat to breeding territories. Peregine falcons can be an important predator on seabird colonies (Drost and Lewis 1995), and may have been a historical predator when nesting at Castle Rock. There is a strong potential for re-establishment of breeding on the island, which may have ecological implications for Castle Rock NWR.

Barn Owl
Barn owls were historically present at Castle Rock, but their present status is unknown. A barn owl was found in the shepherd's cabin by Fraser in 1934 (Osborne 1972). The cabin has been reduced to a pile of wood on the ground, and there have been no recorded detections of barn owls since then. The barn owl is a potential predator on storm-petrels and other seabirds at Castle Rock NWR.

Common Raven
Common ravens (*Corvus corax*) occur regularly on Castle Rock NWR. A raven nest was observed on the western cliffs of the island in 1999. Active predation by a raven on murre eggs was observed in 2004 (Jaques 2004). It is not known how ecologically important this predator/scavenger is to seabirds at Castle Rock NWR.

3.7.7. Castle Rock NWR and Surrounding Area Marine Mammals

Four species of pinnipeds regularly occur at Castle Rock NWR: Steller sea lion, California sea lion (*Zalophus californianus*), Pacific harbor seal, and northern elephant seal (*Mirounga angustirostris*). Harbor and elephant seals breed on the island, and both California and Steller sea lions use the island regularly as a seasonal non-breeding haulout. The Steller sea lion is the only ESA-listed endangered marine mammal that utilizes Castle Rock NWR habitat. The northern fur seal (*Callorhinus ursinus*) could occur at Castle Rock NWR rarely, but the species has not been documented hauled out on the island. North American river otter are common on the beaches and ocean waters just off Point St. George, but have not been documented on Castle Rock.

Gray whales (*Eschrichtius robustus*) and harbor porpoises are the most common cetaceans inhabiting the waters surrounding Castle Rock NWR. Gray whales are relatively abundant in the area during migration, and sightings of small numbers of these whales occur year round. Gray whales have been observed feeding within two miles offshore in the Crescent City area (Jaques and Strong unpublished data), and likely feed in the waters immediately surrounding Castle Rock NWR.

Pacific Harbor Seal

The eastern North Pacific subspecies of harbor seal (*Phoca vitulina richardsi*) ranges from Baja California, Mexico, to the Pribilof Islands in Alaska. Three separate stocks have been identified for management purposes: 1) inland waters of Washington, 2) Oregon and Washington coast, and 3) California. Harbor seals are generally non-migratory, but move locally in relation to factors such as tides, weather, season, food availability, and reproduction (Carretta et al. 2004).

Harbor seals occur in nearshore coastal and estuarine habitats. They feed in marine, estuarine, and, occasionally, fresh waters. They haul out on relatively flat substrates, including rock reefs, sandspits, and mudflats. Peak numbers haul out at low tides, particularly in the afternoon (Le Boeuf and Bonnell 1980). Harbor seals display strong fidelity for haulout sites (Carretta et al. 2004).

Pacific harbor seal breeding takes place from March to June in California, with peak pupping occurring in April and May. Courtship and mating appear to take place in the water. Females give birth on land, often at low tide. Pups are able to swim at birth. After pups are born, the females form nursery areas away from the main colony for about 2 weeks. Pups are nursed for 4–6 weeks. Adult seals may breed again soon after weaning (Knudtson 1974, Shaughnessy and Fay 1977, Loughlin 1978, Newby 1978).

Pacific harbor seal populations have increased since the passage of the Marine Mammal Protection Act (MMPA) in 1972. The California stock may have reached its environmental carrying capacity (Carretta et al. 2004). Harbor seals are not considered depleted or strategic under the MMPA. Based on the most recent harbor seal counts (Lowry and Maravilla-Chavez. 2005), and a correction factor developed by the CDFG, the harbor seal population in California is estimated at 34,233 animals (Carretta et al. 2005). Castle Rock is a year-round haulout, nursery area, and probable breeding site for the Pacific harbor seal. Castle Rock NWR was one of 563 haulout sites documented for the species in California during the 2004 statewide survey (Lowry and Maravilla-Chavez. 2005) (Table 11). The haulout on Castle Rock NWR (109 seals) was larger than the statewide average (51.1 animals), and was one of the largest haul-outs in northern California. Pupping has been documented on the reef adjacent to Castle Rock NWR, but not on Castle Rock NWR itself. Small numbers of harbor seals, including some nursing pups, regularly haul out around the rim of Castle Rock NWR in summer (Jaques and Strong unpublished).

Northern Fur Seal

Northern fur seals range widely in the North Pacific. Less than 1 percent breed in California (Carretta et al. 2004), with the majority breeding in Alaska. Fur seal rookeries in California have been gradually recovering from near extinction by the fur seal trade.

Northern fur seals may have historically occurred at Castle Rock NWR, and may occasionally haul out at Castle Rock NWR. An unusual influx of fur seals occurred in the Crescent City area during winter 2006–2007. Seven malnourished northern fur seal pups were recovered in the Crescent City area from November to January 2007. The pups were taken in for rehabilitation at the North Coast Marine

Table 11. Counts of harbor seals in the Castle Rock vicinity in 2004 (from 126 mm format aerial color photographs).

Location of haulout site	Date	Time	Tide height	Count of seals onshore	Count of seals in water
Vicinity of Castle Rock, Crescent City	5-Jul-04	10:49	-0.03	61	1
Vicinity of Castle Rock, Crescent City	5-Jul-04	10:39	-0.03	109	4
Vicinity of Castle Rock, Crescent City	5-Jul-04	10:38	-0.09	13	0
Vicinity of Castle Rock, Crescent City	5-Jul-04	10:46	-0.03	513	3

Data are from Appendix 1, Carretta et al. 2005.

Mammal Center. Fur seals are negatively affected by strong El Niños (Melin and DeLong 2000), and the pup starvation event along the north coast probably reflected a year of particularly poor ocean conditions rather than increased association with the nearshore environment. A return of fur seals to other historical breeding rookeries in northern California, besides the Farallons, is possible. Careful pinniped monitoring at Castle Rock NWR might reveal more information about the species' population status in this region.

California Sea Lion

California sea lions of the subspecies *Zalophus californianus californianus* range from southern Mexico to British Columbia. They breed mainly on offshore islands, ranging from southern California's Channel Islands south to Mexico. There is a fall northward migration along the coast and more rapid southward migration in spring.

The U.S. stock was most recently estimated at 138,881 animals (Carretta et al. 2004). The population has experienced an annual growth rate of ~6 percent since at least 1975. The species is not listed under the ESA and is not depleted or listed as a strategic stock under the MMPA.

California sea lions occur primarily on rocky islands within a few miles of shore. They are able to climb to the upper reaches of many islands, and can affect vegetation and erosion on islands with fragile topsoil. California sea lions on the U.S. Pacific coast are primarily from the stock that breeds on islands in southern California, although males that breed in Baja California, Mexico, may also spend most of the year in the U.S. (Carretta et al. 2004).

Castle Rock NWR is used by California sea lions year round (Mate 1973, Griswold 1985). It was historically the northernmost haulout site during the breeding season (Mate 1973) and the southernmost overwintering site in northern California (Griswold 1985). Bonnell et al. (1981) identified Castle Rock NWR and associated shoals as one of the largest California sea lion haulout grounds in central and northern California. Use of Castle Rock NWR by non-breeding sea lions has likely increased along with the overall west coast population. Data appear to indicate that numbers of sea lions at Castle Rock in early July are very low, but that post-breeding influx to the island begins by mid-July. Griswold (1985) made 72 censuses of pinnipeds at Castle Rock during 1984, with July the period of lowest abundance. Numbers increased in August and were highest in fall and winter, then dropped again in April. The mean count in July was 11 animals, compared to about 280 on average during September through October. Historic counts made by Bonnell et al. (1983) were higher, with about 1,500 and 570 animals present in October and January, respectively.

The most recent non-breeding season counts of pinnipeds at Castle Rock NWR were made in 1994–1995 (Table 12). Jaques and Strong (1995) conducted aerial photographic surveys of sea lions in March 1994 and January 1995. In January, a total of 1,277 California sea lions were counted, with the majority of the animals (83 percent) on the main island rather than the associated reef. Sea lions climb up to the top of the eastern edge of Castle Rock NWR during winter weather conditions, and can be crowded together on the upper areas of "the pit" during storms and high swells (Griswold 1985).

California sea lions haul out primarily on the east side of Castle Rock NWR, particularly on the beach, outer slopes, and rim of the pit, as well as rock outcrops associated with the cover on the south side of the island. Accelerated erosion of any soil-covered areas used by sea lions is to be expected, particularly sloping areas, such as the area used to access haul-outs.

Steller Sea Lion

Steller sea lions range along the North Pacific rim from northern Japan to central California. The species was divided into two distinct population segments (DPS) in 1997 (NOAA Fisheries Service 2006). Castle Rock NWR occurs in the range of the eastern stock (eastern DPS), which includes the population from the central California coast north to Cape Suckling in southeast Alaska. Both the eastern and western stocks were listed as ESA threatened in 1990 (55 FR 49204); the western stock was subsequently upgraded to endangered status in 1997. The Steller sea lion is also listed as depleted under the MMPA, and is classified as a strategic stock. Critical habitat was designated in 1993.

Table 12. Counts of California sea lions at Castle Rock and reef during July 2000-2004 (from 126 mm aerial color photographs taken by NOAA Fisheries Service).

Location name	Date	Sea lion Count
Castle Rock	8-Jul-00	37
Castle Rock	17-Jul-01	380
Castle Rock	9-Jul-02	2
Castle Rock	12-Jul-03	644
Castle Rock	5-Jul-04	2

Data from Carretta et al. 2005.

Steller sea lions historically occurred at five major rookeries in California, from the Channel Islands to the St. George Reef (NOAA Fisheries Service 2006). The Steller sea lion eastern DPS population is currently between 45,000 and 51,000 animals, and has been increasing at 3 percent per year for the past 30 years, with variation in trends within the range (NOAA Fisheries Service 2006). Numbers have decreased at the southern extent of the range in southern and central California, but have increased in northern California and Oregon (NOAA Fisheries Service 2006).

Steller sea lion breeding areas are typically located on remote offshore islands and reefs, and require adequate areas above high water levels where young pups can survive weather conditions (NOAA Fisheries Service 2006). Female sea lions appear to select haulout birthing habitat that is gently sloping and protected from waves. Birthing occasionally takes place at haul-outs, but more commonly occurs at a rookery where 25–50 pups are born each year. Sea lions use traditional locations from year to year. Factors that influence habitat suitability include substrate, exposure, proximity to food resources, oceanographic conditions, season, and human activities (NOAA Fisheries Service 2006).

Steller sea lion pupping and breeding season extends from late May to early July (NOAA Fisheries Service 2006). Adult females give birth to a single pup and then breed with territorial males about 11–14 days postpartum. Females with pups begin dispersing from rookeries to haul-outs when the pups are about 2.5 months of age. Adult males that breed in California move north after the breeding season. They are rarely seen in California or Oregon except from May through August. Females tend pups for several months following dispersal from breeding rookeries. Juveniles part with their mothers and begin to disperse at about 8 months of age (NOAA Fisheries Service 2006). While Steller sea lions are not known to migrate, they may disperse widely outside of the breeding season (NOAA Fisheries Service 2006).

Castle Rock NWR and its adjacent shoals are a traditional seasonal haulout for the Steller sea lion (Table 13). The species is present year round at Castle Rock NWR and associated shoals where haulout habitat is relatively protected from winter conditions (Griswold 1985, Jaques and Strong 1995). Castle Rock NWR is one of 41 haulout sites noted in California (NOAA Fisheries Service 2006). Data from aerial surveys over the period 2000–2005 indicate that use of Castle Rock is variable and possibly increasing. A high count of 918 individuals occurred at Castle Rock NWR and associated shoals collectively in July, 2004 (M. Lowry pers. comm.).

The NOAA Fisheries Service data indicate that 716 of these animals were on Castle Rock itself. On the same date, 1,092 non-pups and 444 pups were recorded nearby on the St. George Reef. Most of the Steller sea lions using Castle Rock NWR are either immature animals or nursing females with dependent pups (Jaques and Strong 1995). Only a few winter counts of the species are available. Jaques and Strong (1995) counted 203 Steller sea lions from aerial photographs in January 1995, including 36 females with nursing pups. Griswold (1985) had a peak count of about 200 Steller sea lions at Castle Rock in November.

The growing Steller sea lion breeding population at Point St. George Reef is near its physical capacity and may be on the verge of expanding to nearby sites (R. Brown pers. comm.). Castle Rock NWR offers suitable habitat for a new colony in this vicinity. The potential for future breeding on Castle Rock NWR by this ESA-listed species seems high, and may represent a positive step forward in recovery of the eastern population.

Prevention of disturbances to Steller sea lions during the pre-breeding and breeding season would be a step towards encouraging establishment of the island as a rookery.

Northern Elephant Seal

Northern elephant seals in the California stock range from Baja California to the Gulf of Alaska. They breed and give birth in California and Baja California, primarily on offshore islands (Stewart et al. 1994) from December to March (Stewart and Huber 1993). Populations of northern elephant seals in the U.S. and Mexico were all originally derived from a few tens or hundreds of individuals that survived in Mexico after being hunted to near extinction (Stewart et al. 1994). The current population estimate is over 100,000 animals in California alone (Carretta et al. 2005). As the

Table 13. Steller sea lion count data for the St. George Reef and Castle Rock, July 5-17, 2000-2004.

Location	2000	2001	2002	2003	2004
NW Seal Island	334	335	175	220	354
SW Seal Island non-pups	532	455	541	583	738
SW Seal pups	293	338	367	458	444
Castle Rock and shoals	12	66	692	100	918

Preliminary data from M. Lowry, NOAA Fisheries Service, Southwest Fisheries Science Center.

population recovered, breeding colonies formed along the California coast. Most of the stock in the U.S. currently breeds on the southern California Channel Islands, with about 20 percent of the pups born in central California in recent years (Carretta et al. 2005). The breeding range expanded as far north as Oregon by 1993 (Hodder et al. 1998). Based on trends in pup counts, northern elephant seal colonies were continuing to grow in California through 2001, but appear to be stable or slowly decreasing in Mexico (Stewart et al. 1994.)

Male elephant seals feed in the Gulf of Alaska near the eastern Aleutian Islands, and females feed further south, south of 45°N (Stewart and Huber 1993, Le Boeuf et al. 1993). Adults return to land between March and August to molt, with males returning later than females. Adults return to their feeding areas again between their spring/summer molting and their winter breeding seasons.

Elephant seal breeding rookeries occur on relatively flat sand beaches either on islands or relatively isolated coastal mainland areas. Females give birth first when 3–5 years old (Barlow et al. 1993). Males reach prime breeding condition at 9–12 years of age. Pregnant females come ashore to give birth from December through February. The seals mate about 24 days after birthing. Pups are abandoned on beaches when they are about one month old, but remain at the rookery for another one to three months prior to going to sea. Juveniles and adults return to molt from March to August. Most elephant seals return to their natal rookeries when they start breeding (Huber et al. 1991).

Elephant seals breed on Castle Rock and the associated shoals, but the population has not been regularly monitored by NOAA Fisheries Service or any other entity. Although breeding was evident as early as 1978 (Griswold 1985), aerial surveys to confirm that the island was a breeding rookery did not take place until 1994–1995 (Jaques and Strong 1995) (Table 14). No surveys have taken place since that date. The breeding area on Castle Rock NWR is largely out of view from the mainland shore or boat.

The first record of elephant seals on Castle Rock was made by Osborne (1972), who observed six elephant seals there in 1970. A young elephant seal pup washed up a nearby Crescent City beach in 1978 (Griswold 1985). Bonnell et al. (1983) counted four elephant seals on Castle Rock NWR, and speculated that one pup may have been born there that year. Pre-weaned pups have washed up on the mainland regularly since about 1985 (D. Wood, pers. comm.). Sightings of tagged animals indicate that it was initially colonized by immigrants from Año Nuevo Island.

Table 14. Northern elephant seals at Castle Rock and Castle Rock shoals in 1994-1995.

	Elephant Seal Status	Castle Rock	Castle Rock Shoals	Total
20-Jan-95	Bull	1	*	1
	Subadult male	6	*	6
	Female	34	11	45
	Pup	3		3
	Total	44	11	55
4-Feb-95	Bull	1	1	2
	Subadult male	4	*	4
	Female	24	17	41
	Pup	4	7	11
	Total	33	25	58
17-Mar-94	Adult	2	3	5
	Pup	9	2	11
	Total	11	5	16

Counted from aerial photographic surveys; from Jaques and Strong 1995.

Aerial surveys in 1994–1995 confirmed that the elephant seal breeding population at Castle Rock NWR was relatively small, and that breeding takes place on both the main island and inner reef (Jaques and Strong 1995). Up to 52 nonpups and 11 pups were counted at the rookery in January 1995. Most elephant seals on Castle Rock NWR were on the flat beach inside the pit. There is very little suitable elephant seal habitat on Castle Rock NWR and this factor likely limits the size of the breeding population. Pup mortality appears to be high, as evidenced by the number of pups that wash off the site during winter storms.

3.7.8. Castle Rock NWR Mammals

Bats

Bats were historically present in the shepherd's cabin (Osborne 1972), but their current occurrence is not known.

Rodents

Osborne (1972) reported seeing two deer mice (*Peromyscus maniculatus*) on Castle Rock in 1970. The current status of this native mouse at Castle Rock NWR is not known. The house mouse is a non-native species that may be present on Castle Rock NWR. One dead specimen was observed on the island's eastern shore by Osborne (1972).

River Otters
River otters are common along the mainland shore adjacent to Castle Rock, but have not been seen on the island itself. An otter was observed preying on birds at sea between Castle Rock and Point St. George (D. Jaques, unpublished field notes). River otters are a suspected predator on Leach's storm petrels nesting at Prisoner Rock in Humboldt County (Osborne 1972, Sowls et al. 1980, Carter et al. 1992) and at other seabird colonies in the northeastern Pacific (Duffy 1995).

3.7.9. Castle Rock NWR Amphibians and Reptiles

No information is available on possible habitation of Castle Rock NWR by amphibians and reptiles.

3.7.10. Castle Rock NWR Invertebrates

The intertidal region around Castle Rock NWR is rich with invertebrates. However, no surveys have been conducted around or on the island.

3.7.11. Castle Rock NWR Special Status Species

Federal Endangered Species Act Listed Species
Two species using Castle Rock NWR are protected by the Federal Endangered Species Act: the California brown pelican and the Steller sea lion (Table 15). The marbled murrelet (*Brachyramphus marmoratus*) is an ESA-listed threatened species, but it uses habitat outside Castle Rock NWR, including the waters surrounding Castle Rock. The Aleutian cackling goose and gray whale were both formerly listed, but now are recovered species.

California Brown Pelican
The brown pelican became endangered on the U.S. Pacific coast due to pesticide contamination of marine waters near breeding colonies in southern California (USFWS 1983). Breeding populations have generally recovered, and both the State of California and the USFWS are conducting a status review of the species. Non-breeding pelicans roost communally on Castle Rock NWR, but have never been known to nest north of Monterey, California (USFWS 1983). They can be found from April to December, but are most abundant at Castle Rock NWR in fall. As many as 3,660 pelicans have been counted on the island. Castle Rock NWR is a key night roost for pelicans in the Crescent City area.

Peregrine Falcon
(*See Other Bird Species That Use Castle Rock NWR*).

Birds of Conservation Concern
Three bird species recognized as USFWS Species of Conservation Concern occur at Castle Rock NWR: peregrine falcon, black oystercatcher, and Cassin's auklet (*see Other Bird Species That Use Castle Rock NWR*).

Table 15. Threatened or Endangered species that occur or have occurred at Castle Rock NWR or adjacent marine waters.

Common Name	Scientific Name	Federal Status	California State Status	Notes
brown pelican	*Pelecanus occidentalis californicus*	FE 10/13/70	SE 6/27/71	State and Federal status review in progress
Aleutian cackling goose	*Branta (Canadensis) leucopareia*	Delisted 3/20/01 FT 12/12/90 FE 03/11/67		
American peregrine falcon	*Falco peregrinus tundrius*	Delisted 8/25/99 FE 6/2/70	SE 6/27/71	
marbled murrelet *	*Brachyramphus marmoratus*	FT 9/30/92	SE 3/12/92	Surrounding waters only
Steller sea lion	*Eumatopius jubatus*	FT 4/5/90		
gray whale *	*Eschrichtuius robustus*	Delisted 6/15/94 FE 6/2/70		Surrounding waters only

** indicates adjacent waters only*

Steller Sea Lion
(*see Castle Rock NWR and Surrounding Area Use by Marine Mammals*.)

California State Species of Special Concern (SSC)
California Species of Special Concern is a designation that CDFG can give to vertebrate species because of declining population levels, limited ranges, and/or continuing threats that may make the listed species vulnerable to extinction. Four SSC birds (CDFG 2007) breed on Castle Rock NWR: rhinoceros auklet, tufted puffin, fork-tailed storm-petrel, and double-crested cormorant. (*See Other Bird Species That Use Castle Rock NWR*.)

3.7.12. Castle Rock NWR Non-native Wildlife

There has been no assessment of non-native plant or animal species on Castle Rock NWR. Non-native rodents and plants can have a detrimental impact on seabird colonies.

3.8. Castle Rock NWR Cultural Resources

There are no known Native American cultural resources on Castle Rock NWR. The wood remaining from the shepherd's cabin might be considered a historic relic or cultural resource.

