Chapter 4
Biological Environment

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Chapter 4. Biological Environment

This chapter addresses the biological resources and habitats on the Bandon Marsh National Wildlife Refuge (NWR); however, it is not an exhaustive overview of all species and habitats. The chapter begins with a discussion of biological integrity (historic conditions and ecosystem function), as required by the Refuge Administration Act. The bulk of the chapter is then focused on the presentation of pertinent background information for the priority habitats and species that the refuge personnel will actively manage to accomplish biological conservation and/or restoration. The priority habitats and species are collectively known as the Priority Resources of Concern (ROCs) designated under this CCP. Background information includes description, location, condition, trends, key ecological attributes, and threats (stresses and sources of stress) associated with each ROC. The information presented herein was used to develop goals and objectives for the CCP (see Chapter 2).

4.1 Biological Integrity, Diversity, and Environmental Health

The National Wildlife Refuge System Administration Act, as amended, directs the Service to ensure that the biological integrity, diversity, and environmental health (BIDEH) of the Refuge System are maintained for the benefit of present and future generations of Americans. The BIDEH policy (601 FW 3) defines *biological integrity* as “the biotic composition, structure, and functioning at genetic, organism, and community levels comparable with historic conditions, including the natural biological processes that shape genomes, organisms, and communities.” *Biological diversity* is defined as “the variety of life and its processes, including the variety of living organisms, the genetic differences among them, and communities and ecosystems in which they occur.” *Environmental health* is defined as the “composition, structure, and functioning of soil, water, air, and other abiotic features comparable with historic conditions, including the natural abiotic processes that shape the environment.” In simplistic terms, elements of BIDEH are represented by native fish, wildlife, plants, and their habitats, as well as those ecological processes that support them.

The Refuge System policy on BIDEH (601 FW 3) also provides guidance on consideration and protection of the broad spectrum of fish, wildlife, and habitat resources found on the Refuge and in associated ecosystems that represents BIDEH.

4.1.1 Historic Conditions

The mainstem portion of the Coquille River and adjacent bottomlands were historically tidally influenced for approximately 40 miles, from the city of Bandon on the Pacific coast to immediately upstream of the town of Myrtle Point. Prior to influences of Euro-American settlement (mid-1800s), it is estimated that 14,440 acres of vegetated wetland were tidally influenced within the bottomlands of the Coquille River watershed from Myrtle Point to the mouth of the river (Benner 1991). The tidal section of the Coquille River at that time was linked with over 20,500 acres of bottomlands (Benner 1991). In some instances, the bottom swampland was covered with a dense thicket of willow and alder brush, rather than trees.

The tidally influenced mainstem of the Coquille River was historically deep channeled and bordered by a mosaic of fresh, brackish, and marine-driven wetlands covered with a rich riparian bottomland forest habitat (Benner 1991). This riverine and estuarine habitat was also hydraulically and biologically driven by numerous freshwater streams and beaver activity. These elements shaped the riparian communities to foster a mosaic of vegetative diversity of patchy open water and timbered

scrub habitats that were bedded in saturated soils rich in nutrients. Flooding was annual and lasted up to 9 months on the upper bottomlands, generally following an annual pattern of high flows as winter rains saturated the adjacent coastal mountains. Flooding of the lower estuary was more frequent when high river flows combined with the high tides of the winter. Freshwater creek and stream flows into the bottomlands were perennial in all but the driest times. Riparian vegetative response to flooding was variable depending on flooding intervals and intensity. Floods provided the soil disturbance and high water levels required for transport of large amounts of sediments and woody debris to the lower estuary. Flooding alternately created and destroyed estuaries and brackish wetlands. Newly created tidal flats and low marsh supported plant and animal communities that moved successionally toward higher elevation communities.