3.8.1. Prehistoric Use of Castle Rock and Surrounding Area

In aboriginal times, the Tolowa people lived along the extreme northern coast, from the southwestern corner of what is now Oregon to ~15 miles south of the shoreline adjacent to Castle Rock (Cramblit 2007). Humboldt Bay was home to the Wiyot people, an Algic-speaking group that fished and hunted on the California coast from Trinidad Head to the Eel River (Fredrickson 1984). The coastal areas between the Wiyot and Tolowa people was home to the Yurok peoples (Cramblit 2007).

The Tolowa people who originally inhabited what is now Crescent City, California (Cramblit 2007), are an Athabascan tribe (UO 2007). Linguistically they were closer to the Rogue River tribes to the north than to tribes inhabiting the south (UO 2007).

The Tolowa resided in permanent villages along the coast in winter, and in late summer moved inland for salmon and acorns. Their house types were low peaked redwood plank dwellings with gable end entrances. Tolowa society was associated with acquisition of wealth, usually dentalium shells, obsidian blades, and woodpecker scalps. Ceremonialism associated with the taking of the first salmon and sea lion suggests that they belonged to the northern Californian 'World Renewal' complex of the Karok, Yurok, and Hupa type.

'Ee-nii-k'wvt' was the name given to Castle Rock by the Tolowa, which translates to "Ground there upon" (L. Bommelyn pers. comm.). The Tolowa had a subsistence relationship with Castle Rock, but were not known to ever reside on the island. During the 1800s, the Tolowa occupied a large village site on the headland adjacent to Castle Rock at Point St. George. An intensive study of the village site was made by Gould (1966), which incorporated archaeological evidence, oral history, and historical data in an attempt to reconstruct the culture of the people living at Point St. George.

"Ta'giatun" or "Land laying outward place" is one of the names given to Point St. George, and is described as a "…place for shellfish gathering; also camping place for sea-lion expeditions…" (Gould 1966). The intertidal regions surrounding the Point were used by the Tolowa for gathering shellfish and seaweed. The people also engaged in sea lion hunting expeditions offshore. Dugout canoes, 30–40 feet long, were used for regular trips to the St. George Reef and, presumably, Castle Rock. Marine mammal species included in the native diet at the village on the Point were whales, sea otter, Steller sea lion, California sea lion, northern fur seal, and harbor seal. The Steller sea lion was the most common mammalian species found in archaeological digs at the site, and appeared to be of major importance to the people. Gould stated that birds were clearly part of the regular diet and were taken whenever possible. At certain times of year bird eggs and immature birds were harvested in large numbers. The most common bird bones found were those of immature cormorants.

Oral history describes the seasonal taking of flightless cormorants from nesting islands around Point St. George in more recent times (Gould 1966). At Castle Rock, May was egg gathering time (Calla et al. 2005). Men in canoes made expeditions to the island, scaled the cliffs, and marked a circular area with stones. They then threw all the eggs inside the area off the cliff. Ten days later they would return and collect the new eggs, knowing they were fresh. The eggs were probably common murre. Eggs were also blown and used for ornamental purposes, strung in a garland to decorate homes.

EuroAmerican settlement of the Crescent City area began in the 1850s. The general destruction of the native American population followed rapidly. By 1856 there were only an estimated 316 Tolowa survivors (Gould 1966). The village at Point St.

George was abandoned about the mid-1850s, prior to intensive white settlement of the area, but use of Point St. George for subsistence continued after the village was abandoned. Shell middens are present at Point St. George, but there are no recorded archaeological sites on Castle Rock itself (USFWS 1978).

3.8.2. Castle Rock NWR History

EuroAmerican Settlement of Crescent City and Use of Castle Rock

The overland explorations of Jebediah Smith were probably the first contacts between Tolowa peoples and EuroAmericans. Intensive white settlement of the larger region came after the gold rush of 1850 (UO 2007). The Tolowa people probably numbered more than 1,000 prior to EuroAmerican contact. However, the census of 1910 registered only 121 Tolowa, likely as a result of diseases and numerous attacks by EuroAmericans on their settlements (UO 2007). Two small reserves, called Rancherias, at Crescent City and Smith River, continue to be home to some Tolowa descendants, reportedly numbering 37 and 113 respectively in 1945 (UO 2007).

The only recorded uses of Castle Rock by EuroAmerican people were sheep grazing and egg-collecting. The island was initially claimed by the U.S. Government around the turn of the century. A private shepherd grazed sheep on the island from about 1900 to about 1920 (Osborne 1972). Sheep were periodically transported to and from the island by boat during extreme minus tides. A small wooden cabin was constructed on the east end of the island. Fraser, an early ornithologist/egg collector, reported that no sheep were present by the time of his visit, in the 1930s (Osborne 1972).

Several egg collectors visited the island from at least 1917 to 1961. These early oologists left valuable notes in some cases. Clay (1901-1953) visited the island at various times from 1917-1934. Talmage visited in the mid-1930s but lost all of his field notes and specimens in a fire (Osborne 1972). Early ornithological accounts were also provided by Zerlag and Fraser (1940).

Castle Rock was purchased from the U.S. Government in 1937. The intent of the first private owners was to quarry the island for rock to build coastal highways and jetties. Rock quarrying did take place on Point St. George during the 1950s and 1960s. The southwest tip of the point was dynamited to supply the U.S. Army Corps of Engineers with material for the breakwater at Crescent City Harbor. As late as the 1970s, speculators were contemplating guano mining, rocky quarrying, and construction of a tourist attraction on Castle Rock, (Sowls et al. 1980), but for various reasons none of these plans ever proceeded (USFWS 1978).

In 1979, The Nature Conservancy (TNC) purchased Castle Rock. The U.S. Fish and Wildlife Service bought the island from TNC in 1980 for ~$41,250.

3.9. Castle Rock NWR Social Environment

Castle Rock is in Del Norte County, California, ~1 mile off-shore from Crescent City. Del Norte County was founded in 1857 from part of the territory of Klamath County, which ceased to exist in 1875. The name of the county signifies "the north," derived from its location in California.

Del Norte County is the northwesternmost county in California. It is located on the Pacific coast, and bordered by Oregon to the north. The county seat is Crescent City, the county's only incorporated city. Del Norte County is noted for its redwood forests and the wild Smith River National Recreation Area.

3.9.1. Del Norte County Demographics

As of 2007, there were 29,341 people residing in Del Norte County (CDOF 2007). According to the U.S. census of 2000, the population density is 27 per square mile. There are 10,434 housing units at an average density of 10 per square mile. The racial makeup of the county is 78.9 percent white, 4.3 percent black or African American, 6.4 percent native American, 2.3 percent Asian, 0.1 percent Pacific islander, 3.9 percent from other races, 4.1 percent from two or more races, and 13.9 percent of the population Hispanic or Latino of any race.

As of 2000, there were 9,170 households, of which 33.5 percent had children under the age of 18 living with them, 50 percent were married couples living together, 13.6 percent had a female householder with no husband present, and 31.4 percent were non-families. 25.3 percent of all households were made up of individuals and 10.1 percent had someone living alone who was 65 years of age or older. The average household size was 2.6 and the average family size 3.1.

In Del Norte County the population was spread out with 25.1 percent under the age of 18, 8 percent from age 18 to 24, 32.2 percent from age 25 to 44, 22.3 percent from age 45 to 64, and 12.5 percent who were 65 years of age or older. The median age was 36 years. For every 100 females there were 123 males. For every 100 females age 18 and over, there were 130 males.

3.10. Castle Rock NWR Social and Economic Conditions

3.10.1. Castle Rock NWR Social and Economic Regional Overview

Del Norte County has historically been a very productive timber region (TNC et al. 2005). However, over the past 20 years the timber industry in California has undergone a major downturn, economically impacting the industry as well as the local community (TNC et al. 2005). One major factor in the downturn is a reduction in supply due to prior intensive harvest. In addition, an inconsistent domestic housing market, declining Asian markets in the 1990s, and an increasing foreign lumber supply with relatively lower cost from Canada, Brazil, Chile, and Russia have had negative impacts (TNC et al. 2005). In 2005, Del Norte County timber production was 22,500,000 board feet, just 1.3 percent of California's total production (CDOF 2007).

As of 2000, agricultural employment in Del Norte County was just 370. Agricultural products such as livestock and livestock products, as well as plant products, had a value of over $41 million (in year 2000 $) (CDOF 2007).

The majority of non-agricultural employment in Del Norte County is in a few sectors including State and local government; trade, transportation and utilities; educational and health services; and leisure and hospitality.

3.10.2. Castle Rock NWR Regional Land Use

Del Norte County Land Use

Del Norte County is less than half the size of Humboldt County and comprises 644,990 acres. More than 32,000 residents reside in more than 9,100 households, including over 3,300 prisoners in Pelican Bay State Prison. The county is rural, consisting of Crescent City and several small unincorporated towns such as Smith River, Gasquet, Hiouchi, and Klamath. As of 2005, there were over 417 miles of streets, roads, and highways in the county (CDOF 2007). In 2002 there were 89 farms, comprising over 13,300 acres (CDOF 2007). Field crops, vegetables and fruits, nursery stock, timber, and livestock all continue to be produced throughout parts of Del Norte County, with trends of increasing nursery stock and livestock (DNC 2003).

Del Norte County historically had 43 large lumber mills; by 1994 the last one closed. With this closure Del Norte County began a regional economic transition. The establishment of Redwood National and State Parks in the early 1970s, and the Smith River National Recreation Area in the late 1980s, put more than 75 percent of the county land area in NPS, U.S. Forest Service, or other publicly owned land.

3.10.3. Castle Rock NWR Local Land Use

Crescent City is a mixture of natural area preserves, a long coastline, and creeping urbanization. Highway access is provided by U.S. Route 101, which runs directly through the city, and extents to Brookings, Oregon, to the north and Eureka to the south.

In 2007 there were 7,762 people residing in Crescent City (CDOF 2007). Census data from the year 2000 indicate that the population density is over 2,500 per square mile in Crescent City, orders of magnitude higher than the rest of Del Norte County. There are over 1,700 housing units with an average density of over 980 per square mile. Pelican Bay State Prison, located on 275 acres near Crescent City, opened in 1989 principally to house the growing population of maximum-security and high-security risk inmates in the California prison system. The Del Norte County airport covers 500 acres ~3 miles northwest of Crescent City (Mead and Hunt 2005). The airport consists of two intersecting runways with regular flights over Castle Rock NWR. To date, no collisions have been reported between planes and nesting birds.

3.10.4. Castle Rock NWR Local Economy and Employment

When Crescent City became the county seat of Del Norte County in 1857, most of the inhabitants worked in the nearby mines. As the mining industry waned, it was largely replaced by logging and fishing industries during the early twentieth century. Although these industries have also experienced recent decline, forestry product processing continues, and the Crescent City Harbor still serves as a commercial fishing boat basin for salmon, shrimp, tuna, cod, and Dungeness crab commercial fishing vessels. The harbor is also home to multiple fishing and non-fishing related businesses and harbor governmental offices. The Crescent City Harbor has several pleasure boat docks.

The median income for a household in Crescent City is $20,133, and the median income for a family is $22,058. Males have a median income of $36,667 versus $19,922 for females. The per capita income for the city is $12,833. Over 34 percent of the population, and over 33 percent of families, are below the poverty line.

3.10.5. Castle Rock NWR Management Economics

There are no staff or base budget funds specifically allocated to Castle Rock NWR. Management of Castle Rock NWR is covered by the staff and budget at Humboldt Bay NWR. Recent work there on research and visitor services/outreach has been paid for primarily with special programmatic and grant funding. Annual costs to keep up this level of effort would be ~$30K.

National Wildlife Refuges contribute funds to local counties through revenue sharing programs that are intended to cover unrealized tax revenues for either lands purchased in fee title or lands reserved from the public domain. To mitigate the loss in property taxes, Del Norte County receives an annual payment in accordance with the Refuge Revenue Sharing Act of 1964. The county receives either 0.75 of 1 percent of the value of Castle Rock, annually (~$4,000).

3.10.6. Castle Rock NWR Environmental Justice

There are no minority or low income populations that would be affected by any management alternatives on Castle Rock NWR.

3.11. Castle Rock NWR Public Access and Recreation

3.11.1. Castle Rock NWR Traffic, Public Access, and Recreation

Crescent City can be accessed from the north and south on Highway 101, and from the east on highway 199. There is no public access to Castle Rock NWR.

3.11.2. Aesthetics of Castle Rock NWR

The primary viewing area for Castle Rock NWR is from Pebble Beach Drive and the mainland at Point St. George. The area surrounding Castle Rock NWR contains other, smaller rocks and offers majestic views of California's coastline.

3.12. Castle Rock NWR Public Use

Castle Rock NWR is currently closed to all public access and is very unlikely to ever be opened. Sensitive cavity nesting bird and other habitats would be irreparably damaged by visitor use of Castle Rock NWR.

Periodic visits to the island are conducted only by Complex staff and academic researchers accompanied by staff, to install and maintain remote sensing wildlife cameras or to conduct other forms of monitoring and research. A remote viewing site and interpretive panels are provided on shore immediately adjacent to Castle Rock NWR, on Pebble Beach Drive. With binoculars or, better yet, a spotting scope, visitors can see seabirds and resting pinnipeds from this remote viewing location.

3.12.1. Castle Rock NWR Environmental Education and Interpretation

Interpretive signs are provided at a rest stop along Pebble Beach Drive, from which the public can safely view Castle Rock NWR and learn more about its wildlife (Figure 12).

Real-time video of Castle Rock NWR and associated seabirds is available over the internet, through a partnership between the USFWS, HSU, and the NPS.

Figure 12. Castle Rock NWR interpretive panels along Pebble Beach Drive, Crescent City. Photo: USFWS

3.12.2. Castle Rock NWR Trends

Kayaking, jet skiing, and other recreational boating occur around Castle Rock NWR, but landing is not permitted. No trend information about these uses is available.

3.12.3. Castle Rock NWR Management and Monitoring

Since establishment, Castle Rock NWR has been passively managed by preventing disturbance of refuge wildlife. Because Castle Rock NWR is so rich with sensitive wildlife species and fragile habitat, only very limited access for research, monitoring, and management can be allowed while fulfilling the purposes for which it was established. Limited remote observation of Castle Rock NWR has been allowed for research purposes. The Complex collaborates with partners such as HSU, AFWO, and NOAA to conduct photo surveys of birds and marine mammals utilizing Castle Rock NWR and associated habitat.

Estimates of the abundance of common murres, cormorants, pigeon guillemots and tufted puffins on the refuge can be obtained using aerial photos or other means. However the burrow-nesting nocturnal species (rhinoceros and Cassin's auklets, fork-tailed and Leach's storm-petrels) are not easily seen because they are out in the ocean feeding during the day and only come to the island between sunset and sunrise to attend to their young. Human activity on the island is very restricted because the burrow systems can be destroyed or badly damaged when stepped on by people. Therefore, they have posed a very difficult challenge to study. Based on past surveys, it is suspected that Castle Rock still hosts substantial numbers of these burrow-nesting species, but their current status is not known. With advanced technology we can now use cameras to view the seabirds without the disturbance associated with having people present. Our intent is to establish a long-term, forward looking monitoring program on this very important seabird island.

The camera system installed on Castle Rock NWR sends video signals to an antenna on top of the NPS building in Crescent City, then to a digital video recorder, and finally to a screen. This system allows us to gather information on the number of birds in a certain area, the percentage of burrows occupied by which types of birds, when the birds are there, how often they bring fish back, when eggs are laid and hatch, when young birds leave the nest, and other date that helps us determine how the populations are doing. Additionally, the video from the camera will be available to the public "live," either by high quality TV in the Crescent City visitor center of the NPS, or via an internet connection to the web at http://www.humboldt.edu/~rtg1/research/castle_rock.html

Besides seabirds, Castle Rock is used as a rest site by thousands of brown pelicans from July–October, and about 20,000 Aleutian cackling geese from mid-February through the end of March. Marine mammals that haulout and rest on the island include harbor and northern elephant seals and Steller's and California sea lions.

4. Issues, Challenges, and Opportunities

4.1. Issues and Challenges Identified by the Public and the Service

Based on input from the public, agencies, tribes, and elected officials, as well as internal scoping, the Service developed the following planning issues to guide the development of alternatives. A third planning update, summarizing the results of the CCP scoping process, was sent out to over 600 interested stakeholders on September 14, 2007. In addition, a fourth planning update was sent out during spring of 2008.

4.1.1. Potential Impacts of Global Climate Change on the Complex

The recent warming trend of the global climate is confirmed by observations of increases in global average air and ocean temperatures and rising mean sea level (IPCC 2007). Since Humboldt Bay NWR is located adjacent to the Pacific Ocean, it is likely to be impacted by both increased temperature and sea level rise (see section 3.1.2 for further discussion).

Given the height of Castle Rock NWR above mean sea level, its habitat for nesting sea birds and roosting birds is unlikely to be impacted by rising sea level in the near term. More likely impacts to resident and migrant wildlife are any changes in the supply of marine prey that could result from changes in ocean temperatures or ocean currents.

4.1.2. Staffing Needs for the Complex

The Complex currently has six permanent full time equivalent (FTE) employees; five positions are stationed at the Visitor's Center, while one permanent employee and one term employee are stationed at the office at the Lanphere Dunes Unit. In 2008 the refuge received additional base funding for a permanent Visitor Services/Outreach position to be shared with the Arcata Fish and Wildlife Office. When filled, the shared position will be stationed at the Salmon Creek Unit of the Humboldt Bay NWR. Since 2002 the Complex has had a graduate Student Career Experience Program (SCEP) position (two different students) that has helped with the Complex's biology program.

The Complex has also periodically had one or two six-month temporary contract positions that have assisted primarily with Visitor Services, and a Youth Conservation Corps Crew Leader and Crew.

4.1.3. Aleutian Cackling Goose Habitat Management

The recovery of the Aleutian cackling goose population from endangered (~800 birds in 1974) to thriving is one of the signature success stories of the Federal Endangered Species Act.

To the best of current knowledge, Aleutian cackling geese historically used Castle Rock NWR in Del Norte County, but did not use the Humboldt Bay area, as a spring staging area. This historic use pattern is consistent with historic vegetation conditions around the bay. However, since 2001, the use of private and public grasslands around Humboldt Bay and the lower Eel River by Aleutian cackling geese has increased significantly. The Humboldt Bay area now receives the majority of use by 50,000 to 80,000 Aleutian cackling geese from mid-January to late March. The Pacific Flyway objective for this population is 60,000. However, the current population is ~100,000 and is likely still increasing (see Figure 3 and Table 9). Use of habitat in Humboldt by Aleutian cackling geese has already increased to the point where local ranchers are reporting financial losses due to forage removed by geese and therefore unavailable for livestock (Nelson pers. comm., Mini 2005). As long as ranchers are suffering these losses without any compensation, they look to the public agencies to make the public land available for goose forage. However, one of the challenges is that most public lands around Humboldt Bay and the Eel River are former tidelands and therefore potential habitat for listed salmonids and tidewater goby. Any acre of land managed for geese is land that can not or is not being managed for salmonids and gobies, see below.

4.1.4. Estuarine Habitat Restoration on Humboldt Bay NWR

The Salmon Creek, White Slough, and Hookton Slough units of Humboldt Bay NWR consist primarily of diked former salt marsh and, to a lesser

extent, brackish marsh. Humboldt Bay has lost ~90 percent of its salt marsh since EuroAmerican settlement through diking and draining as well as filling for development. Of the remaining salt marsh, 95 percent has been invaded by introduced dense-flowered cordgrass, which displaces native plant communities resulting in a loss of biodiversity and unknown impacts to marsh function and productivity. Much of the former salt marsh around the bay still supports seasonal wetlands, including "agricultural wetlands" used primarily for grazing and hay production. In other areas where there is substantial freshwater input, including the Salmon Creek, Hookton Slough and White Slough units, there are fresh to brackish marshes and riparian areas supporting native plant communities. Restoration of some former tidelands to tidal influence is desired by the Service as well as some other resource agencies and community members both to restore function as well as to provide habitat for native plant and animal communities, some of which are listed.

However, the restoration of tidal influence to former salt marsh is also constrained by a number of factors. Some residents and private ranch owners are opposed to tidal restoration because it removes land from agricultural production. The use of grazed, short-grass agricultural grassland by increasing numbers of migrating Aleutian cackling geese has resulted in the need for public landowners to retain some amount of this grazed habitat to support these populations and to remove geese grazing pressures from private lands. Restoration of salt marsh and brackish marsh is also constrained by the substantial subsidence that has occurred in most of these former tidelands. The majority of these lands may be two to three feet below the elevation needed to establish salt marsh, and three to four feet below the elevation required to establish native plant communities instead of dense-flowered cordgrass-dominated communities. Both cost and the need to model and experimentally test methodologies constrain the potential conversion of these areas to a condition that supports native salt marsh vegetation, either through raising elevations or establishing muted tidal influence. In addition, the presence of relatively uncommon native brackish to fresh marsh communities on some of these lands may affect the desirability of restoration. Since bay-wide vegetation mapping has not occurred, and little research has been devoted to the habitat values and functions of these wetlands, it is difficult to precisely quantify the impact of converting these vegetation types.

Lastly, but certainly not least is the fact that additional constraints exist due to proximity and exposure of adjacent infrastructure to flooding, including: Highway 101, Hookton Road, private lands and the refuge headquarters.

4.1.5. Replacement of Eucalyptus Trees with Native Vegetation

Blue gum (*Eucalyptus globulus*), a tree native to Australia, was introduced in California in the mid to late 1800s. A variety of reasons are listed as to why these trees were planted all along the coastal and interior valleys of California, such as crop trees, wind breaks, lumber, firewood, medicine, and shade. In the 1920s an approximately one mile long strip of blue gum was planted on the Humboldt Bay NWR, north of what is now the Visitor Center, by McBride Family ranch hands probably as a wind break. Blue gum and other non-native trees, such as Monterey pine (*Pinus radiata*) and Monterey cypress (*Cupressus macrocarpa*), were also planted in this area. Currently this area is ~85 percent blue gum. Blue gum stands tend to be monotypic, largely due to their rapid growth and the toxins released by leaves and in the surrounding soil, which inhibit the growth of other species.

Although some wildlife, such as raptors, European starlings (*Sturnus vulgaris*), skunk, and deer use this area in general for resting and in some limited cases foraging and breeding, blue gum is recognized to be largely detrimental to wildlife. All birds that naturally evolved with this tree species have long bills and are typically not diminutive songbirds. A few of the species of songbirds that would typically inhabit the native trees in winter are Anna's (*Calypte anna*) and Allen's (*Selasphorus sasin*) hummingbirds, yellow-rumped warblers (*Dendroica coronata*), and kinglets (*Regulus* sp.). These birds have short bills and small nasal openings relative to the species that have evolved with the blue gum. The gum (thick nectar) and pollen of these winter blooming trees tends to clog the nasal openings of these birds, which can lead to starvation. In addition, hummingbirds that nest in these trees typically have low nesting success as their nests blow out of trees five times more often than in native vegetation. Although blue gum are used by some birds, the diversity and number of birds and other wildlife that uses native riparian habitat is far greater.

Removal of the non-native trees was recommended in the original 1989 Management Plan for the refuge. According to the Management Plan, blue gum is to be replaced with native vegetation such as Sitka spruce, alders (*Alnus* sp.), and willows (*Salix* sp.), which have thrived when planted elsewhere on the Salmon Creek Unit. Incremental

removal has taken place, primarily by the California Conservation Corps (CCC), after approval of the 1989 Management Plan. Downed trees are then donated to programs that distribute the wood to seniors and other needy citizens. This program is scheduled to continue in cooperation with the Humboldt Fish Action Council (HFAC).

4.1.6. Potential Water Quality Concerns with Increased Public Use in Mad River Slough

The oyster growers in Mad River Slough expressed concern to the proposal for opening the Ma-le'l Dunes Cooperative Management Area for public use, especially related to potential impacts on water quality (Figure 13).

Their primary concern is that if the California Department of Public Health (CDPH) will not certify the waters of Mad River Slough, the oyster growers are out of business. Both growers and CDPH are concerned that increased public use in the area can potentially jeopardize the water quality.

To address these concerns, refuge and SCC staff have met with the oyster growers and HBHRCD to assure them that work on the Ma-le'l Dunes Unit will be phased and will include the following:

- Along with the vault toilets, there will be both signage and brochures that explain the need to maintain water quality, how and where to properly dispose of waste, and the need to be responsible neighbors.
- The Ma-le'l Dunes Cooperative Management Area caretaker will patrol the shoreline on a regular basis and properly dispose of any trash and waste.

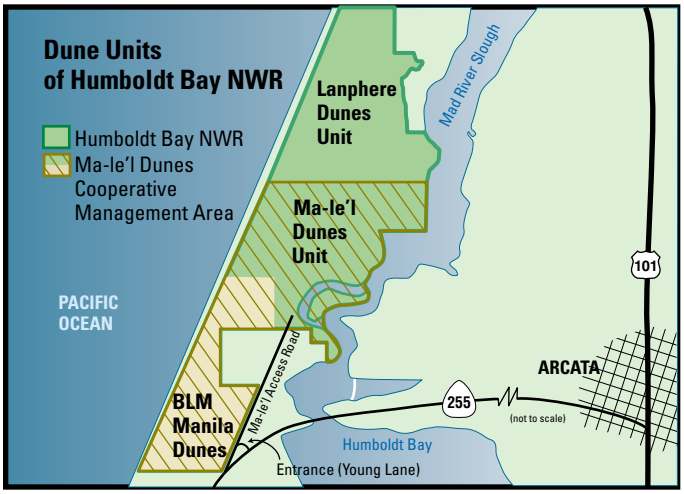


Figure 13. Dune Units of Humboldt Bay NWR.

The Service is committed to maintaining water quality standards in Mad River Slough.

The oyster growers also are concerned about "ownership" lines on maps and whether FWS has legal jurisdiction over certain slough areas (see 4.1.9). In addition their concern is the possibility that other agencies then "adopt or overlay" lines on certain conservation areas like refuges or state WMAs which then can become, for example, Marine Life Protection Areas (MLPAs).

From 1990 to 1994, when it was formerly open to the public, the Ma-le'l dunes area received substantially more public use than it does currently. At that time there was an above-ground composting toilet in place.

4.1.7. Invasive Plant Species on Humboldt Bay and Adjacent Lands

An invasive species is a non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human health (E.O. 13112, 3 February 1999). Invasive species are widely considered to be the greatest threat to natural areas after habitat loss. They negatively affect 35 to 46 percent of endangered species. There are 2.3 million acres of Refuge System lands infested with invasive plants and this number is increasing. The Biological Integrity Policy (601 FW 3) specifies that the Refuge System manages non-native invasive species by the use of integrated pest management strategies, which can include mechanical, chemical, biological, and cultural techniques. The ecosystem of the south bay units has been highly altered through human manipulation and invasive species, which are widespread within these units. Many of these species are in an incipient stage of infestation, occurring only in a few small areas.

Invasive species infestations are not limited by ownership boundaries. Identifying the threat of an invasive species at an ecosystem level improves the ecological and economical effectiveness of the control methods. The Humboldt Bay NWR is committed to cooperatively work with adjacent landowners and the Humboldt-Del Norte Weed Management Area to control the spread and impact of invasive species. This cooperation will enhance the effectiveness of control strategies on Humboldt Bay NWR lands and will reduce the ecological impacts of invasive species on those lands and the surrounding ecosystems.

4.1.8. Flooding of Highway 101

During heavy rain events Salmon Creek goes out of its bank on a regular basis, both above and below the Highway 101 bridge. Salmon Creek overtops its banks primarily because it has been channelized in its lower portion and over time silt has aggraded in the lower channel of the creek. The elevation of the creek bottom at the Hookton Road bridge is now ~5 feet higher than it was historically due to aggraded sediment. This elevated creek bottom acts as a "dam" in the creek. During large storm events the creek comes out of its channel on the east side of Highway 101 and can flood the east side of the Hookton Road interchange and just to the north where Cattail Creek runs under Highway 101. This occurs less often than flooding of the west Hookton exits and the Humboldt Bay NWR entrance road. This flooding impacts access for many people in the Tompkins Hill and Table Bluff area.

Parts of Phase I of the Salmon Creek restoration should reduce this problem. Two new tidegates installed during summer 2007-08 will improve fish passage, estuarine conditions, sediment, and flood flow transport. Phase II of the project is designed to help remove aggraded material in the lower creek channel and to further improve the objectives of Phase I.

4.1.9. Legal Jurisdiction of Tidelands

Federal ownership and management of "State tidelands" has long been an issue in Humboldt County and affects refuge management in multiple places around the bay. While the county assessors parcel map may show Service ownership, the State Lands Commission claims that all lands below mean high water are owned by the State, and in this case are "owned/managed" by the Humboldt Bay Harbor Recreation and Conservation District (HBHRCD). Other "owners/managers" can be CDFG. The primary impact this can have on refuge management is confusion of the public over where refuge jurisdiction begins and ends on some refuge units.

4.1.10. Hunting Regulations on Humboldt Bay NWR

The current sport hunting plan for Humboldt Bay NWR is over 17 years old and was due for an update (see Appendix C). There have been relatively large land acquisitions for Humboldt Bay NWR since 1990, including some historically hunted salt marsh islands associated with the Ma-le'l Dunes Unit.

In 2005, portions of the former Buggy Club (private land) were transferred to the Service from the Center for Natural Lands Management (CNLM). The lands had been purchased by the California Coastal Conservancy and donated to CNLM to hold until the Service could complete the National Environmental Policy Act (NEPA) process. These lands were then combined with the southernmost portion of the Lanphere Dunes Unit (also known as the Fernstrom-Root parcel) to create the Ma-le'l Dunes Unit. The Ma-le'l Dunes Unit, along with the BLM's Manila Dunes parcels, now form the Ma-le'l Dunes Cooperative Management Area. Interim compatibility determinations (CD) were done for established authorized priority public uses and boating, but not hunting because it was not a recognized and authorized public use.

The previous draft Public Access Plan included the formal closure of some areas that while not officially authorized had been traditionally hunted. Hunting on those areas was considered incompatible. A previously used (1990–1994) trail along the shoreline was planned to be used again, which would make hunting in close proximity to this location a safety issue.

Because any refuge areas proposed to be newly opened to hunting need to go through NEPA and no other new public uses were proposed to the area, it was decided to deal with hunting in this area through the CCP process and it was excluded from the final Cooperative Area Management Plan. The Coastal Conservancy and the Service have had multiple discussions with hunters and their representatives and have proposed the following adjustments that would partially accommodate the hunters' position(s):

1. Allow hunting, but no blind construction on the portion of the Fernstrom-Root Island owned by the Service;
2. Allow retrieval only on the island adjacent to the trail, Ma-le'l Island;
3. Post educational materials on hunting and avoiding conflict between user groups.

In summary, the Service believes that the adjustments outlined above reflect a viable balance and compromise between priority refuge uses that sometimes conflict.

4.1.11. Sport Fishing Regulations on Humboldt Bay NWR

The current sport fishing plan for Humboldt Bay NWR is over 17 years old, and there have been many changes in infrastructure and management of refuges units since that time. Internal scoping motivated the creation of an updated Sport Fishing Plan for Humboldt Bay NWR (See Appendix D).

4.1.12. Non-Wildlife Dependent Visitor Services on Humboldt Bay NWR

Since the emphasis of visitor services for Humboldt Bay NWR is on wildlife-dependent recreation, other uses such as dog walking, horseback riding, bicycling, and jogging/running are currently not allowed, with the exception of the use of bikes on the paved entrance road. Any other proposed uses must be found to be compatible before they can be allowed. The process of evaluating proposed uses is discussed in Chapter 1 of this CCP under Legal and Policy Guidance.

4.1.13. Traditional Tribal Uses on Humboldt Bay NWR

Increased communication with the Wiyot Tribe, Blue Lake Rancheria, and Bear River Band of Rohnerville Rancheria is very important to the Complex. For reported thousands of years, the lands from Little River south along the coast to Bear River and inland to the first set of mountains were Wiyot territory. This area includes all of the existing units of the Humboldt Bay NWR. The Wiyot hunted wildlife, fished, and gathered plants for food, medicine, and basketry. Many of these uses are still practiced today. The Native American Policy of the Fish and Wildlife Service states that "The Service will provide Native Americans reasonable access to Service managed or controlled lands and waters for exercising ceremonial, medicinal, and traditional activities recognized by the Service and by native American governments. The Service will permit these uses if the activities are consistent with treaties, judicial mandates, or Federal and tribal law and are compatible with the purposes for which the lands are managed" (USFWS 1994).

4.1.14. Mosquito Integrated Pest Management on Humboldt Bay NWR

Mosquitoes are a natural component of wetland ecosystems. Both adult and larval forms are a food source for a variety of wildlife, such as birds, mammals, fish, and other invertebrates. Mosquitoes are also associated with being a nuisance species and vectors of disease-causing microorganisms, such as West Nile Virus (WNV). Five species of mosquitoes are known to inhabit the Humboldt Bay NWR and surrounding areas (*Culex tarsalis, Culesita particeps, Aedes increpitus, Aedes dorsalis,* and *Aedes vexan*). These mosquitoes can breed in and inhabit salt and freshwater marshes, riparian areas, and any objects that retain open water. Adult mosquitoes appear as early as April and persist until late summer, depending on the species. Although adults of individual species are relatively short lived, there are certain years when they experience natural periodic population explosions. In Humboldt County, *Culex tarsalis* transmits WNV, but is not the most numerous species found around the county.

The virus responsible for WNV entered California from the eastern U.S. in 2003 and was first reported in Humboldt County in 2004. WNV is found locally in corvids (crows and ravens), and raptors such as hawks and owls. To date, no human cases of WNV have been reported in Humboldt County. The young, old, and those with compromised immune systems are the most susceptible to being affected by WNV. Not all who contract the disease die from it, but fatalities from WNV have been recorded across the country.

In 2003 the county began implementing the Humboldt County West Nile Virus Monitoring and Response Plan. This program involved public education, media outreach, breeding source abatement, disease surveillance, and identification of mosquito species. Currently the county is not an abatement district, but is set up to become one if voted on by the County Supervisors. The state's Department of Public Health just released Best Management Practices for mosquito control on California State properties, the Service's Draft Mosquito Abatement Policy and Humboldt County's Mosquito Abatement Policy have similar methods and approach this issue in similar ways. The key to maintaining seasonal and estuarine wetlands with a minimum of mosquito production is to avoid conditions where pockets of water become isolated. If wetlands are connected to larger water bodies then most mosquito larvae are consumed by predators. Appendix F contains a draft compatibility determination for Mosquito Control for Humboldt Bay NWR.

4.1.15. Management of Older Buildings on Humboldt Bay NWR

The Humboldt Bay NWR has several old buildings on site. All are located on the Salmon Creek and Lanphere Dunes units. Disposal through sale, donation, recycling, demolition, or a combination thereof is currently the desired goal for the old Complex quarters/office, and at least the south part of the large barn, and possibly the quarters at Lanphere Dunes.

The refuge is planning to restore and maintain the old hunting cabin and much of the large barn if they pass a safety review. Both of these buildings have historic value locally and could add greatly to the refuge's connection with the local public.

4.1.16. Potential Humboldt Bay NWR Acquisitions

The refuge has recently worked with the Service's Region 8 realty staff to complete environmental compliance documentation for several small properties adjacent to the Hookton Slough Unit and one larger property adjacent to the Lanphere Dunes Unit. Other potential acquisitions in the foreseeable future could include several tracts within and/or adjacent to the Lanphere Dunes Unit, tidelands in both North and South Bay, and tracts adjacent to the Salmon Creek Unit. Lands are only acquired from willing sellers. Depending on the preference of each landowner, and according to Service's policy, the USFWS protects lands by acquiring the least amount of "interest" in a property necessary to accomplish refuge goals. This may include technical assistance, cooperative agreements, easements, fee title acquisition, and donations.

4.1.17. Potential Management Options for the Hookton Slough Unit

The Hookton Slough Unit was historically tidally influenced with freshwater contributions coming from Salmon Creek during floods, runoff and perennial springs from Table Bluff. In the 1800s, it was split by a road that led to what was a docking point for sailing ships, which were taking crops from the Eel River Valley to other places of commerce. This road still exists and serves as a dam that separates the unit hydrologically, except during the largest flood events. In later years, the rest of the area was diked and managed as short-grass pasture until purchased by the Refuge in the 1970s. Livestock was removed shortly after Refuge acquisition. During the 1980s and 1990s, the Refuge removed two large barns, a small residence, and a small shack at the slough's edge while at the same time constructing a parking area and trailhead that leads to a 1.5-mile trail with interpretive panels, vault restrooms, and a fishing dock/launch area for non-motorized boats.

During the early-1980s, when the Refuge was still being managed from South San Francisco due to budget constraints, the decision was made to repair the outer dike along the edge of Hookton Slough. The dike was rip-rapped and tidegate structures were replaced. In 2002, the two water control structures to the west of the parking lot failed and were replaced. In fall 2006, both the concrete box culvert east of the parking area and the 36-inch water control structure at the terminal end of the slough were modified with side-hinged gates to improve estuarine connection and fish passage. In January 2006, storm-driven tides topped this dike in several places and relatively minor repairs are necessary.

Because of the proximity of the Hookton Slough Unit to Salmon Creek, the potential value of these marshes as off channel rearing habitat for salmonids is very high (compared to the White Slough Unit, for instance). The Hookton Slough Unit also has high potential as tidewater goby habitat and is designated as critical habitat in the recovery plan for this species.

Existing issues/constraints to wetland connection and management options include:

- the aforementioned road,
- two homes along Hookton Road on the east side,
- at least two areas where Hookton Road would be inundated (if dikes were breached for tidal restoration),
- a relative lack of hydrologic, topographic, and ecological information,
- drainage issues of adjacent landowners, and
- potential for mosquito production and impacts.

The area is currently a mixture of fresh and brackish marsh and introduced grasses. The vegetation on Hookton Slough Unit has recently been mapped and there are some unique wetland vegetation associations. Current wildlife use is primarily by small birds, mammals, and invertebrates; however, cattail swamp is a relatively rare wetland type around Humboldt Bay and is used extensively by bitterns, rails, marsh wrens and red-winged blackbirds. Much of the unit (especially the west side) is currently not conducive to use by waterfowl or shorebirds due to vegetation and/or water conditions.

The original 1989 refuge management plan called for separating the Hookton Slough Unit into three management sections. The section east of the parking area would have been managed as freshwater marsh. The west side was to be split by a low contour dike constructed on the west side of an existing drainage ditch. The west side of this was proposed to be managed as more brackish and the middle area would be muted tidal marsh. This management was not implemented due to concerns over the constraints mentioned previously, permitting issues and other priorities. If the above mentioned constraints can be addressed, the options for management would be expanded.

4.1.18. Habitat Management on Castle Rock NWR

A major concern on Castle Rock NWR is loss of vegetative diversity, structure, and soil erosion. The concern about vegetation is primarily due to potential impacts on burrow-nesting species. Management intervention may be needed to maintain or restore healthy populations of burrow nesting species.

Vegetative changes on Castle Rock NWR occur annually due to grazing and roosting activities by geese and breeding activities by cormorants. Concern about the potential impacts of geese on vegetation and seabird habitat at Castle Rock were first mentioned by Osborne (1972) following the observation of 600 Aleutian Canada Geese on the island in 1970. Visible changes in the island's vegetation and declines in numbers of some breeding seabird species prompted management concern regarding potential negative impacts of the growing population of geese on the island's seabirds and sensitive habitats (Carter et al. 1992, Jaques and Strong 2001). Jaques (2004) conducted a preliminary examination of spatial and temporal relationships between selected breeding seabirds and roosting geese and suggested that night roosting geese are probably not a significant concern for surface nesting seabirds, but may represent an important negative impact on burrow-nesting species such as the tufted puffin. Changes in vegetation and soil erosion due to goose/cormorant use of Castle Rock NWR may be affecting other species including the Leach's storm-petrel and Cassin's auklet. The first step in addressing these issues is to establish baseline vegetation and erosion monitoring in order to better see if/what changes are actually occuring.

Mice can be a harmful predator for burrow-nesting seabirds. In addition to native mice, house mice (*Mus musculus*) have been found on Castle Rock NWR and could have ecological impacts if a breeding population exists.

4.1.19. Protection of Castle Rock NWR from Disturbance

Very few human disturbance events have been documented at Castle Rock NWR. However, due to its close proximity to shore and the Del Norte County airport it is vulnerable to disturbance from recreational boaters, low-flying aircraft, and other potential sources. Disturbance to seabird colonies during the breeding season can cause lowered reproductive success, breeding failure, and even colony abandonment.

4.1.20. Educational Outreach Regarding Castle Rock NWR

Educational outreach may help the public to generate voluntary support to reduce disturbance on and around Castle Rock NWR and to promote stewardship of the island resources by the local community.

Educational outreach and interpretation partnerships have been or could be developed with some of the following organizations to improve effectiveness: the U.S. Coast Guard (USCG), the Del Norte County Airport, Del Norte County Planning Department and Department of Parks, Del Norte County School System, kayaking guides/groups, and the sport and commercial fishing industries. The Aleutian Goose Festival held annually in Crescent City provides an excellent opportunity for educational outreach to the local and visiting public.

4.1.21. Seabird Monitoring on Castle Rock NWR

There is a need to establish a consistent seabird monitoring program at Castle Rock NWR to better inform population management for species that use its habitat. Management questions associated with this need include: how to accomplish the necessary monitoring without causing undue disturbance to sensitive island resources; what the monitoring frequency and techniques should be for given species; how can monitoring be funded; what parameters should govern the issuance of special use permits for research and monitoring; and how can Castle Rock NWR make the most of interagency relationships and larger-scale monitoring programs that are already in place.

5. Refuge Complex Goals, Objectives, and Strategies

This chapter presents the Refuge goals based on the vision statements described in Chapter 1. The management objectives and strategies to achieve the goal are listed after each goal.

Humboldt Bay NWR Goals

Goals are descriptive, open-ended, and often broad statements of desired future conditions that convey a purpose, but do not define measurable outcomes. Goals translate refuge purposes into management direction. Each goal is supported by one or more specific, measurable, achievable, results-oriented, time-fixed objectives with specific strategies needed to accomplish the objectives. Objectives are designed to be accomplished within 15 years. Actual implementation may vary as a result of available funding or other resource limitations.

Currently, the Service manages approximately 35 percent of the lands within the approved Humboldt Bay NWR boundary. This CCP presents goals and objectives primarily for those lands that are or will soon be managed by the Service, as well as limited voluntary cooperative land management with adjacent and regional landowners. The restoration objectives identified here are consistent with the restoration goals identified in the 1989 Humboldt Bay NWR Management Plan, described in Chapter 1.

Although invasive plant species are an integral part of managing salt marsh and other habitat types, prevention and control of invasive species are addressed in Goal 3, Objectives 3.1 through 3.3.

Note: Acreages given are approximate.

Goal 1. Conserve, manage, restore, and enhance estuarine and palustrine wetland habitats representative of the Humboldt Bay area to benefit their associated native fish, wildlife, plants, and special status species.

Objective 1.1 - Salmon Creek Delta Restoration:

- Adaptively manage ~60 acres of Salmon Creek overflow and ~50 acres adjacent to the main channel to meet the goals of Phase I of the Salmon Creek Restoration project.
- Within 3 years, meet the goals of Phase II of Salmon Creek Restoration project.
- Within 5 years, connect the new Salmon Creek channel to salmonid rearing habitat (Cattail Creek), and enhance habitat in upper section of Hookton Slough.

Rationale - Salmon Creek Delta Restoration:

The entire Salmon Creek watershed has been significantly impacted by logging in its upper reaches, agricultural development in the lower portion, and road building throughout. All of these activities have cumulatively altered the natural hydrology and topography of the Salmon Creek watershed and the delta in particular. Much habitat diversity has been lost, converted, or simplified due to historic diking, ditching, and removal or lack of recruitment of large woody debris to the system. Logs and rootwads that historically came down the creek and were integral components of the delta and marsh habitat have either been removed or cannot pass through smaller culverts or under low bridges.

Following refuge goals established in the previous management plan, Phase I of the Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities Project (PCFWWRA 2003, 2008) has been underway since 2002. The goals of this project are to improve fish passage, fish habitat, and water quality, create additional estuarine habitat, improve sediment transport, and reduce flooding upstream of the refuge. The first phase included replacement of the Lower Salmon Creek tidegate and installation of a second tidegate at the west end of the Salmon Creek overflow. In addition, two smaller tidegates on the Hookton Slough Unit were modified and some excavation work done to connect adjacent ponds to the creek to prevent fish stranding (PCFWWRA 2003).

Phase II of the Salmon Creek Restoration project includes:

- Relocate the reach of Salmon Creek channel within the refuge that currently flows through a linear ditch. A new channel will be constructed in the upper reach of tidal influence, and include a

stable channel form, historic habitat complexity and sinuosity, and improved routing of sediment and flood waters.

- Construct off-channel estuarine wetlands and side-channels in upper reach for salmonid rearing habitat and channel maintenance.
- Screen existing high-flow water diversion to eliminate stranding.

Many special status fish species use Salmon Creek during some stages of their lifecycle. Steelhead, Coho, and Chinook salmon are all Federal ESA-listed threatened species, which migrate upstream through Salmon Creek between fall and early spring (HBWAC, RCAA 2005). The tidewater goby, a Federal ESA-listed endangered species, uses the brackish, slower moving portions of the creek (USFWS 2006).

Large woody debris has been shown elsewhere on the west coast to be a key habitat component for salmonids in estuaries, providing them both feeding areas and refuge from predators (Simenstad et al. 2003). Currently, Hookton Slough is almost completely lacking in habitat diversity due to diking and no large woody debris. Recent research has increasingly demonstrated the importance of tidal estuaries and low gradient freshwater wetlands in the life history of salmonids (Cornu and Sadro 2002, Wallace pers. comm. 2006).

Increasing natural estuarine function at the lower end of Salmon Creek will help to restore habitat used by protected fish species. Truly functional estuarine habitat around Humboldt Bay is rare. It is a goal of the Complex to restore estuarine habitat to the maximum extent practicable on the Humboldt Bay NWR.

Refuge staff will continue to use the principles of adaptive management to restore natural function, conditions, and processes to the extent practicable on refuge lands without harm to adjacent landowners. This has been the goal since refuge acquisition of these lands in the 1980s.

Strategies - Salmon Creek Delta Restoration:

1.1.1. Continue to adaptively manage during all phases of the Salmon Creek Restoration project (monitor species and habitat use, changes in channel cross-sections, sediment transport, water quality, etc., and use results to guide future management).

1.1.2. Continue to develop and implement restoration projects with the staff of the Partners for Fish and Wildlife and Coastal Programs at the Arcata Fish and Wildlife Office. Also coordinate restoration projects with the NOAA Fisheries Service, USACE, and other regulatory agencies.

1.1.3. Implement Phase II of the Salmon Creek Restoration project, including excavation and restoration of 1,500 linear feet of meandering channel and other features as described in PCFWWRA (2003).

1.1.4. Establish a permanent tidal elevation station on Hookton Slough to quantify tidal change over time and assess managed conditions (ie., how creek level upstream of the dike reflects tidegate parameters).

1.1.5. Work with appropriate bay management partners and permitting agencies to develop and implement a plan to place large woody debris in Hookton Slough to improve habitat diversity for salmonids and goby and reduce predation.

1.1.6. Use excavated material from Phase II for salt marsh restoration and/or dike maintenance.

1.1.7. Install fish screen(s) at appropriate locations on the Salmon Creek Unit to allow diversion to seasonal wetlands without adverse effects to salmonids or other listed species.

1.1.8. Seek opportunities to work with upstream private landowners on habitat improvement projects.

1.1.9. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

1.1.10. Develop Habitat Management Plan and Resource Inventory and Monitoring Plan for all refuge units.

1.1.11. Excavate 500 linear feet to connect the new meandering Salmon Creek channel to salmonid rearing habitat (Cattail Creek) and secure large woody debris in the upper section of Hookton Slough to increase habitat, if feasible.

Objective 1.2 - Salt Marsh Habitat:

- Within 15 years, maintain 313 acres of existing salt marsh habitat and remove western dike on Table Bluff Unit.
- If feasible, restore 235 acres (90 acres at the Hookton Slough Unit, 45 acres on White Slough Unit, and 100 acres on Table Bluff Unit) to native salt marsh habitat.

Rationale - Salt Marsh Habitat:

Salt marsh was historically the most widespread wetland type around Humboldt Bay, but only ~10 percent remains, largely due to diking from the late nineteenth to the early twentieth century. The majority of land within the Humboldt Bay NWR boundary was historically tidally influenced, comprising large areas of salt marsh. Most of the lands were diked to prevent tidal water exchange and to promote agricultural practices. Many changes in the topography, hydrology, soils, and plant species composition have taken place since these lands were diked.

Native salt marsh is a threatened habitat type in Humboldt Bay and throughout the United States. Salt marsh contributes invaluable nutrients to the estuarine ecosystem; provides important habitat for fish, invertebrates, many shorebirds, and some other waterbirds; filters out pollutants; and buffers adjacent lands from flood tides and storms. Salt marshes may provide habitat for the endangered tidewater goby; several species of threatened salmonids; and eulachon, a CDFG California Species of Special Concern. Because of extensive diking, the Humboldt Bay estuary has sustained significant losses of salt marsh, primary productivity, and natural hydrology resulting in changes to sedimentation, deposition, currents, habitat for estuarine plant and animal species, and water quality.

Currently, the Humboldt Bay NWR includes 205 acres of salt marsh in North Bay distributed among the Lanphere and Ma-le'l Dunes units adjacent to Mad River Slough (46 acres) and the Jacoby Creek (73 acres) and Eureka Slough (86 acres) units, and a total of 108 acres of salt marsh in South Bay within the Salmon Creek (36 acres), Hookton Slough (26 acres), White Slough (11 acres) and Table Bluff (35 acres) units.

Several units of the refuge may provide some of the few remaining opportunities to regain some of the lost salt marsh around Humboldt Bay, including the Hookton Slough, White Slough, and Table Bluff units, which are all diked former salt marsh. However, there are substantial challenges including subsidence, lack of information on sedimentation rates and locations, invasive plants, and potential sea level rise. Refuge staff will use the principles of adaptive management to restore natural function, conditions, and processes to the extent practicable on refuge lands.

Possibilities for salt marsh restoration range from a managed muted tidal exchange through tidegates to completely natural and unmanaged tidal flow. The Table Bluff Unit mudflat and Teal Island are similar environments in that both were diked former salt marsh that have now had tidal flow re-established but have converted to mudflat due to subsidence. Methods employed for restoration to salt marsh here would necessitate fill being placed on existing mudflat to raise elevations. The Hookton Slough and White Slough units contain diked former salt marsh that is now subsided freshwater or brackish marsh. On these sites there is the possibility of managing for muted tidal exchange in order to avoid the necessity of elevation increases. Alternatively, if appropriate material was available, these sites could also be raised in elevation and subject to full tidal exchange. Potential methods to bring substrate up to the appropriate level include use of excavated or dredged materials, both of which have been used in San Francisco Bay and other coastal locations. Other factors to be considered during restoration planning include: impacts on threatened, endangered, and other species, values and uniqueness of existing habitat types, feasibility, and cost. While each coastal location presents a unique set of challenges, Refuge managers can learn from other sites and projects, employ an adaptive approach, and restore estuarine habitats on the refuge to the extent practicable.

Strategies - Salt Marsh Habitat:

1.2.1. Continue to develop and implement restoration projects with the staff of the Partners for Fish and Wildlife and Coastal Programs at the Arcata Fish and Wildlife Office. Also coordinate restoration projects with the NOAA Fisheries Service, USACE and other permitting agencies.

1.2.2. Do maintenance on tidegates and low points of dikes on the White Slough Unit in 2009-2010 in order to preserve the opportunity to have a managed restoration.

1.2.3. Gather existing information and pursue funding to assess existing elevations on refuge units and sedimentation rates and locations in South Bay with respect to salt marsh restoration.

1.2.4. Repair and modify the White Slough tidegate to improve estuarine and brackish marsh conditions on the inside of Salmon Creek dikes.

1.2.5. Collect data needed to model sea level rise for HBNWR using SLAMM (Sea Level Affecting Marsh Management), including sedimentation rates. Update National Wetland Inventory (NWI) maps for HBNWR to be used as basis for SLAMM models. Continue to keep informed of the latest research on sea level rise and other salt marsh

restorations, especially in Humboldt Bay, SF Bay, and in the Pacific Northwest, and factor information into restoration plans.

1.2.6. Assess possibilities of using clean dredge spoil or excavated materials to increase tidal elevation prior to restoration (HBHRCD, Caltrans, etc.).

1.2.7. Facilitate research projects related to salt marsh function (efficient restoration techniques, value to wildlife, influence on hydrology, functions).

1.2.8. Adaptively manage restoration of salt marsh habitat and maximize experimental value of all projects using adequate monitoring.

1.2.9. Collect native salt marsh vegetation prior to raising elevations, stockpile and re-plant vegetation after topsoil has been replaced on raised elevation site.

1.2.10. Raise the marsh plain elevation of Salmon Creek overflow by placing a layer of native, appropriate fill soil.

1.2.11. If feasible, use the dike material and additional appropriate fill from local sources on the White Slough Unit to raise the marsh elevation.

1.2.12. Use the dike material on the west side of the Table Bluff Unit to fill in the adjacent borrow ditch.

1.2.13. Use existing contractors and/or work with Humboldt Botanical Garden and Humboldt Fish Action Council to propagate salt marsh species for revegetation in restored salt marsh areas.

1.2.14. Coordinate with the North Coast Railroad Authority to open tidegates on the north end of the White Slough Unit to allow muted tidal action.

1.2.15. If feasible, import local topsoil layer or dredge spoil as fill to increase the elevation on the Table Bluff Unit to restore native salt marsh.

1.2.16. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

1.2.17. Develop Habitat Management Plan and Resource Inventory and Monitoring Plan for all refuge units

Objective 1.3 - Freshwater and Brackish Marsh (FBM).

- Within 15 years at the Salmon Creek Unit (SCU) (not including Salmon Creek restoration area), maintain 630 acres of seasonal FBM, maintain 270 acres of short-grass pasture, and of the 270 acres restore 100 acres to improve short-grass pasture for Aleutian cackling geese and other species. At the Hookton Slough Unit maintain 150 acres of FBM, within 2 years at the White Slough Unit repair perimeter dike and maintain 50 acres of FBM, at the Table Bluff Unit maintain 25 acres of FBM and restore 13 acres of non-native pasture grasses and weedy species to FBM.
- At the White Slough Unit maintain 7 acres of FBM.

Rationale - Freshwater and Brackish Marsh

Freshwater and brackish marsh are relatively rare and extremely valuable habitat types for a large variety of birds, and contribute to the abundance and diversity of wildlife found at the refuge. These two habitat types help sustain a variety of waterfowl, shorebirds, passerines, and waterbirds, as well as the raptors that prey upon them and other animals. In addition, otters, weasels, frogs, salamanders, and invertebrates use these habitats. Sloughs lined by brackish marsh are used by threatened salmonids and endangered tidewater gobies. Historically, there would have been a natural continuum or gradient of wetland habitats based on the salinity of the water from the bay's eelgrass and mudflats to salt marsh, brackish marsh, freshwater marsh, swamp, and riparian zones as the habitats progressed upstream. To the extent practicable on refuge lands, refuge staff will use the principles of adaptive management to restore these natural functions, conditions, and processes to refuge lands.

On the Hookton Slough Unit, restoring freshwater and brackish marshes at the east and west ends of the unit will allow for fish passage and increase rearing habitat for species such as threatened salmonids, listed endangered tidewater goby, and other associated species.

On the White Slough Unit, maintaining brackish marsh, enhancing and restoring freshwater riparian/swamp habitat, and restoring a continuum of freshwater to brackish to salt marsh in the northwestern portion of the unit will optimize estuarine conditions.

A unique situation has developed regarding the management of Aleutian cackling geese. Aleutian cackling geese are a recovered (previously endangered) species. The geese use short-grass habitat around Humboldt Bay during the winter and spring. Currently, the geese have reached a population level (100,000+) where they are having

depredation impacts on ranchers and farmers from the Eel River in northern California to the New River in southwestern Oregon. Enhancing grasslands on the Humboldt Bay NWR for Aleutian cackling goose forage can help reduce goose grazing pressure on adjacent agricultural lands and provide valuable short-grass habitat for many species of wildlife. Short-grass habitat also supports other wildlife such as invertebrates, some amphibians, small mammals, and migratory birds, including many species of shorebirds. Studies done on both the refuge and local ranches show that these geese prefer feeding on annual and perennial rye grasses, white clover, and berseem clover (USFWS unpubl. report).

Strategies - Freshwater and Brackish Marsh:

1.3.1. Continue to develop and implement restoration projects with the staff of the Partners for Fish and Wildlife Program and the Coastal Program at the Arcata Fish and Wildlife Office. Also develop and coordinate restoration projects with the NOAA Fisheries Service, USACE, and other permitting agencies.

1.3.2. Continue to work with Aleutian Goose Working Group on goose depredation and management issues.

1.3.3. Develop detailed designs to facilitate permitting on all South Bay Units restoration work.

1.3.4. Implement Phase II of the Lower Salmon Creek Restoration Plan.

1.3.5. Implement best management practices to minimize mosquito breeding habitat on all units.

1.3.6. Continue to use a cooperative land management agreement (CLMA) with local ranchers to manage short-grass pasture through a combination of grazing and haying.

1.3.7. Continue to update soil testing approximately every five years, and add lime when necessary to raise soil pH.

1.3.8. Continue seasonally appropriate mowing to maintain short-grass pasture and control thistle.

1.3.9. Assess implementation of Aleutian cackling goose study recommendations for management of short-grass pasture.

1.3.10. Use seasonally appropriate mowing to encourage growth of short-grass species favorable to Aleutian cackling geese on the Salmon Creek Unit and Hookton Slough Unit.

1.3.11. Study long term effects of disking and water management on wetland vegetation.

1.3.12. Enhance drainage (by cleaning ditches and maintaining water control structures) to create conditions more favorable to short-grass species and less favorable to salt grass and other non-target species such as drier and less saline tolerant species on the Salmon Creek Unit and Hookton Slough Unit.

1.3.13. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

1.3.14. Maintain and enhance existing native grass populations, including *Deschampsia caespitosa* and *Leymus triticoides,* through seeding and other cultivation activities on the Hookton Slough Unit.

1.3.15. On the Hookton Slough Unit, use existing and/or new water control structures to allow for muted tidal exchange and fish passage in eastern and western areas without loss of freshwater and brackish marsh.

1.3.16. On the White Slough Unit, work with Caltrans to dechannelize Chism Creek so that it enters the west White Slough Unit area to maximize freshwater/salt marsh continuum.

1.3.17. Develop wetlands around Headquarters Unit and adjacent to Long Pond on the Salmon Creek Unit.

1.3.18. On the Salmon Creek Unit (near the duck ponds), install a low contour dike to impound water, or for a more stable wetland habitat excavate and use excavated materials for a contour dike.

1.3.19. On the Hookton Slough Unit, develop and implement a hydrologic model and restoration plan that allows for at least partial tidal restoration in the central area (see Salt Marsh alternatives), with muted tidal influence to eastern and western areas such that native freshwater to brackish vegetation is preserved while allowing for fish passage, salmonid rearing, and tidewater goby habitat.

1.3.20. Construct a 1/4 mile low contour dike along Hookton Road to allow muted tidal flooding on the Hookton Slough Unit.

1.3.21. Develop Habitat Management Plan and Resource Inventory and Monitoring Plan for all refuge units.

Objective 1.4 - Riparian Swamp Habitat

- Within 15 years, manage 35 acres of existing riparian/swamp habitat, plant native riparian/swamp vegetation in agricultural wetlands, and within 5 years replace 20 acres non-native tree community (including eucalyptus, Monterey pine, and Monterey cypress) on Salmon Creek Unit with native riparian vegetation. Species that may benefit from riparian swamp habitat restoration include the bank swallow (a California ESA-listed as threatened bird) and Vaux's swift (a California bird species of special concern).

- Restore approximately 3 acres of riparian habitat on the White Slough Unit.

Rationale - Riparian Swamp Habitat:

Riparian habitat is very rare now compared to what existed historically in the Humboldt Bay area. This diverse plant community provides valuable travel corridors for wildlife and habitat supporting biological integrity and environmental health on the refuge. Riparian forests provide rich habitat for a wide variety of plant species, mammals, reptiles, amphibians, and especially migrating and nesting songbirds, and improve conditions for fish by contributing nutrients, shade, and cover to streams. Riparian/swamp plant communities in the region are largely composed of red alder, willows, Sitka spruce, salmonberry, twinberry, California blackberry, wax myrtle, ladyfern, woodfern, sword fern, small-fruited bulrush, skunk cabbage, and associated species in wetter areas. Since refuge acquisition in the late 1980s, much effort has been put into development of riparian habitat. However, much of the restored riparian habitat on the refuge lacks a complex understory and has limited species diversity. These areas can be enhanced through additional plantings.

Strategies - Riparian Swamp Habitat:

1.4.1. Continue selective removal of non-native tree communities as resources allow.

1.4.2. Use a combination of IPM techniques to control non-native tree communities.

1.4.3. Enhance riparian/swamp habitat by planting native understory plants, and provide deer protection until establishment.

1.4.5. If feasible, implement cooperative agreements with interested parties to remove non-native eucalyptus trees.

1.4.6. Continue to partner with local habitat restoration groups and volunteers (CA Trout, Fortuna Creeks, CCC, Master Gardeners, FHBNWR, College of the Redwoods, Humboldt State University, Humboldt Fish Action Council and Botanical Garden Foundation to complete riparian restoration projects.

1.4.7. Use local native plant genotypes for restoration.

1.4.8. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

1.4.9. If the railroad authority declines to open tidegates on the White Slough Unit, assess possibility of restoring northern 16 acres to riparian habitat.

Objective 1.5 - Eelgrass and Mudflat Habitat:

- Over 15 years, participate in ongoing partnerships and create new partnerships to conserve and manage mudflat/eelgrass habitat for long term health.

Rationale - Eelgrass and Mudflat Habitat:

Maintaining healthy eelgrass beds is essential to the health and productivity of Humboldt Bay fish and wildlife. Eelgrass is a key component of the lifecycle of many bay species. Among waterfowl, the Pacific Flyway population of brant is dependent upon eelgrass throughout the Flyway. Humboldt Bay is a critical spring staging area for brant because it has the greatest amount of eelgrass between their wintering areas in Baja California and Willapa Bay in Washington, their next most important stop after Humboldt Bay during spring migration.

Currently, refuge staff coordinates with researchers monitoring eelgrass beds in Humboldt Bay. Monitoring eelgrass beds is important because many human land use activities can impact the survival and health of eelgrass communities. In addition, non-native dwarf eelgrass (*Zostera japonica*) has been introduced to Humboldt Bay and the Eel River estuary. Detecting and controlling new or previously unidentified infestations of dwarf eelgrass will be an important part of maintaining healthy native eelgrass beds.

Some restoration activities have the potential to affect eelgrass beds. To help ensure that restoration activities are not adversely affecting eelgrass beds, the Refuge will pursue new partnerships to assist in monitoring and management of eelgrass

beds in south Humboldt Bay. Some examples of how restoration activities may effect eelgrass beds include (Thayer et al. 2005):

- siltation can entirely smother plants or increase turbidity, lowering available radiation for photosynthesis
- high levels of nutrients in run-off can cause increases in algal growth and subsequent eutrophication detrimental to eelgrass
- mechanical damage to eelgrass can result from fishing, anchoring, and dredging
- oil spills can cause direct mortality of plants

Transplanting eelgrass rhizomes with shoots can be a successful way to restore eelgrass beds if the habitat requirements of eelgrass are met (Thayer et al. 2005). Perhaps the greatest threat to eelgrass in the longer term is sea level rise, and for this both local and regional monitoring will be needed.

Strategies - Eelgrass and Mudflat Habitat:

1.5.1. Work with partners including HBHRCD to monitor potential impacts of Salmon Creek restoration projects on eelgrass beds.

1.5.2. Continue partnership with the Humboldt Bay Ecosystem-based Management (HBEBM) program for studying the bay ecosystem, including mudflat/eelgrass habitat, and continue collaboration with Humboldt State University and USFWS/ USGS to study eelgrass/brant/sea level rise interrelationships.

1.5.3. Continue partnership with CDFG, University of California Sea Grant, and Humboldt Bay Harbor, Recreation, and Conservation District (HBHRCD) for continued monitoring of and research on invasive species that may impact eelgrass.

1.5.4. Pursue additional funding for research on the ecology and conservation of eelgrass, including effects of sea level rise, through the PCJV and the Service's coastal program.

1.5.5. Pursue an MOU with the HBHRCD and CDFG, which have special regulatory and legal jurisdiction over the bay, to conserve inter-tidal areas within the approved refuge boundary.

1.5.6. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

Objective 1.6. - Floodplain Management:

- Manage Humboldt Bay NWR floodplain lands in a manner consistent with local, State, and Federal flood management, sediment, and erosion control and water quality objectives as required by local, State, and Federal guidelines, and within 10 years work toward achieving the North Coast Basin Plan objectives for inland surface waters, enclosed bays, and estuaries for the benefit of fish and wildlife resources.

Rationale - Floodplain Management:

Refuge restoration and management will be consistent with Federal, State, and local flood guidelines. Compliance with guidelines can largely be achieved by operating the Humboldt Bay NWR consistent with the North Coast Regional Water Quality Control Board (NCRWQCB) Basin Plan. Water quality control basin plans provide a basis for protecting water quality throughout California (NCRWQCB 2007). The goal of the Basin Plan is to provide a definitive program of actions designed to preserve and enhance water quality and to protect beneficial uses of water in the North Coast Region.

A water quality monitoring program can be used to further education and outreach efforts with local landowners and agricultural landowners. Current threats to the water quality of the refuge and bay include bacterial quality concerns, and to a lesser extent include sediment, nutrients, bacteria and pesticides from agricultural runoff; impacts from forestry activities; urban runoff; and spill sites around the bay (NCRWQCB 2007).

Strategies - Floodplain Management:

1.6.1. Implement Humboldt Bay NWR habitat improvement projects and strategies in a manner that does not exacerbate local or regional flooding, water quality, or erosion effects on adjacent or nearby landowners or residents.

1.6.2. Within 10 years, work to achieve the relevant water quality objectives as described in Section 3 of the North Coast Basin Plan (as described in NCRWQCB 2007).

1.6.3. Review and participate in regional planning activities sponsored by Humboldt County and local municipalities, such as the cities of Eureka and Arcata, which may affect flooding regimes or water quality in and around Humboldt Bay.

1.6.4. Work with the appropriate entities, such as CA Dept. of Public Health, to develop a long-term water quality monitoring program to assess the effects of non-point sources of pollution entering the Humboldt Bay NWR and contaminant levels in fish and other biota (especially in Mad River Slough, above the oyster racks).

1.6.5. Work with the appropriate entities to develop a long-term water quality monitoring program to assess the impact of sediment flushing from Salmon Creek on eelgrass beds in southern Humboldt Bay and potential non-point source pollutants adjacent to Mad River Slough.

1.6.6. Work with partners to develop strategies to inform people within the watershed about non-point sources of pollution and the benefits of reduced pollutants entering Humboldt Bay.

1.6.7. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

Goal 2. Conserve and restore globally rare dune and dune forest habitats, associated native plant and animal species, and support recovery of threatened, endangered, and endemic species dependent upon these rare habitats.

Objective 2.1 - Dune Mat/Foredune Grassland

- Within 5 years, restore the Ma-le'l Dunes and Table Bluff units dune mat/foredune grassland habitat.

- Over 15 years, create ongoing experimental dune blow-outs in late successional, low diversity dune mat (to mimic natural disturbances), and assess impacts on existing habitat and special status plants on the Lanphere Dunes Unit.

Rationale - Dune Mat/Foredune Grassland:

Dune mat habitat on the Humboldt Bay NWR is some of the most pristine habitat of its type on the west coast of the United States, containing native plant communities that are globally declining (Pickart and Barbour 2007). Humboldt Bay wallflower and beach layia are listed as endangered species under the Federal ESA. California Native Plant Society 1B list plants (rare or endangered in California and elsewhere) in the dune mat/foredune grassland plant community include dark-eyed gilia and pink sand verbena. Due to the isolation of dune habitats, many rare species occur there, and many potentially endemic or rare species may not have yet been scientifically documented. Under-studied species of globally endangered lichens, endemic insect populations, and endemic mycorrhizal fungi exist in unknown quantities in this rare habitat type. Foredune plant communities are globally rare, and the Lanphere Dunes represent some of the most pristine dunes left on the west coast of the United States.

Due to a combination of natural succession and possibly some human-induced impacts, early successional vegetation found at the Lanphere and Ma-le'l Dunes Units is succeeding to more stable, less diverse communities in many areas. It is likely that dune mat and foredune grasslands evolved with dune blow-outs (rapid shifts in tall dunes) as a factor in their constant regeneration (Pickart and Barbour 2007). The refuge proposes to experiment with the use of heavy equipment to mimic large scale disturbances such as blow-outs to stimulate localized sand movement to sustain early successional communities. By creating blow-outs and monitoring the effects on plant communities, the refuge will increase the understanding of the best methods to manage these communities over time.

Strategies - Dune Mat/Foredune Grassland:

2.1.1. Continue to work with the Humboldt County Dunes Cooperative to contribute to managing Humboldt County dunes as an ecosystem.

2.1.2. Conduct experiments with heavy equipment to create and monitor blowouts in strategic areas where foredunes are stable and species diversity is declining.

2.1.3. Repeat vegetation sampling done in 1987 to quantify dunemat/foredune grassland succession rate and impacts to Humboldt Bay wallflower.

2.1.4. Conduct research on interactions between endemic solitary bees and biotic soil crusts (cryptogamic crusts).

2.1.5. Conduct Humboldt Bay wallflower population viability assessment (PVA) using existing demographic data set for Lanphere Dunes.

2.1.6. Develop a cooperative agreement with adjacent private landowners to collect native dune grass propagules, and plant out to increase population of *Leymus mollis* at Lanphere and Ma-le'l units.

2.1.7. Develop a Habitat Management Plan and Resource Inventory and Monitoring Plan for all refuge units.

2.1.8. Inventory wildlife species, including invertebrates, in dune mat/foredune grassland habitats.

2.1.9. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

2.1.10. Continue to conduct metapopulation sampling of Humboldt Bay wallflower North Spit populations. Expand to include South Spit and Elk River spit populations. Track population size, reproductive rate, size class distribution, and disease incidence by geographic areas on a 9- or 10-year interval.

2.1.11. Develop partnerships to conduct habitat restoration, caging of reproductive plants to protect from deer, and to collect Humboldt Bay wallflower seed from South Spit, with the goal of increasing this subpopulation size. Reintroduce seeds from this subpopulation to restored habitat on Table Bluff Unit.

2.1.12. Disperse seeds of Humboldt Bay wallflower from Lanphere Dunes and Ma-le'l dunes subpopulations to unoccupied, restored habitat on Ma-le'l dunes and monitor results.

2.1.13. Continue annual monitoring of *Layia carnosa* on northern dune units. Map and begin monitoring of Table Bluff Unit subpopulations.

Objective 2.2 - Dune Swale

- Within 10 years, restore ~67 acres of dune swale plant communities on all dune units. Species that may benefit from dune swale habitat restoration include northern red-legged frog (a California species of special concern), black-capped chickadee, yellow warbler, and Cooper's hawk and a variety of mammals.

Rationale - Dune Swale:

Dune swales are a relatively rare vegetation type, occurring strictly in dune systems and primarily north of the central coast of California. Swales provide valuable habitat for several species of reptiles and amphibians, including the northern red-legged frog, a California Species of Special Concern (SSC). Several bird SSC also use dune swale habitat, including black-capped chickadee, yellow warbler, and Cooper's hawk. Many mammal species use this habitat for foraging and cover, as well as for breeding by small mammals. As with other rare dune habitats, pristine dune swales are rare on the west coast of the United States, occurring only north of the central coast in California (Pickart and Barbour 2007). Compared with the coniferous forests and dune mat, swales have received relatively little management attention. Quantitative descriptions of these plant communities are needed, especially given potential changes induced by climate change.

Given the rarity of dune swale habitat and its value to wildlife, removal of invasive plant species and restoration of native plant species is necessary for the maintenance of the biological integrity, diversity, and environmental health of the dune ecosystem as well as to protect many California Species of Special Concern.

Strategies - Dune Swale:

2.2.1. Continue to work with the Humboldt County Dunes Cooperative to contribute to managing Humboldt County dunes as an ecosystem.

2.2.2. Assess need for and revegetate with appropriate native local plants after invasive plants are removed.

2.2.3. Pursue funding to complete restoration.

2.2.4. Develop a Habitat Management Plan and Resource Inventory and Monitoring Plan for all refuge units.

2.2.5. Inventory wildlife species, including invertebrates, in dune swale habitats.

2.2.6. Inventory nonvascular plants, and quantitatively sample and describe dune swale plant communities.

2.2.7. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

Objective 2.3 - Dune riparian/swamp:

- Within 5 years, restore ~33 acres of riparian/swamp habitat on the Ma-le'l and Lanphere Dunes units, and gain a more comprehensive understanding of plant and animal species that inhabit the riparian/swamp habitat on the Ma-le'l and Lanphere Dunes units. Species that may benefit from dune riparian/swamp habitat restoration include the northern red-legged frog (a California species of special concern), many species of migratory birds, several bird species of special concern, including Vaux's swift, willow flycatcher, yellow-breasted chat, and the bank swallow, a California ESA-listed as threatened bird.

Rationale - Dune Riparian/Swamp

Dune riparian swamp habitat provides valuable habitat for several species of reptiles and amphibians, including the northern red-legged frog, a California Species of Special Concern. Many species of migratory birds use dune riparian/swamp

habitat, as do several SSC bird species including Vaux's swift, willow flycatcher, yellow-breasted chat, and a California ESA listed threatened bird, the bank swallow. The SSC yellow warbler nests in this habitat type. Many mammals also make use of dune riparian/swamp habitat for foraging, cover, and breeding. Maintaining and restoring this habitat will contribute to the biological integrity, diversity, and environmental health of this rare dune habitat type.

Currently there are no complete inventories of nonvascular plants and wildlife species, including invertebrates, that are resident or migratory inhabitants of riparian/swamp habitats on the dune units. Although plant inventories have been completed, there has been no quantitative description of the vegetation of these habitats. While riparian swamps are known to be rich habitats for wildlife, the lack of adequate information on wildlife use of dune riparian and swamp habitat makes it difficult to prioritize management of this habitat when compared with other management needs of the refuge. Gaining a comprehensive understanding of vegetation, nonvascular flora, and animal species utilizing dune riparian and swamp habitat would yield information that may provide guidance to the management of these habitats for higher priority species conservation. Once comprehensive species information is obtained, managers would have a basis upon which to implement various strategies to enhance dune riparian and swamp habitats that would be more likely to benefit conservation of high priority species, and a reasonable basis for expending limited resources.

Strategies - Dune Riparian/Swamp:

2.3.1. Continue to work with the Humboldt County Dunes Cooperative to contribute to managing Humboldt County dunes as an ecosystem.

2.3.2. Develop a Habitat Management Plan and Resource Inventory and Monitoring Plan for all refuge units.

2.3.3. Inventory wildlife species, including invertebrates, in dune riparian/swamp habitat.

2.3.4. Work with Humboldt Bay Bird Observatory, the Humboldt State University wildlife department, and other partners to develop avian research objectives.

2.3.5. Continue collaborative research on neo-tropical migrant birds by Humboldt State University, Humboldt Bay Bird Observatory, or other partners.

2.3.6. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

2.3.7. Inventory nonvascular flora, and quantitatively sample and describe vegetation communities of riparian/swamp habitats.

Objective 2.4 - Coniferous Dune Forest:

- Over 10 years, maintain and restore 180 acres of coniferous dune forest habitat on the Ma-le'l and Lanphere Dunes units; within 10 years, gain a more comprehensive understanding of animal species that inhabit the coniferous dune forest habitat on the Ma-le'l and Lanphere Dunes units.

Rationale - Coniferous Dune Forest:

Coniferous dune forest is a globally declining habitat type. It includes a number of different plant associations, some of which are restricted in distribution or at the edge of their geographic ranges. Coniferous forest supports many of Humboldt Bay NWR's mammal species, including the rare white-footed vole, a CDFG California Species of Special Concern (CDFG 2007). Several CDFG California Bird Species of Special Concern also use coniferous dune forest habitat including Cooper's hawk, yellow warbler, osprey, and black-capped chickadee. Coniferous dune forest provides habitat for several species of amphibians and reptiles. Many specialized (including mycoheterotrophic) plant species, such as sugar stick (*Allotropa virgata*), spotted coral-root (*Corallorhiza maculata*), calypso orchid (*Calypso bulbosa*), and twayblade (*Listera cordata*), are uncommon close to the coast, and have been found only in a few locations in the coniferous dune forest habitat. Maintaining and restoring healthy native plant communities in the coniferous dune forest contributes greatly to the overall biological integrity, diversity, and environmental health of the refuge and surrounding area.

The coniferous forest at the refuge was subject to a large windfall event during the storm of New Years eve, 2005. Although wind is recognized as the structuring agent of these forests, the large losses of trees may be ecologically significant given the fragmented state of the forest. Research is needed to evaluate the effects of this event, particularly given the likelihood of increased extreme weather events with climate change.

While some information is available, currently there are large gaps in survey information of

nonvascular plants and wildlife species that are resident or migratory inhabitants of coniferous dune forest habitats on the dune units, and this limits the ability to effectively manage this habitat. Restoring coniferous dune forest margins at the Ma-le'l Dunes Unit, now dominated by European beachgrass, to native coniferous forest communities will enhance habitat for many special status species. There is currently a discontinuity in forest habitat at this location. Restoring forest species will provide a corridor for movement of wildlife species and prevent the continued expansion of European beachgrass.

Strategies- Coniferous Dune Forest:

2.4.1. Continue to work with the Humboldt County Dunes Cooperative to facilitate coordinated, ecosystem management of dune forests.

2.4.2. In 5 years, inventory, remove, and restore non-designated human trails throughout the forest.

2.4.3. Develop a Habitat Management Plan and Resource Inventory and Monitoring Plan for all refuge units.

2.4.4. Pursue funding for research on coniferous dune forest ecology, including 2005 windstorm/tree fall event, and initiate longterm monitoring in forest gaps resulting from this event.

2.4.5. Pursue grant funding and research on neo-tropical migrant birds by Humboldt Bay Bird Observatory, Humboldt State University, or other partners.

2.4.6. Repeat endangered (e.g., internationally endangered *Bryoria* spp.) lichen survey and consider management; tie research into 2005 windstorm/tree fall event.

2.4.7. Inventory wildlife species, including invertebrates, in dune forest habits.

2.4.8. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

2.4.9. Grow or identify local appropriate sources for restoration plant materials.

2.4.10. Pursue grant funding to restore European beachgrass stands to coniferous forest at the Ma-le'l Dunes Unit.

Goal 3. Conserve and restore all refuge habitats through the prevention and control of invasive plants and animals.

Objective 3.1. Prevention and early detection

- Over the next 5 years, develop and implement a Hazard Analysis and Critical Control Point (HACCP) Plan for the Refuge.

- Within 10 years, develop and enhance the Refuge's capacity to identify, report and effectively respond to newly discovered, localized invasive species.

- Over the next 15 years, increase organizational collaboration on invasive species issues with Federal, State, and local entities, tribes, private organizations and individuals.

Rationale - Prevention and early detection:

An invasive species is a non-native species whose introduction does or is likely to cause economic or environmental harm or harm to human health (E.O. 13112, 3 February 1999). Invasive species are widely considered to be the greatest threat to natural areas after habitat loss. They negatively affect up to 46 percent of endangered species. The USFWSs Biological Integrity Policy (601 FW 3) specifies that the Refuge System manage non-native invasive species by the use of integrated pest management strategies, which can include mechanical, chemical, biological, and cultural techniques.

Early detection and prevention are the most ecological and economical methods of invasive species control. Humboldt Bay has a regional fishing industry and commercial shipping. These boats and ships are potential carriers of invasive species. Preventive measures (similar to those used in Alaska, Hawaii, Australia) to invasive species importations would not only support the Refuge System's mission, but would support the protection of the Bay's biodiversity during the upcoming challenges that will be faced by land management agencies with global climate change. The Refuge promotes preventive measures for the current and future threats to the integrity of biological diversity and natural ecosystem integrity in this region and nationally.

Invasive species infestations are not limited by ownership boundaries. Identifying the threat of an invasive species at an ecosystem level improves the ecological and economic effectiveness of the control methods. The Humboldt Bay NWR is committed to cooperatively work with adjacent landowners

and the Humboldt-Del Norte Weed Management Area to control the spread and adverse effects of invasive species. This cooperation will enhance the effectiveness of control strategies on Humboldt Bay NWR lands and will reduce the ecological impacts of invasive species on those lands and the surrounding ecosystems.

The Humboldt Bay NWR has been highly altered through human manipulation and invasive species, which are widespread within the Refuge's units. However, many of these species are in an incipient stage of infestation, occurring only in a few small areas. Control at this early stage of infestation is most efficient and effective. The dune units of the Refuge have received extensive management for the control and eradication of invasive species beginning in the 1970s. Ongoing maintenance efforts are needed to prevent new infestations from occurring, and to locate and eradicate missed occurrences. This minimal effort protects the financial investment as well as the ecological values of these highly diverse natural systems.

In this section, the scientific names are used in cases where the use of the common name alone would not provide sufficient information to identify the plant species being discussed. Scientific names are shown in italicized text. All species presently on the refuge are included in the plant list in Appendix J.

Strategies - Prevention and early detection:

3.1.1. Develop a Hazard Analysis and Critical Control Point (HACCP) Plan for the Refuge to prevent establishment of new invasive species on the refuge.

3.1.2. Continue to develop the Volunteer Invasives Mapping and Control Program at south refuge units and seek Service funding of $16,000 per year for volunteer and Friends groups' invasive plant control programs.

3.1.3. Continue coordination and collaboration on control projects with existing partners (e.g., FOD, Friends of HBNWR, Fortuna Creeks Project, CCCs, CDF, etc.).

3.1.4. Participate in the local weed management area coordination meetings.

3.1.5. Recruit local high school students to support the volunteer mapping program.

3.1.6. Develop a volunteer early detection rapid response crew that can quickly remove incipient invasive species populations at all units.

3.1.7. Provide outreach and information to adjacent landowners, cooperators and the public informing them of the complete costs of invasive plants.

3.1.8. Eradicate/control invasive species in south refuge units identified in Volunteer Invasive Species Mapping Program as early detection species; *Phalaris arundinacea*, *Phalaris aquatica*, *Echinochloa crus-galli*, *Cortaderia jubata*, *Cirsium arvense* and *Calystegia silvatica*.

3.1.9. Work with partners, including the Humboldt Bay Harbor Recreation and Conservation District, the Humboldt Bay Ecosystem Management Program and Humboldt County Weed Management Area to develop and fund a multi-species monitoring program for Humboldt, Eel River and Mad River estuaries to detect new infestations of high priority intertidal and sub tidal species such as dwarf eelgrass (*Zostera japonica*).

3.1.10. Continue ongoing survey, monitoring and treatment of new occurrences of previously eradicated species including English ivy and other forest invasive plants.

3.1.11. Continue the annual European beachgrass (*Ammophila*) Sweep at dunes units and expand to detect new infestations of other high priority previously eradicated species including *Cortaderia jubata* and *Cirsium vulgare*.

3.1.12. Work with partners including Friends of the Dunes to complete eradication of *Coincya monensis*, a highly invasive mustard known to only one area (in Manila) west of Mississippi and *Senecio elegans*, known in Northern California only in the Manila area.

3.1.13. Work with partners including Redwood National and State Parks to eradicate the highly invasive purple loosestrife on the South Fork Eel River to prevent infestation of Eel River estuary and Humboldt Bay wetlands.

3.1.14. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

3.1.15. Coordinate with adjacent landowners and proactively work with partners and pursue grant funding to control the spread of invasive plants onto Humboldt Bay NWR units.

Objective 3.2. Control and reduce the spread of established invasive species populations in Refuge habitats

- Within 15 years, monitor and strategically remove, control, or eradicate invasive plant infestations.
- Within 5 years, expand the existing the volunteer program for invasive plant control to achieve maintenance level control of high priority target invasive plant species.
- Within 10 years, use an additional contract based control program to achieve maintenance level control of all targeted invasive plants.

Rationale - Management of established invasive species

As discussed under Objective 3.1, invasive species are among the most pressing threats to natural areas, their biodiversity, ecosystem function, and endangered species. Invasive plants directly displace native plants through competition, resulting in a loss of species diversity and creating artificially homogeneous communities. They also indirectly impact native plants by altering soils and biophysical processes, facilitating secondary invasive species, and altering the balance of plant-invertebrate, plant-microbe, and plant-fungal interactions including pollination, herbivory, and mutualism, and increasing susceptibility to pathogens. Invasive plants impact wildlife by providing inferior forage for mammals, eliminating the food base for species-specific invertebrate herbivores, and by negatively changing habitat structure. Invasive species affect ecosystem processes such as mineral, nitrogen, and carbon cycling, and hydrology. Invasive species are not generally confined to the refuge; rather, they spread to and from private and other public lands and cause the same impacts there. This presents the dual problems of protecting the refuge from adjacent impacts and protecting refuge neighbors from dispersal of invasives already on the refuge.

Partnerships and volunteer programs can be a valuable way to increase the refuge's ability to remove invasive plant species. Both types of programs offer important outreach opportunities. However, volunteer time is limited and may only allow for maintenance level control of the highest priority invasive plants. Staff oversight of an expanded volunteer invasive plant control program would either require additional staff time or would draw limited staff resources away from other projects.

The highest level of invasive species control would be achieved through a combination of expanded volunteer, partner, and supplemental contractor based programs. Invasive species control is a priority for the refuge system. This combined approach would achieve the highest level of invasive species control, but would require additional staff time, material support for volunteer programs, and resources for contract support.

Strategies - Management of established invasive species

3.2.1. Within 3 years, complete and implement a step-down Integrated Pest Management Plan for control of all invasive plant species that threaten Humboldt Bay NWR habitats and species

3.2.2. Control and/or eradicate invasive plants on all units, with emphasis on newly established populations including *Lotus uliginosus, Iris pseudacorus, Senecio sylvaticus*, reed canarygrass (*Phalaris arundinacea*), and *Erechtites glomerata* on the Hookton Slough Unit, and on annual grass infestations on dune units.

3.2.3. Work with Youth Conservation Corps (YCC) to eradicate/control invasive plant species, particularly *Cirsium vulgare* and *Erechtites glomerata* on the Table Bluff Unit.

3.2.4. Manage non-native pasture grass in restored areas of Hookton Slough and Table Bluff units to a maintenance level of control.

3.2.5. Systematically carry out seasonally appropriate mowing to maintain short-grass pasture and control thistle on most South Bay refuge units.

3.2.6. Develop and implement a 5-year plan to remove eucalyptus and other non-native tree communities, and restore native communities using IPM techniques for removal and control of the eucalyptus.

3.2.7. Work with California Conservation Corps and California Dept. of Forestry (High Rock Conservation Camp) to complete removal of *Hedera helix* and other forest invasive plants and any remaining ice plant on dune units.

3.2.8. Assess dune swale invasive plants and implement large scale experiments as appropriate (e.g., flaming, controlled burning, mowing).

3.2.9. Work with CDF to complete manual removal of European beachgrass on appropriate areas of Ma-le'l Dunes Unit in areas that were not covered under Ma-le'l CDF restoration plan.

3.2.10. Use heavy equipment to remove European beachgrass on appropriate areas of Ma-le'l Dunes Unit in areas that were not covered under Ma-le'l CDF restoration plan.

3.2.11. Work with YCC, volunteers, and contractors to plant coniferous dune forest species on Ma-le'l in areas with European beachgrass that were not included in Ma-le'l CDF restoration plan (on interior high slipfaces).

3.2.12. Address off-site source of annual grass infestation on dune units through cooperative agreements or acquisition and management of source sites.

3.2.13. Work with Ma-le'l CMA partners (BLM, Redwood Gun Club, Sierra Pacific, Friends of the Dunes, staff of the Service's Partners for Fish and Wildlife and Coastal Programs, and private landowners) to address offsite sources of invasives such as reed canary grass (*Phalaris arundinacea*), pampas grass (*Cortaderia jubata*), yellow bush lupine (*Lupinus arboreus*), and Scotch broom (*Cytisus scoparius*) using YCC volunteers. Seek funding from multiple sources such as the Coastal Program, Partners for Wildlife, and the Humboldt WMA.

3.2.14. Test use of prescribed burns on dunes to control annual grass invasions.

Objective 3.3 - Control of Spartina densiflora

- Within 10 years, control *Spartina* on all refuge locations.
- Within 15 years, participate in a collaborative interagency effort to eradicate *Spartina* on the majority of coastal habitats of Humboldt County, if found to be feasible.

Rationale - Control of Spartina densiflora:

Salt marsh was historically the most widespread wetland type around Humboldt Bay, but only ~10 percent of those wetlands remain, largely due to diking from the late nineteenth to the early twentieth century. Remaining native salt marsh habitat is threatened by invasive dense-flowered cordgrass, (*Spartina densiflora*, hereafter *Spartina*), which was introduced from Chile in the nineteenth century in ship ballast. Native salt marsh vegetation has several State-listed plant species of special concern, including Pt. Reyes birds-beak (*Cordylanthus maritimus* ssp. *palustris*), Humboldt Bay owl's clover (*Castilleja ambigua* ssp. *humboldtiensis*). Of the remaining ~900 acres of salt marsh, ~90 percent has been invaded by the non-native *Spartina*. This *Spartina* out-competes native salt marsh plants, reducing native biodiversity and converting marshes to a monoculture. *Spartina* likely changes sedimentation patterns, alters carbon cycling and productivity, and changes the estuarine food web in undocumented ways. Control of this non-native plant is important to re-establishing the native salt marsh plant and animal communities in Humboldt Bay and adjacent estuaries, as well as preventing the spread of *Spartina* to other locations on the Pacific coast that are trying to protect their own native flora and fauna. Because of *Spartina* spp. ability to spread and their threat to native fish, wildlife, and habitats, eradication of *Spartina* spp. on the west coast of the United States was identified as a high priority in the West Coast Governors Agreement that was signed in 2007. Over the past two years, the refuge has developed a successful methodology for controlling *Spartina*, although true eradication is not possible while sources of seed continue to exist outside the refuge's boundaries.

Strategies - Control of Spartina densiflora:

3.3.1. Complete and maintain *Spartina* removal at dune units using methods that have proven to be successful at the refuge (including the use of metal-bladed weed-eaters).

3.3.2. Seek funding to expand *Spartina* control to south refuge units, focusing on early infestations in Hookton Slough, Salmon Creek, and White Slough brackish marsh areas.

3.3.3. Consider effects of climate change during planning and implementation of *Spartina* control in Humboldt Bay; utilize available models to develop predictions and adaptive responses.

3.3.4. Keep informed of other *Spartina* eradication efforts, especially on the west coast.

3.3.5. To the extent feasible, build monitoring and detection efforts for other *Spartina* species into planned and future *Spartina densiflora* mapping, monitoring, and control.

3.3.6. Work with existing non-profit organizations, such as Humboldt Fish Action Council, to collect seeds and to propagate plants to be used in enhancement and restoration projects.

3.3.7. Participate with the State Coastal Conservancy in planning and outreach effort for regional *Spartina* eradication in Humboldt Bay, Eel River, and Mad River estuaries.

3.3.8. Continue to coordinate research projects related to mapping of regional *Spartina* distribution, control methods and impacts to sedimentation, soil properties, tidal creek morphology, vegetation, and rare plants.

3.3.9. Coordinate research on seed bank ecology with respect to regional control of *Spartina*.

3.3.10. Work with academic partners, including Humboldt State University and the State Coastal Conservancy, to facilitate research on salt marsh function (productivity, value to wildlife, plant animal interactions.).

3.3.11. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

Goal 4: Promote long-term viability of the Humboldt Bay estuarine and dune ecosystems through ecosystem-based management (including endangered and threatened species management across boundaries) coordinated with both public and private partners around the Bay.

Objective 4.1 - Ecosystem Management:

- Over 15 years, continue participation on ecosystem-based management collaborations as staff time and resources permit. Pursue information and activities that will help determine a long term sustainable management direction for refuge lands.

- Within 2 years, devote an additional 1/4 FTE (combined staff time) to serve an increased role in ecosystem-based management collaborations over the 15-year period.

Rationale - Ecosystem Management:

The Humboldt Bay Ecosystem Program is a relatively new program, a comprehensive process of integrated resource management that considers the entire ecosystem, including humans. It is coordinated by the Eureka Sea Grant Office in cooperation with the HBHRCD and many other partners (http://groups.ucanr.org/HumboldtBayEBM/). The program mission is "to create an integrated framework that links the needs of people, habitats, and species by increasing our scientific understanding of our ecosystem and by promoting community-wide collaboration in sound natural resource management." It also seeks to develop recommendations for establishment and maintenance of a Humboldt Bay ecosystem database and continued work on research, education, and outreach projects with an ecosystem approach.

While all Humboldt Bay NWR units conserve and/or preserve ecologically important estuarine, palustrine, and dune habitats, these habitats are part of a larger ecosystem that extends beyond the refuge boundary. Because the South Bay refuge units in particular have been altered so significantly, there is concern about the long-term sustainability of diked coastal wetlands, especially given projections of sea level rise. Sustainable efficient management of public trust resources that utilize bay/refuge habitats will require management coordination and information sharing with other landowners and partners throughout the Humboldt Bay ecosystem.

Additional staff time will increase the extent to which refuge staff can engage in collaborative management efforts for the Humboldt Bay ecosystem.

Strategies - Ecosystem Management:

4.1.1. Participate on the Humboldt Bay Ecosystem-based Management Project Advisory Committee, the Humboldt Bay and Eel River Estuary Habitat Goals Advisory Committee, and the Humboldt Bay Harbor, Recreation Conservation District Management Plan Advisory Team.

4.1.2. Pursue and support relevant bay ecosystem studies and modeling (currents and sediment transport, hydrology, sea level rise, nutrient cycling, etc.) that would provide information needed to determine a long-term sustainable management direction for refuge lands.

4.1.3. Work with USFWS, USGS, academic institutions, other agencies, and collaborative groups to monitor and address effects of and management response to local sea level rise and other environmental changes resulting from climate change.

4.1.4. Coordinate with the AFWO Conservation Partnerships Program (Partners for Fish and Wildlife and Coastal Program) within the North Coast Initiative Area to provide technical advice to private landowners and other entities.

4.1.5. Collaborate to the extent possible with public and private partners, including but not limited to:
- local representatives of the Wiyot Tribe and the Blue Lake Rancheria and Bear River Band of the Rohnerville Rancheria
- Arcata Fish and Wildlife Office (AFWO) Fisheries and Endangered Species Programs
- Bureau of Land Management, NOAA, NPS, Natural Resources Conservation Service, US Geological Survey, US Army Corps of Engineers

- CA Dept of Fish and Game, CA Coastal Conservancy, CA Coastal Commission, CA State Parks, CalTrans, CA Dept. of Forestry, CA Conservation Corps, CA Dept. of Corrections, CA Dept. of Health Services
- Humboldt Bay Harbor, Recreation and Conservation District; Humboldt County; local cities and communities
- Humboldt State University, UC Sea Grant, College of the Redwoods
- Humboldt County Dunes Cooperative, Humboldt-Del Norte Weed Management Area, Humboldt and Del Norte County Resource Conservation Districts
- Pacific Coast Joint Venture, Audubon Society, Ducks Unlimited, and California Waterfowl Association
- Aleutian Goose Working Group, Farm Bureau, Humboldt Bay Oyster Growers
- Friends of Humboldt Bay NWR, Friends of the Dunes, North Coast Explore, North Coast Chapter, California Native Plant Society
- private landowners
- local, regional, and national non-profits

4.1.6. Seek funding for a new FTE biologist position to assist in planning and implementing projects and strategies.

Goal 5. To provide the public (and especially children) with accessible, safe, high-quality wildlife-dependent recreation opportunities to enhance public appreciation and understanding of fish, wildlife, plants, and habitats of Humboldt Bay and associated watersheds.

Objective 5.1 - Visitor Services—Wildlife Observation and Photography:

- Within 15 years, provide 20,000 annual wildlife observation and photography visitor opportunities by land and water trails, 3/4 mile (Salmon Creek Unit-Shorebird Loop Trail out to kiosk and Ma-le'l Dunes Unit Railroad berm trail) of wheelchair-accessible wildlife viewing opportunities for all primary habitat types on the Humboldt Bay NWR.

- Provide a total of 3.7 miles of ADA trail at Salmon Creek, Hookton Slough, and Ma-le'l Dunes units.

- Within 2 years of its adoption, implement all phases of the Ma-le'l Dunes Cooperative Management Area Access Plan, which includes an expanded trail system, interpretive panels, a viewing deck, a volunteer caretaker, restrooms and, if feasible (see concerns below), a non-motorized boat launch at the Ma-le'l Dunes Unit.

Rationale - Visitor Services—Wildlife Observation and Photography:

A Draft Visitor Services Plan has been developed concurrently with the preparation of the CCP (Appendix B). In addition, in collaboration with BLM, the CA Coastal Conservancy, and Friends of the Dunes, there has been considerable effort to provide additional public use opportunities at the Ma-le'l Dunes Cooperative Management Area, including a publicly reviewed plan. Wildlife observation and photography are two of the six priority public uses identified in the National Wildlife Refuge System Improvement Act of 1997. Despite a small staff and a refuge of relatively small size, all six priority public uses are made available at Humboldt Bay NWR. With few exceptions, the vast majority of wildlife species found on the refuge can be viewed and/or photographed from existing trails and/or blinds. A common comment from the public at this and many other refuges is, "The trails you have are great but we would like to hike/bike/drive around the rest of the refuge." While this desire to "see the rest of the refuge" is certainly understandable, it is often not compatible when considered cumulatively with all other actions occurring on the refuge. Managers need to better clarify for the public the need for portions (often large) of the refuge to be closed to public use to conserve fish, wildlife, and habitat.

Similar to national trends, there is a large and growing desire for wildlife observation and photography opportunities on Humboldt Bay NWR. If additional staff and project resources are available, the refuge could provide increased opportunities for wildlife observation and photography from refuge facilities, if compatible.

One way people are getting out and observing and photographing wildlife is by non-motorized boating. This type of recreation has increased dramatically both nationally and on Humboldt Bay in the last 20 years. In order to help accommodate this increasing use around the bay, the refuge would like to pursue construction of a non-motorized boat launch on the Ma-le'l Dunes Unit. However, prior to construction the CA Dept. of Public Health (CDPH), the HBHRCD, and local oyster growers must be assured that additional public use on the Ma-le'l Dunes Unit will not jeopardize the water quality rating (and the oyster companies' business) in the slough. Construction of the non-motorized boat launch will be based on demonstration of acceptable water quality to CDPH.

If additional resources are available, offering increased opportunities for the public to observe

wildlife would build local support and appreciation for the refuge and the natural resources it helps to conserve.

Strategies - Visitor Services—Wildlife Observation and Photography:

5.1.1. Maintain existing visitor use facilities, making all as fully accessible as possible.

5.1.2. Work with Friends groups and other partners to develop and implement FWS Initiatives (Connecting People with Nature, Schoolyard Habitats and Birding Initiatives).

5.1.3. Develop wheelchair access out to the kiosk on the Salmon Creek Unit and on the Ma-le'l Dunes Unit Cukish trail.

5.1.4. Continue to collaborate with Friends groups and other partners to provide regularly scheduled and special event guided wildlife observation day use opportunities.

5.1.5. Continue to work with local and national wildlife photography groups (and individuals) to improve wildlife photography day use opportunities on the refuge.

5.1.6. Install a wildlife camera on the Salmon Creek Unit which will provide opportunities for "live action" wildlife observation from the closed portion of the refuge back to a large screen TV at the Visitor Center.

5.1.7. Monitor and assess disturbance caused by different public uses on Humboldt Bay NWR to both develop a baseline of use and provide the best possible management direction regarding existing and proposed future uses.

5.1.8. Work with partners to fully implement Ma-le'l Dunes Cooperative Management Area Access Plan, including the non-motorized boat launch if water quality stipulations are met.

5.1.9. Work with HBHRCD, Redwood Community Action Agency (RCAA), and Humboldt Bay boating groups to produce an assessment of needs for safe compatible boating experiences (including the proposed bay trail(s) on or adjacent to the refuge, and then implement recommendations.

5.1.10. Work with the same groups to produce guidelines and conduct outreach to the boating community on avoiding impacts (especially disturbance) to natural resources on and around the bay.

5.1.11. Provide both signage and brochures to explain the need to maintain high water quality, how/where to properly dispose of waste, and the need to be good stewards of the bay.

5.1.12. Assess opportunities to increase seasonal day use hiking on the Salmon Creek Unit around the hunt area or other areas normally closed to the public.

5.1.13. Work with CA Coastal Conservancy, HBHRCD, RCAA, City of Arcata, Humboldt County, and groups interested in the "Trail Around the Bay" to assess the potential and compatibility of a bay trail(s) on or adjacent to the refuge.

5.1.14. Seek funding for a new FTE Volunteer Coordinator position to assist in planning and implementing projects.

5.1.15. Increase law enforcement on the Humboldt Bay NWR by contract or hiring a seasonal law enforcement officer.

5.1.16. Assess the need to implement a fee collection program.

Objective 5.2 - Visitor Services—Environmental Education and Interpretation:

- Within 15 years, provide wildlife-dependent educational opportunities for at least 8 school or community groups per month, and 35,000 annual visitor opportunities for interpretive experiences on and off refuge to foster public awareness and appreciation of the natural heritage of the north coast.
- Develop and construct a Children's Outdoor Exploration Area on the Salmon Creek Unit.
- Within 3 years, complete the Salmon Creek Historic Hunt Cabin.
- Assess feasibility for an on-site environmental education outdoor classroom facility on the Salmon Creek Unit.

Rationale - Visitor Services—Environmental Education and Interpretation:

Environmental education and interpretation are two of the six priority visitor uses identified in the National Wildlife Refuge System Improvement Act of 1997. The Humboldt Bay NWR provides a unique opportunity for the local community to experience pristine dune habitats, native bay

habitats, and wildlife in proximity to an urban area with multiple educational institutions. Refuge-based environmental educational and interpretive activities can also be integrated into both indoor and outdoor classroom curricula. Interpretive activities can introduce the public to habitat management activities and familiarize them with the conservation efforts that protect local natural resources. The activities currently offered at the refuge are primarily the result of collaboration with refuge Friends groups and volunteer efforts, which we will seek to enhance.

If additional staff and project resources are available, the refuge will work with Friends groups, volunteers, and others to provide additional environmental education and interpretation opportunities to foster public awareness and appreciation of unique Humboldt Bay and north coast natural heritage, which will ultimately help to fulfill the purposes for which the refuge was established. The refuge will look at opportunities to implement existing (Junior Duck Stamp, The Nature of Learning, Project WILD, Shorebird Sister Schools, etc.) and new (Children in Nature, Schoolyard Habitats) environmental education/ interpretation initiatives from the Service and others.

Strategies: - Visitor Services—Environmental Education and Interpretation:

5.2.1. Maintain existing Visitor Services Programs and infrastructure, including completion and upgrading of interpretive exhibits, panels, and signage plans.

5.2.2. Maintain, improve, and keep updated refuge website to provide information on refuge complex history, management, visitor service opportunities, and current events.

5.2.3. Continue to offer guided bird walks by Friends of the Humboldt Bay NWR (FHBNWR) every other week and Audubon once per month.

5.2.4. Continue to offer Humboldt State University and College of the Redwoods professors, high school classes, and other local citizens access to the Salmon Creek, Lanphere, and Ma-le'l Dunes units for guided and self-guided educational tours and study.

5.2.5. Continue to partner with Friends of the Dunes to offer guided natural history walks on the dunes units (once per month).

5.2.6. Continue to coordinate with the Friends of the Dunes (FOD), which leads a restoration work day once a month on Ma-le'l Dunes or Lanphere Dunes units, and for their annual Spring Breakaway event.

5.2.7. Continue to coordinate with Friends of the Dunes for the annual lupine bash; work to increase involvement by additional partners (particularly North Coast Chapter of California Native Plant Society).

5.2.8. Continue to participate in interpretive events both on the refuge and off (e.g., Aleutian Goose Fly-Off, CA Waterfowl Outdoor Adventure Day, CA State Fair, Humboldt County Fair, Godwit Days, Aleutian Cackling Goose Festival, National Wildlife Refuge Week, etc.).

5.2.9. Offer a seasonal lecture series (3-6 per year) that interprets pertinent natural and cultural resources.

5.2.10. Continue to offer occasional presentations to community groups and college/university classes (four to six per year).

5.2.11. Continue to offer a self-guided trail guide, produced by FHBNWR, on the Salmon Creek Unit.

5.2.12. Build on existing Outdoor Youth Days event and offer multi-day programs during the summer (e.g., Day Camp, Jr. Ranger/Naturalist, etc.).

5.2.13. Work with refuge Friends groups to locate and develop a Children's Outdoor Exploration Area at the Salmon Creek Unit to provide unstructured environmental education/interpretation opportunities for children.

5.2.14. Work with the Regional Office, AFWO, and Friends groups to develop/implement environmental education programs that could include Junior Duck Stamp, Schoolyard Habitats, Nature of Learning, Bay to Dunes, Shorebird Sister Schools, Salmon Creek Watershed Education, and others.

5.2.15. Work with AFWO and two schools in the Humboldt Bay area to develop pilot Schoolyard Habitat Projects.

5.2.16. Complete the "Historic Hunt Cabin," which will interpret the history of the Salmon Creek Unit and how it came to be, refuge development, and the historic role of waterfowl management in Humboldt Bay NWR and the Refuge System.

5.2.17. Work with Coastal Conservancy and Friends of the Dunes to implement planned interpretive themes at Ma-le'l Dunes Unit, including Wiyot tribal heritage. (See also Strategy 6.2.1 under Strategies - Cultural Resource Management - Partnerships.)

5.2.18. Work with partners to develop and/or modify existing interpretive outreach for the public about the historical support hunters and fishermen have provided for the refuge system and conservation.

5.2.19. Assess feasibility of conversion of the barn or construction of a new covered outdoor structure for environmental education wet lab type activities.

5.2.20. Investigate grants and/or community assistance to acquire rain gear for use by K-12 visitors, and facilitate visitation by economically challenged members of the community (e.g., shuttle buses/vans, etc.).

5.2.21. Develop an off-refuge wildlife presentation for K-12.

5.2.22. Develop traveling trunks of educational materials for use by staff and/or Friends on and off site.

5.2.23. Facilitate teacher training workshops so that teachers can lead environmental education field trips.

5.2.24. Create a curriculum that corresponds to California state education standards to cultivate an appreciation for refuge resources.

5.2.25. Design training guide for volunteer docents who would like to lead environmental education activities.

5.2.26. Provide for additional program assistance through trained volunteers, friends, interns, grant funding, and other partnerships.

5.2.27. Develop and implement greening policies, and then interpret greening activities completed on the refuge.

5.2.28. Seek funding for permanent full-time Information and Education Specialist and Volunteer Coordinator positions to assist in planning and implementing projects.

Note: See also Strategy 6.2.1.

Objective 5.3 - Visitor Services—Outreach/ Friends and Partners:

- Over 15 years, refuge staff will collaborate with Friends groups and other regional partners to annually host at least two regionally based environmental education field trips, workshops, seminars, or study courses, and refuge staff will take a local leadership role in developing and strengthening partnerships.

Rationale - Visitor Services—Outreach/Friends and Partners:

Part of the mission of the Service is working with others to conserve, protect and enhance fish, wildlife, and plants, and their habitats. Staff at the Humboldt Bay NWR realize that all wildlife, plants, and habitats on the refuge are part of an interdependent ecosystem that extends beyond the refuge boundaries. Providing outreach to the public and developing partnerships is the best way to manage the Humboldt Bay ecosystem for the benefit of all. Additionally, when the public and partners are not aware of the refuge and its role in local, regional, and national conservation, they are less likely to value, appreciate, or advocate for the resources on the refuge.

If additional staff and project resources are available, the Humboldt Bay NWR should provide additional environmental education and outreach to contribute to the protection of the Humboldt Bay ecoregion.

Strategies - Visitor Services—Outreach/Friends and Partners:

5.3.1. With Friends groups, volunteers, and staff, continue to participate in interpretive events both on and off the refuge.

5.3.2. Continue to involve volunteers in a variety of refuge programs and community events to strengthen ties with the community.

5.3.3. Incorporate elements of FWS Initiatives (Connecting People with Nature and Birding Initiatives).

5.3.4. Work with Friends groups to develop and implement priority projects for the refuge (environmental education/interpretation programs, trailguide, Children's Outdoor Exploration Area, bookstore, etc.).

5.3.5. Pursue funding for permanent full-time Information and Education Specialist and Volunteer Coordinator positions to assist in planning and implementing projects to strengthen and enlarge the volunteer services program, and to provide effective training and program management of the program for a corps of 50-100 volunteers.

Objective 5.4 - Visitor Services—Hunting:

- Within 15 years, maintain and improve existing waterfowl, coot, and snipe hunting program to accommodate a minimum of 1,200 hunter opportunities per year on the Salmon Creek Unit, and continue waterfowl, coot, and snipe hunting on Table Bluff, Eureka Slough, and Jacoby Creek units, as well as Egret Island, Teal Island, and Hookton Slough, concurrent with State regulations.

- Improve information and outreach of existing regulations.

- Open the Service-owned Fernstrom-Root island portion of the Ma-le'l Dunes Unit to waterfowl, coot, and snipe hunting and retrieval. The Service would also provide 2 additional Junior-only hunting days on the Salmon Creek Unit.

Rationale - Visitor Services—Hunting:

The existing (1990) Humboldt Bay NWR Sport Hunting Plan has been revised concurrently with the preparation of the Humboldt Bay NWR Complex CCP (Appendix C).

Hunting is one of the six priority public uses identified in the National Wildlife Refuge System Improvement Act of 1997. Currently, waterfowl hunting regulations on the Salmon Creek Unit are slightly less permissive than State hunting regulations, as follows. Hunting on the Salmon Creek Unit is permitted from legal shoot time to 3 pm on Tuesdays and Saturdays of the regular waterfowl hunting season (usually the last weekend in October through January). Waterfowl, coot, and snipe hunting is permitted on the Table Bluff, Eureka Slough, and Jacoby Creek units, including Egret Island, Teal Island, and Hookton Slough, concurrent with State regulations. In the best professional judgment of the Humboldt Bay NWR Manager, restricting the number of days that hunting occurs on the Humboldt Bay NWR maintains a high quality hunting experience. Upland game hunting (e.g., deer hunting) is not permitted on the Humboldt Bay NWR due to the small size of potential hunt areas, safety issues, and likelihood for conflicts with other high priority wildlife-dependent recreational uses recognized by the Improvement Act.

Portions of the recently acquired Ma-le'l Dunes Unit adjacent to the Mad River Slough, while privately owned, were hunted for waterfowl, coot, and snipe prior to acquisition by the Service, so the refuge will be opening portions of these areas to hunting and/or retrieval from adjacent areas that are open to hunting (see Appendix C: Figure C–4).

Limited junior-only hunting opportunities in the Humboldt Bay area and the high quality of waterfowl hunting on the Salmon Creek Unit justifies the addition of two days for junior-only hunts. In addition, allowing less experienced junior hunters to learn hunting skills outside of the regular hunting times will avoid impacts on the quality of the hunting experience for regular, more experienced hunters.

Strategies - Visitor Services—Hunting:

5.4.1. Maintain current sport hunting program as described in the updated Humboldt Bay NWR Sport Hunting Plan.

5.4.2. Continue to fund and use MOUs with Federal, State, and local agencies for law enforcement support.

5.4.3. Follow necessary procedures to permit waterfowl hunting on portions of the island salt marsh areas of the recently acquired Ma-le'l Dunes Unit.

5.4.4. Add two junior-only waterfowl hunt days per season at the Salmon Creek Unit.

5.4.5. Improve interpretation and outreach, especially on Salmon Creek, Hookton Slough, Jacoby Creek, and Ma-le'l Dunes units to make sure that where hunting and other wildlife-dependent visitor uses come together, all users are aware and all uses are managed for maximum mutual compatibility.

5.4.6. Conduct daily bag checks (i.e., verify number and species of waterfowl), which will promote compliance with regulations and keep biological data on species harvest.

5.4.7. Improve hunt program record-keeping by improving harvest record card.

5.4.8. Improve directional signs in the hunt area on the Salmon Creek Unit.

5.4.9. Create new maps of hunting areas to improve accuracy and quality of the hunting experience and the efficiency of the hunting system.

5.4.10. Increase staffing of the hunter check station, to a minimum of two individuals per hunt day (Humboldt Bay NWR staff, temporary hires/ contractors, or volunteers) to best manage refuge hunt.

5.4.11. Modify hunting pit blinds to prevent stranding of wildlife.

5.4.12. Post additional boundary signs on the Eureka Slough, Jacoby Creek, and Table Bluff units, and Egret Island, Teal Island, and Hookton Slough.

5.4.13. Enforce boat in only regulations on Humboldt Bay NWR land on the Eureka Slough and Jacoby Creek units in order to meet USFWS safety standards.

5.4.14. Work with CDFG, HBHRCD, and USFWS Solicitor's Office to clarify legal jurisdiction of over-water hunting in bay sloughs and salt marsh islands.

5.4.15. Increase law enforcement on the Humboldt Bay NWR, especially during waterfowl season, by contract or hiring a seasonal law enforcement officer.

5.4.16. Seek funding for permanent full-time Volunteer Coordinator positions to assist in planning and implementing projects.

Objective 5.5 - Visitor Services—Fishing:

- Maintain existing sport fisheries program. Provide fishing opportunities at the Ma-le'l Dunes Unit.

- Collaborate with CDFG and other local agencies and private entities to increase awareness of fishing and shellfishing opportunities on the Humboldt Bay NWR and/or in Humboldt Bay.

Rationale - Visitor Services—Fishing:

The existing (1990) Humboldt Bay NWR Sport Fishing Plan has been revised concurrently with the preparation of the Humboldt Bay NWR Complex CCP (Appendix D).

Fishing is one of the six priority public uses identified in the National Wildlife Refuge System Improvement Act of 1997. Most local fishing occurs in freshwater areas that are not within the refuge boundaries. Limited fishing does occur for sharks, rays, and shellfish on Humboldt Bay NWR. Shell fishing is most popular on South Bay mudflats. Many other freshwater and saltwater fishing areas are located nearby to the Humboldt Bay NWR.

While fishing opportunities on the Humboldt Bay NWR are limited, fishing is a priority wildlife-dependent recreational use recognized by the Improvement Act and additional outreach may promote its use by the public.

Strategies - Visitor Services—Fishing:

5.5.1. Maintain current fishing program as described in the updated Humboldt Bay NWR Sport Fishing Plan.

5.5.2. Continue to fund and use MOUs with Federal, State, and local agencies for law enforcement support.

5.5.3. Incorporate elements of USFWS Initiatives (i.e., Connecting People with Nature).

5.5.4. Enhance outreach and education on fishing regulations and opportunities on Humboldt Bay NWR.

5.5.5. Increase signage at allowable sport fishing sites.

5.5.6. Advertise and participate in events which promote fishing (e.g., CDFG free fishing day, USFWS fishing days, etc.).

5.5.7. Conduct outreach at pertinent events, such as Harbor District Maritime Expo, etc.

5.5.8. Increase law enforcement on the Humboldt Bay NWR by contract or hiring a seasonal law enforcement officer.

Goal 6. In cooperation with tribal representatives, identify and protect tribal cultural resources on the Humboldt Bay NWR. In addition, assess and manage refuge's more recent cultural resources and structures.

Objective 6.1 - Cultural Resource Management:

- Create and implement a basic Cultural Resources Management capability at Humboldt Bay NWR to respond to the basic compliance requirements of Federal cultural resources legislation.

Rationale - Cultural Resource Management:

Three contemporary entities represent the historic Wiyot Ancestral Territories located around Humboldt Bay: the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria. Cultural resources are non-renewable resources and are protected under Federal law and Service/Refuge System policy. The Service Manual section on Cultural Resource Management (Part 614) describes Service/Refuge System policies regarding management of cultural resources on refuges.

Creating a basic Cultural Resources Management capability at Humboldt Bay NWR would save time and resources by reducing the need for consultations on a project-by-project basis with the Regional Cultural Resources program.

Strategies - Cultural Resource Management:

6.1.1. Notify the Regional Office Archaeologist when site-specific projects are initiated so that appropriate resource assessments and coordination with California State Historic Preservation Office (SHPO) and the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria will occur.

6.1.2. Consult with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria, and the Regional Office Archaeologist on a project-by-project specific basis to collect related cultural resources background information and develop strategies for protection and preservation of cultural resources within refuge boundaries per Section 110 of National Historic Preservation Act.

6.1.3. Work with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria to develop an MOU for resource management issues.

6.1.4. Incorporate cultural resource values, issues, and requirements into design and implementation of the other habitat, wildlife, and public use activities and strategies conducted by the refuge.

6.1.5. Communicate and consult with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria, academic institutions, advocacy organizations, agencies, and the California SHPO for basic informational, compliance, research, and "government-to-government" purposes.

6.1.6. Develop and implement a plan to survey the Humboldt Bay NWR for newly identified cultural resources, including archaeological sites and traditional cultural properties, and previously unsurveyed areas.

6.1.7. Assess options for refuge-owned Indian Island parcels with Wiyot Tribe.

6.1.8. Identify, inventory, evaluate, and nominate to the National Register sites eligible for the National Register under Criteria A-D in consultation with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria.

6.1.9. Create a cultural resource layer in the refuge GIS that aids in the identification, planning and monitoring, and interpretation of cultural sites.

6.1.10. Complete the "Historic Hunt Cabin," which will interpret history of the Salmon Creek ranch and how it came to be, refuge development, and the historic role of waterfowl management in Humboldt Bay and the Refuge System.

6.1.11. Convert the Salmon Creek Unit barn into an environmental education/interpretation facility, if feasible. If not, maintain in present condition or remove/recycle it.

6.1.12. Restore or replace quarters and storage buildings at the Lanphere Dunes Unit.

6.1.13. Designate a refuge Cultural Resources Management coordinator.

Note: See also Strategy 6.2.1.

Objective 6.2 - Cultural Resource Management—Partnerships:

- Within 10 years of CCP approval, develop, in partnership with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, the Blue Lake Rancheria and other preservation partners, a cultural resources overview of the Humboldt Bay NWR.

Rationale - Cultural Resource Management—Partnerships:

Cultural resources are not renewable. Thus, interpretation of cultural resources can instill a conservation ethic among Humboldt Bay NWR visitors who encounter or manage them.

If additional staff and project resources are available, the Humboldt Bay NWR should provide additional interpretation of cultural resources

and history of Humboldt Bay NWR. The goals of the cultural resource education and interpretive program would be to:

- translate the results of cultural research into interpretive media that can be understood and appreciated by a variety of refuge visitors
- engender an appreciation for the Native American culture and perspective on cultural resources
- relate the connection between cultural resources and natural resources and the role of humans in the environment
- instill an ethic for the conservation of our cultural heritage

Cultural resources overview materials will aid refuge staff in explaining historical ecological conditions, the importance of restoring and/or maintaining the integrity of those conditions, and the role the native environment plays in Native American culture and history.

Strategies - Cultural Resource Management—Partnerships:

6.2.1. Develop interpretation and education programs and information at the Headquarters Unit that illustrate indigenous lifestyles and various subsistence strategies of the Wiyot Tribe.

6.2.2. Consult with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria and other stakeholders to design and implement educational materials, programs, and activities that would be used to address traditional or sacred resources.

6.2.3. Update the Humboldt Bay NWR brochures and interpretive signage, as staffing and funding allow, with appropriate cultural resources information.

6.2.4. Work with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria to provide education and training to refuge staff on tribal cultural history.

6.2.5. In consultation with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria, research the ethnobotany and traditional plants and periodic use locations on the refuge; and plan, fund, and implement restoration of ethnobotanical resources on the dunes units.

6.2.6. In consultation with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria, conduct research on Traditional Ecological Knowledge and its contribution to habitat management on the refuge.

6.2.7. Identify and evaluate cultural resources that can educate refuge users on how humans have interacted with wildlife and habitats in the past, and consult with tribes and other stakeholders on ways to use these resources to achieve educational, scientific, and traditional cultural needs.

Objective 6.3 - Cultural Resource Management—Coordination:

- Meet periodically with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria and other concerned tribal groups to discuss land management and restoration activities planned for the future.

Rationale - Cultural Resource Management—Coordination:

The Wiyot people have lived on the shores of Humboldt Bay and surrounding areas for thousands of years. Indian Island, within the approved Humboldt Bay NWR boundary, is home to two ancient Wiyot villages: EtpidoL and Tuluwat, a National Historic Landmark. Today the Wiyot Tribe has over 600 enrolled citizens. Native peoples with Wiyot ancestry are also enrolled locally at Blue Lake Rancheria, Bear River Band of Rohnerville Rancheria, and other tribal governments on the North Coast. Fifty tribal citizens reside on Table Bluff Reservation to the south of Humboldt Bay NWR. Traditional Wiyot village sites were located on the bay and along the sloughs and rivers. The Wiyot traditionally used the dunes for implement making sites, gathering, and surf fishing.

Annual meetings would provide a forum for tribal representatives to present any of their proposals or discuss other concerns that relate to proposed management of Humboldt Bay NWR lands.

Strategies - Cultural Resource Management—Coordination:

6.3.1. Offer an annual meeting with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria to review previous projects or summarize management or restoration projects and public events that are planned by the Humboldt Bay NWR for the upcoming year, whether or not these activities will require formal SHPO consultation.

6.3.2. Work with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria on projects to restore habitats of important native plants, and to harvest (for traditional non-commercial purposes) native plant foods.

6.3.3. Review and reissue, if appropriate, any special use permits for traditional activities such as plant collecting for basket weaving.

6.3.4. Develop in consultation with the appropriate tribes procedures and information required under the Native American Graves Protection and Repatriation Act.

Castle Rock NWR Vision Statement

Castle Rock National Wildlife Refuge preserves in perpetuity one of the most important seabird nesting colonies on the Pacific coastline. This 14 acre island continues to be preserved in a natural condition with minimal human intrusion.

Management activities focus on research and monitoring of refuge wildlife and on protection and maintenance of a natural, functioning ecosystem. The U.S. Fish and Wildlife Service coordinates with tribes, other agencies and entities as well as the public to ensure the long-term health and viability of native seabird and marine mammal populations.

We work with others to provide wildlife viewing and interpretation at selected locations on the adjacent coastline. Fostering an appreciation for Pacific coast wildlife enriches people in a variety of ways and ensures that this outstanding legacy of wildlife is passed on to future generations.

Castle Rock NWR Preliminary CCP Goals, Alternatives, and Strategies

Goal 1. Protect and maintain habitats for migratory birds and marine mammals, with an emphasis on seabirds and Aleutian cackling geese.

Objective 1.1 - Castle Rock Research and Monitoring

- Over the 15 year life of the plan, sustain and protect habitat for healthy breeding seabird populations, seasonally roosting Aleutian cackling geese, and marine mammals by conducting monitoring supported by remote research and preventing disturbance.

- In collaboration with partners, including Humboldt State University, the the Coastal Program at Humboldt Bay managed from the AFWO, Bureau of Land Management and the NPS: Develop and Implement a seabird Research and Monitoring Plan based on the USFWS California Current Seabird Management Plan.

- In collaboration with partners, including Humboldt State University and NOAA: Develop and Implement a Research and Monitoring Plan for the marine mammals which use Castle Rock NWR.

Objective 1.2 - Castle Rock NWR Wilderness Designation

Within 15 years of the approval of the CCP, the Service would recommend a wilderness designation for Castle Rock NWR and complete the associated environmental impact statement.

Rationale - Castle Rock Research and Monitoring:

Breeding birds of Castle Rock NWR include: open area nesters such as common murres; double-crested, Brandt's, and pelagic cormorants, western gulls, black oystercatchers; the pigeon guillemot, a crevice nesting species; and burrow nesters including: Cassin's and rhinoceros auklets, Leach's and fork-tailed storm-petrels, and tufted puffins. A portion of the Aleutian cackling goose population (~20,000 geese) roosts at night on Castle Rock NWR from January through April. Several of the species that utilize Castle Rock NWR are California Species of Special Concern including: tufted puffin, fork-tailed storm-petrel, and double-crested cormorant.

Obviously, a thorough understanding of the biology of these seabirds is important to their conservation. As the second largest breeding colony in California, Castle Rock is a vital link in the health of these populations. Further, these birds forage in the ocean and the health of their populations is reflective of ocean conditions. Having reliable data on the common murre and other seabird populations of Castle Rock NWR is an important part of understanding the California Current System, and the effects of natural and anthropogenic change occurring along this portion of the coast.

While some species like common murres nest on rock ledges and can be observed and monitored through aerial photography; other species, such as rhinoceros and Cassin's auklets, and storm-petrels, are nocturnal and burrow into the soft soil making aerial observation impossible. These burrowing species can make tunnels up to six-feet long, into the soft and fragile ground. Any human disturbance on the surface can easily crush and destroy the underground nest of these seabirds.

Thus, a challenge of monitoring seabirds on Castle Rock is to minimize disturbing the birds and avoid the crushing of burrow nests and habitat. In 2005, in partnership between the US Fish and Wildlife

Service, the Coastal Program at Humboldt Bay, Humboldt State University, the US Geological Survey, Redwood National and State Parks, and the USCG, robotic video cameras were installed as a remote sensing technique to gather data on relative abundance, burrow use, attendance and departure, nesting chronologies, and breeding behavior of seabirds on Castle Rock. Part of this project is to develop formal monitoring protocols to assist managers on the north coast to follow trends, detect disturbance, and understand the biology of the seabirds which use Castle Rock and the surrounding area.

Seabirds are not generally well understood by the public. The colonies are very sensitive to disturbance and public outreach is needed to conserve these species. We propose to use the scientific findings from this effort and interpret seabird biology on the north coast to the public. Better public access (via video) can lead to better public protection of these unique birds. As part of the project discussed above, we also successfully established a live video feed which is available (seasonally from ~March–August) to the public over the internet (see www.humboldt.edu/~rtg1/research/castle_rock.html) and in the national park visitors center in Crescent City. The live video feed available to the public will allow public observation of wildlife values that can not otherwise be viewed. We hope that soon this will also be coordinated with the California Coastal National Monument via the Arcata Field Office of the Bureau of Land Management.

Marine mammals that use Castle Rock NWR for resting and or pupping include Steller sea lions, harbor seals, elephant seals, California sea lions, and northern fur seals. These species are susceptible to the same types of disturbance from humans that seabirds are, the only exception being they are often the first to react as they are generally closer to the source of disturbance (except for aerial disturbances). We seek to conserve and protect marine mammals for essentially the same reasons we seek to conserve and protect seabirds.

Strategies - Castle Rock Research and Monitoring:

1.1.1. Pursue base funding to accomplish necessary work at Castle Rock NWR annually.

1.1.2. Continue collaboration with Humboldt State University, San Francisco Bay NWR staff, AFWO, and Coastal Program staff to monitor and research seabird populations.

1.1.3. Continue photo surveys both aerially and by remote camera for population estimates.

1.1.4. Conduct further research into the monitoring frequency required and best (scientifically valid and lowest impact on species) techniques for each species as recommended in the California Current System Seabird Monitoring plan.

1.1.5. Develop alternative monitoring techniques to assign cost effectiveness. This task will include storm-petrel assessments, boat-based surveys, and early morning shore-based surveys to refine alternative methods.

1.1.6. Develop formal monitoring protocol for nocturnal nesting seabirds. Camera maintenance, data compilation, analysis and the addition of camera validation for nesting by rhinoceros auklets and common murres.

1.1.7. Coordinate with NOAA on marine mammal issues and population estimates.

1.1.8. Increase signage, distribute brochures, and use other outreach to educate kayakers, anglers, and the commercial fishing industry to the risk of disturbance, the potential impact on seabirds and marine mammals and the illegality of trespass or disturbance to seabirds and marine mammals.

1.1.9. Provide outreach on aviation hazards as well as over-flight impacts to seabirds and ACG at Crescent City airport for commercial and private pilots and with USCG annually.

1.1.10. Implement a study to quantify sources, frequency and severity of disturbance (including research) to seabirds and marine mammals.

1.1.11. Conduct surveys for flora and fauna besides birds and marine mammals including; invertebrates, salamanders, rare and invasive plants.

1.1.12. Evaluate additional options for remote monitoring of seabird, and Aleutian cackling goose monitoring on Castle Rock NWR.

1.1.13. Assess the possibility to experiment with options for seabird habitat restoration by excluding geese from key habitat locations.

Goal 2. Provide high quality environmental education, interpretive information, and outreach to the public highlighting the ecology and sensitivity of the wildlife of Castle Rock National Wildlife Refuge.

Objective 2.1 - Environmental Education, Interpretive Information, and Outreach

- Over the 15 year life of the plan coordinate environmental education and interpretation on the seabird, marine mammal, and Aleutian cackling geese populations that use Castle Rock NWR with that of tribal, Federal, State, and local, and other California Current System seabird programs.
- Within 3 years, collaborate with Federal and State organizations to develop and provide additional environmental education, interpretation, and outreach to kindergarten through 12th grade school groups, community groups, and individuals, and participate in at least 2 community events annually.
- Continue participation in the Aleutian Goose Festival and within 3 years develop a Friends of Castle Rock NWR and/or work with local entities and NPS/BLM to coordinate something similar.

Rationale: Environmental Education, Interpretive Information, and Outreach

Standard visitation is inappropriate for Castle Rock NWR due to the potential for sensitive wildlife disturbance and the general inaccessibility of this island refuge. However, by working collaboratively with Humboldt State University, NPS, USCG, and BLM (which manages adjacent islands as part of the California Coastal National Monument), NOAA, local tribes, agencies, schools, and individuals we can still effectively and efficiently reach interested audiences and provide educational and interpretive messages about the natural resources of Castle Rock NWR. Methods of outreach include an existing web cam that is available online seasonally, associated instructional DVDs, and more traditional methods including development of interpretive panels, brochures, and outreach to local communities and schools.

As Castle Rock NWR is not a staffed refuge, developing local support via a Friends group and/or collaboration with local entities and other Federal agencies with similar interests, such as NPS and BLM, will help conserve the resources of the refuge and surrounding marine areas.

Strategies: Environmental Education, Interpretive Information, and Outreach

2.1.1. Continue collaboration with Humboldt State University, NPS, and AFWO to provide the seabird web cam online, and improve outreach information in NPS Visitor Center.

2.1.2. Continue participation in the Aleutian Goose Festival.

2.1.3. Develop a Friends of Castle Rock NWR group and/or work with local entities and NPS/BLM to coordinate something similar.

2.1.4. Conduct outreach to educate the public, develop stewardship, and ultimately help protect the natural resources of Castle Rock NWR and integrate outreach with other programs.

2.1.5. Collaborate with Redwood National and State Parks, the chamber of commerce, and other tourism information centers to increase environmental education and community outreach through means such as newsletters, web sites, brochures, and campfire talks.

2.1.6. Develop an age group specific instruction curriculum for kindergarten through 12th grade students using video on DVD, live feed video, and science-based monitoring.

2.1.7. Work with community partners (e.g., College of the Redwoods, Marine Mammal Center, and Siskiyou Field Institute) to provide educational interpretive field trips and courses using Castle Rock NWR to showcase wildlife, seabird, and marine mammal ecology.

2.1.8. Increase signage and make brochures available to fisherman, kayakers, aircraft pilots, and the general public with information about the sensitivity of the seabirds and marine mammals to disturbance, and provide the link to the seasonally live video-stream.

2.1.9. Collaborate with local tribal entities to provide interpretation of traditional uses of Castle Rock NWR as appropriate.

2.1.10. Work with partners to provide educational and interpretive information for guided excursions around Castle Rock.

6. Management Plan Implementation

Implementation

The CCP 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 CCP 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 are contingent upon a variety of factors, including:

- Funding & Staffing
- Completion of Step-Down Plans
- Compatibility Determinations
- Compliance Requirements
- Adaptive Management
- Monitoring

Each of these factors is briefly discussed as it applies to the CCP.

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 the USFWSs strategic planning and program prioritization purposes. Accordingly, the plans do not constitute a commitment for staffing increases, operational and maintenance increases, or funding for future land acquisition.

Funding & Staffing

Resources are required to adequately operate any National Wildlife Refuge including initial capital outlay for equipment, facilities, labor and other expenses as well as recurring expenses. The estimated initial capital outlay to implement the strategies described in this CCP is approximately $3.8 million (Table 16). Not all of these capital expenditures would occur in the same year as many of these expenses would be most likely implemented over the next 15 years if approval and funding is provided by Congress. The detailed descriptions of the objectives and their associated implementation strategies serve as a guide to the ideal time frame in which to implement capital expenditures. The largest costs for initial outlays are for visitor services and habitat restoration.

Annual contracts or cooperative agreements will be needed to provide specialized services beyond the core refuge functions for which staff are required. The estimated annual cost to fully implement the CCP is approximately $1 million (Table 17).

Table 17 shows both existing and new positions for the Complex. If all positions are filled, the Refuges would be able to carry out all aspects of this plan to a reasonable standard. If some positions are not filled, all aspects of the Plan would not be completed or those projects may be done over a longer period of time.

Step-Down Management Plan Summaries

Some projects or types of projects require more in-depth planning than the CCP process is designed to provide; for these projects, the Service prepares step-down management plans. Step-down management plans provide the additional planning details necessary to implement management strategies identified in a CCP. Included in this document are three step-down management plans: the Visitor Services Plan, Waterfowl Hunt Plan, and Sport Fishing Plan. The CCP also proposes four new step down plans for Habitat Management, Resource Inventory and Monitoring, Waterfowl Disease Contingency and Integrated Pest Management. These plans are scheduled to be completed within four years of the completion of the CCP.

Visitor Services Plan

The purpose of the Visitor Services Plan (Appendix B) is to establish guidelines for public uses at the Humboldt Bay and Castle Rock refuges that will provide the public with a quality wildlife-dependent recreational experience. The Visitor Services Plan was developed to provide safe wildlife-dependent recreation opportunities, while minimizing adverse impacts to the wildlife resources. The plan will allow the visitor services program to be conducted in a

Table 16. Estimated initial capital outlay to fully implement the Comprehensive Conservation Plan.

Expenditure [Related Objective(s)]	Unit Cost	Priority
Continue to adaptively manage during all phases of the Salmon Creek Restoration project (monitor species and habitat use, changes in channel cross-sections, sediment transport, water quality, etc. and use results to guide future management). [1.1.1]	$50,000	1
Implement Phase II of the Salmon Creek Restoration project as described in (PCFWWRA 2003). [1.1.3]	$750,000	1
Work with appropriate Bay management partners and permitting agencies to develop and implement a plan to place large woody debris in Hookton Slough to improve habitat diversity for salmonids and goby and reduce predation. [1.1.5]	$75,000	2
Use excavated material from Phase II for salt marsh restoration and/or dike maintenance. [1.1.6]	$250,000	2
Install fish screens as needed at appropriate locations on the Salmon Creek Unit to allow diversion to seasonal wetlands without impact to salmonids or other listed species. [1.1.7]	$200,000	1
Gather existing information and pursue funding to assess existing elevations on refuge units and sedimentation rates and locations in South Bay with respect to salt marsh restoration. [1.2.3]	$150,000	2
Repair and modify the White Slough tidegate to improve estuarine and brackish marsh conditions on the inside of Salmon Creek dikes. [1.2.4]	$250,000	2
Develop detailed designs to facilitate permitting on all South Bay Units restoration work. [1.3.3]	$50,000	1
On the White Slough Unit work with Caltrans to de-channelize Chism Creek so that it enters west White Slough Unit area, rather than terminating directly into Humboldt Bay, to maximize freshwater/salt marsh continuum. [1.3.16]	$15,000	3
On the Hookton Slough Unit develop and implement a hydrologic model and restoration plan that allows for at least partial tidal restoration in central area (see Salt Marsh alternatives), with muted tidal influence to eastern and western areas such that native freshwater to brackish vegetation is preserved, while allowing for fish passage, salmonid rearing and tidewater goby habitat. [1.3.19]	$100,000	3
Enhance riparian/swamp habitat by planting native understory plants and provide deer protection until established. [1.4.3]	$50,000	3
Work with the appropriate entities to develop a long-term water quality monitoring program to assess the impact of sediment flushing from Salmon Creek on eelgrass beds in southern Humboldt Bay and potential non-point source pollutants adjacent to Mad River Slough. [1.6.5]	$100,000	3
Develop a Hazard Analysis and Critical Control Point (HACCP) Plan for the Refuge to prevent establishment of new invasive species on the refuge [3.1.1]	$20,000	2
Continue to develop the Volunteer Invasives Mapping and Control Program at south refuge units and seek Service funding for volunteer and Friends invasive plant control programs [3.1.2]	$25,000	2

Expenditure [Related Objective(s)]	Unit Cost	Priority
Develop and implement a 5-year plan to remove eucalyptus (20 acres) and other non-native trees and replace with native communities. Use a combination of mechanical and chemical IPM techniques for removal and control of the eucalyptus [3.2.6]	$75,000	1
Within 10 years, control *Spartina* on all refuge locations. [3.3.1-3.3.9, 3.3.11]	$400,000	1
Conduct Humboldt Bay wallflower population viability assessment (PVA) using existing demographic data set for Lanphere Dunes. [2.1.5]	$25,000	2
Continue to conduct metapopulation sampling of Humboldt Bay wallflower North Spit populations. Expand to include South Spit and Elk River spit populations. Track on a 9 or 10-year interval. [2.1.10]	$15,000	3
Develop partnerships to conduct habitat restoration activities and collect Humboldt Bay wallflower seed from South Spit. Reintroduce seeds from this subpopulation to restored habitat on Table Bluff Unit. [2.1.11]	$10,000	2
Repeat Pickart 1987 vegetation sampling to quantify succession rate and impacts to Humboldt Bay wallflower. [2.1.3]	$20,000	2
Pursue and support relevant bay ecosystem studies and modeling (currents and sediment transport, hydrology, sea level rise, etc.) that would provide information needs to determine a long-term, sustainable management direction for refuge lands. [4.1.2]	$200,000	1
Develop wheelchair access out to the kiosk on the Salmon Creek Unit and on the Ma-le'l Dunes Unit Cukish trail. [5.1.3]	$50,000	1
Install a wildlife camera on the Salmon Creek Unit which will provide opportunities for "live action" wildlife observation from the closed portion of the refuge back to a large screen TV at the Visitor Center. [5.1.6]	$20,000	3
Monitor and assess disturbance caused by different public uses on Humboldt Bay NWR to both develop a baseline of use and provide the best possible management direction regarding existing and proposed future uses. [5.1.7]	$40,000	2
Work with partners to fully implement Ma-le'l Dunes Cooperative Management Area Access Plan, including the non-motorized boat launch if water quality stipulations are met. [5.1.8]	$65,000	1
Complete the "Historic Hunt Cabin", which will interpret the history of the Salmon Creek Unit and how it came to be, refuge development, and the early role of waterfowl management in Humboldt Bay NWR and the Refuge System. [5.2.16]	$100,000	2
Develop and implement a comprehensive plan to survey the HBNWR for newly identified cultural resources, including archaeological sites and traditional cultural properties. [6.1.6]	$50,000	2
Convert the Salmon Creek Unit barn into an EE/I facility, if feasible. [6.1.11]	$350,000	3
If above conversion not feasible, maintain at present condition or remove [6.1.11]	$100,000	3
Restore or replace the Quarters and Storage sheds at the Lanphere Dunes Unit [6.1.12]	$200,000	2

Expenditure [Related Objective(s)]	Unit Cost	Priority
In consultation with the Wiyot Tribe, Bear River Band of Rohnerville Rancheria, and the Blue Lake Rancheria, research the ethnobotany and traditional plants and use locations on the refuge, and the Traditional Ecological Knowledge and its contribution to habitat management on the refuge. [6.2.6]	$30,000	2
Total Humboldt Bay NWR	**$3,835,000**	

Castle Rock NWR

Develop a Monitoring Plan that takes into account the monitoring frequency required and best (scientifically valid and lowest impact on species) techniques for each species as recommended in the California Current System Seabird Management Plan [1.1.4]	$30,000	2
Camera maintenance, data compilation and analysis of existing data on rhinoceros auklets and common murres [1.1.6]	$50,000	1
Implement a study to quantify sources, frequency and severity of disturbance (including research) to seabirds and marine mammals [1.1.10]	$25,000	3
Develop an age group specific instruction curriculum for K through 12 schools using video on DVD, live feed video, and science based monitoring [2.1.6]	$35,000	1
Increase signage and make brochure available to fisherman, kayakers, aircraft pilots, and the general public with information about the sensitivity of the seabirds and marine mammals to disturbance and has the link to the seasonally live video-stream [2.1.8]	$50,000	2
Total Castle Rock NWR	**$190,000**	

Table 17. Estimated annual cost to fully implement the Comprehensive Conservation Plan[1].

Expenditure	Status	Unit	Quantity	Total Cost
Salaries and Benefits				
Refuge Manager – GS-12/13	Existing	FTE	1.0	
Deputy Refuge Manager – GS-11/12	Existing	FTE	1.0	
Administrative Officer – GS-7/9	Existing	FTE	1.0	
Refuge Ecologist – GS-11/12	Existing	FTE	1.0	
Biological Technician – GS-5/7/9	Existing	FTE	1.0	
Wildlife Biologist – GS-9/11 To fulfill Goals 1,2,3,4 at Humboldt Bay NWR and Goal 1 at Castle Rock NWR	Proposed & Unfunded	FTE	1.0	
Engineering Equipment Operator – WG-8/9/10	Existing	FTE	1.0	
Maintenance Worker – WG-7/8	Existing	FTE	1.0	
Information & Education Specialist – GS-7/9/11 Currently a shared position, proposed to be full time	Newly Funded	FTE	1.0	
Volunteer/YCC Coordinator – GS-7/9 To fulfill Goals 5,6 at Humboldt Bay NWR and Goal 2 at Castle Rock NWR	Proposed & Unfunded	FTE	1.0	
Database Manager & IT Specialist – GS-7/9 Proposed position	Proposed & Unfunded	FTE	1.0	
Subtotal Salaries and Benefits		***FTE***	***11.0***	***$845,655***

Expenditure	Unit Cost	Unit	Quantity	Total Cost
Programs				
Maintenance (repairs, replacement, rentals, etc.) & Utilities (fuel, propane, electricity, phones, postage, etc.)	$75,000	ea	1.0	$75,000
Invasive Weed Program	$20,000	ea	1.0	$20,000
Water/Pumping Costs and Water Quality Monitoring	$10,000	ea	1.0	$10,000
Castle Rock NWR Wildlife Monitoring	$25,000	ea	1.0	$25,000
Travel/Training	$10,000	ea	1.0	$10,000
Supplies	$25,000	ea	1.0	$25,000
Printing	$2,000	ea	1.0	$2,000
Computer Services and Maintenance	$1,000	ea	12.0	$12,000

Volunteer Invasives Program and Stipends	$1,500	ea	12.0	$18,000
Law Enforcement MOU with BLM	$5,000	ea	1.0	$5,000
Subtotal Programs				***$202,000***
Grand Total (Annual salaries and benefits budget and annual maintenance program budget)				**$1,047,655**

[1] *Staffing and funding would be sought over the 15-year life of this plan subject to approval and funding by Congress.*

cost-effective manner. The program will be reviewed annually by Refuge staff during the Habitat Management Plan review conducted each spring. The activities within the Visitor Services Plan are evaluated within compatibility determinations (hunting, wildlife observation and photography, environmental education and interpretation, and bicycling) located in Appendix F.

Hunt Plan

The purpose of the Waterfowl Hunt Plan (Appendix C) is to establish guidelines for hunting on the Humboldt Bay NWR that will provide the public with a quality wildlife-dependent recreational experience, an opportunity to use a renewable resource, and the ability to maintain wildlife numbers at levels compatible with Refuge habitat. It was developed to provide safe hunting opportunities, while minimizing conflicts with other priority wildlife-dependent recreational uses. The plan will allow the hunting program to be conducted in a cost-effective manner, coordinated with the State. The hunting program will be reviewed annually by Refuge staff during the Habitat Management Plan review conducted each spring. The activities within the Waterfowl Hunt Plan are evaluated within a waterfowl hunting compatibility determination located in Appendix F.

Sport Fishing Plan

The purpose of the Sport Fishing Plan (Appendix D) is to establish guidelines for fishing on the Humboldt Bay NWR that will provide the public with a quality wildlife-dependent recreational experience, an opportunity to use a renewable resource, and the ability to maintain sport fish numbers at levels compatible with Refuge habitat. The plan will allow the sport fishing program to be conducted in a cost-effective manner, coordinated with the State. The fishing program will be reviewed annually by Refuge staff during the Habitat Management Plan review conducted each spring. The activities within the Sport Fishing Plan are evaluated within a fishing compatibility determination located in Appendix F.

Waterfowl Disease Contingency Plan

Refuge staff will develop a Waterfowl Disease Contingency Plan for Humboldt Bay NWR, , which will guide the refuge manager in the decision making process. The purpose of the Waterfowl Disease Contingency Plan is to establish protocols for monitoring and responding to wildlife disease outbreaks on the refuge. It will be developed to ensure a safe working environment for personnel involved in associated disease monitoring and clean-up activities while minimizing wildlife losses.

Habitat Management Plan

Refuge staff will develop an annual Habitat Management Plan for Humboldt Bay NWR, which will guide the refuge manager in the decision making process. This process is based on annual visits to each unit by the refuge's core staff to identify resource issues, develop a prioritized list of projects to address those issues, and monitor outcomes/responses. The database for this planning document will be annually updated. The plan is based on an adaptive management philosophy that allows the team to assess habitat condition and wildlife use of the units annually and make adjustments accordingly in order to meet the Refuges' goals and objectives.

Resource Inventory and Monitoring Plan

The purpose of the Wildlife Inventory and Monitoring Plan is to establish guidelines and a schedule for conducting routine surveys to inventory and monitor wildlife and plant populations on the refuges. It will be developed to maintain consistency in the timing and methods used to collect population and habitat data in all years.

Integrated Pest Management Plan

Refuge staff will develop an Integrated Pest Management (IPM) Plan to address/reduce public nuisance and human health risk from mosquito-transmitted diseases, as well as to address invasive and exotic plants on the refuges. The purposes of this plan are: to identify mosquito abatement

Photography blind. Photo: HBNWRC

methods and materials currently approved for use on the refuge; identify use in an IPM program that is consistent with the goals of the refuge and minimizes public health risk from refuge-harbored mosquitoes; and provide long-term planning to meet the USFWSs goal of reducing effects of pesticide use on DOI trust resources to the greatest extent possible. This plan will be reviewed and updated to include new information and policy changes as needed. It will cover chemical herbicide/pesticide use, mechanical eradication, and biological controls. Mosquito monitoring and control activities are evaluated within a compatibility determination located in Appendix F.

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, 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 Refuges. Grazing and haying for wildlife habitat management, recreational boating (including kayaking) in navigable waters, research, walking/hiking, invertebrate sampling with nets, and mosquito integrated pest management were found to be appropriate uses on all units of the Humboldt Bay NWR. Biking, paddle-in access site for camping, dog field training, a 2 to 3 week day camp for kindergarten through 12th grade, and dog walking were found to be not appropriate uses on all units of the Humboldt Bay NWR.

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.

Bird banding being observed by Youth Conservation Corps members.
Photo: HBNWRC

Compatibility determinations for environmental education, fishing, grazing and haying, mosquito integrated pest management, plant gathering, recreational boating, research, waterfowl hunting, wildlife observation and photography for Humboldt Bay NWR; and research for Castle Rock NWR are included in Appendix F. These uses were all found to be compatible.

Compliance Requirements

This CCP was developed to comply with all Federal laws, executive orders, and legislative acts. Some activities (particularly those that involve a major revision to an existing step-down management plan, or preparing a new plan) would need to comply with additional laws or regulations besides NEPA and the Improvement Act. A list of Federal laws, executive orders, and legislative acts is in Appendix H.

Monitoring and Evaluation

The CCP 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 CCP is implemented as scheduled. The monitoring program will focus on issues involving visitor service activities, habitat management programs, wildlife inventory, and other monitoring and management activities. Monitoring and evaluation will use the adaptive management process. This process includes goal and objective setting, and applying management tools and strategies followed by monitoring and analysis to measure achievement of objectives and then refining management techniques based on the results of that analysis.

Collection of baseline data on wildlife and plant populations will continue. This data will be used to update existing species lists, wildlife habitat requirements, and seasonal use patterns. Migratory and resident birds, raptors, endangered plants and plant communities, 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 visitor service 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.

Adaptive Management

Adaptive management is the process of implementing policy decisions as scientifically driven experiments that test predictions and assumptions about management plans, using ongoing monitoring to measure success and provide 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 success of objectives, and adapts original strategies to reach desired objectives. Habitat, wildlife, plants and plant communities, and visitor service 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 embraces uncertainty and provides new information for future decision-making while allowing resource use.

Erosion control and dike maintenance at Salmon Creek Unit. Photo: HBNWRC

CCP Plan Amendment and Revision

The CCP is intended to evolve as refuges change, and the Improvement Act specifically requires that CCPs be formally revised and updated at least every 15 years. The formal revision process would follow the same steps as the CCP creation process. In the meantime, the USFWS would be reviewing and updating this CCP periodically based on the results of the adaptive management program. While preparing annual work plans and updating the Refuge database, refuge staff will also review the CCP. It may also be reviewed during routine inspections or programmatic evaluations. Results of any or all of these reviews may indicate a need to modify the plan. The goals described in this CCP would not change until they are reevaluated as part of the formal CCP 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 USFWS to have the CCP apply to any new lands that may be acquired. If changes are required, the Complex would complete the any associated NEPA documentation required.

The intent of the CCP is for the refuges' 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.

Art students at Salmon Creek Unit of Humboldt Bay NWR. Photo: Shannon Smith

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