The lower Coquille River estuary is the remains of an ancient submerged river mouth that was bordered by dynamic sand dunes (Peterson et al. 2005, Byram and Witter 2000). The effects of anthropogenic, climatic and geological forces have occurred and continue to occur on a variety of temporal and spatial scales. Sea level variations, major Cascadian subduction zone seismic events (e.g., uplifting, subsidence, and tsunami waves), climatic change, and cultural and natural fire have altered the region over time (Tveskov and Cohen 2007, Witter et al. 2003, Byram and Witter 2000). Between 6,500-6,700 years ago and the present there have been 12 large earthquakes (on average, every 570-590 years) which dropped the tidal marshes and low wetland forests, resulting in reduced local elevations and more flooding of the area. More recently, accretion of fine sediments and the accumulation of woody and vegetative debris have resulted in the development of our current tidally influenced tidal mudflat and salt marsh system (Brophy 2005, Byram and Witter 2000).

The Coquille River estuary was historically described in writing and with maps developed by the first Oregon land surveys. Generally, the area was depicted as a deep channel river bordered by a tidally influenced bottomland that was swampy or marshy in nature (Oregon Original Land Cadastral Survey Notes 1857-1872; in Benner 1991). The Bandon Marsh NWR was described in these surveys as “marsh prairie” in the area of the Ni-les’tun Unit and the Bandon Marsh Unit was mainly open water or “low, flat tidal land” with the northern portion described as a “tide prairie”, and both units being bordered by “spruce swamp.” The streams in the area were described by Aiken in 1871 as “mostly thick growth of vine-brush (e.g., crab apple, vine maple, willow, salmon-brier brush) and timber, on them is mostly alder myrtle and maple and some spruce.” The upland forest located to the north of the Coquille River as mapped in these early accounts as shore pine forest. This survey interpretation from the early 1850s of the estuary and surrounding uplands was done by a variety of individuals that may have had varying levels of skill in interpreting vegetation types and the primary purpose of the exploration was for potential settlement and conversion of land to agriculture.

4.1.2 Habitat Alterations

The Coquille River native people (the Nasomah) hunted, fished, and created river shoreline settlements for thousands of years (Byram and Shindruk 2010, Tveskov and Cohen 2007). Use of the estuary and tidal wetland forests by Native peoples most likely had little effect on the functioning of estuarine and forest ecological systems. There is evidence that early Native people of the region intentionally used fire to manipulate vegetation at the landscape scale (LaLande and Pullen 1999). They likely used other land management techniques, but little evidence remains. The culture and location of settlements within the Coquille estuary were driven by oral traditions and an understanding of the dynamic nature of the landscape (Don Ivy, Coquille Indian Tribe, personal communication) The locations of villages and use of natural resources shifted with the subsidence

and uplift that affected suitable sites for settlement and canoe access (Byram and Shindruk 2010, Hall 2001).

The mid-1800s ushered in the beginning of ecologically significant land alterations for the wetlands of the Coquille River watershed. Over the past 150 years, the estuary and wetland forests have been physically altered to provide land for agricultural purposes (e.g., diking and draining), timber production (timber harvest, land clearing, log and milled wood transport), development of communities, roads and infrastructure (filling of marsh habitat), river navigation and shipping commerce (stabilization and deepening of the river mouth and channel with jetties and dredging).

The earliest European inhabitants of the Coquille watershed were believed to be fur trappers, traders and explorers. The Coquille River Valley was flooded timber scrub woodland and provided abundant beaver for the fur trading industry. Early surveyors reported using boats and canoes to make their way up the Coquille River Valley by moving from one beaver pond to the next (Benner 1991). European settlement began in the mid-1850s. As the Euro-American population increased, it moved away from fur trading and diversified into resource extraction industries of fishing and forestry, and large-scale land manipulation for agriculture. In addition, the hydrology of the riverine and tidally influenced portions of the Coquille River was altered by dredging and maintenance for commerce and travel. By 1878, steamboats could travel from Bandon to the population centers of Myrtle Point and Coquille (Benner 1991).

When European settlers began inhabiting the Coquille Valley and coastal plain, the extent and pace of human disturbance to the aquatic and terrestrial environments increased rapidly. Early logging practices focused on the removal of riparian timber in order to facilitate removal of higher elevation old growth timber. Upper watershed streams were used to transport logs by the stream altering methods of splash damming. Harvested timber was released and transported in torrents of water to the mainstem of the river where logs were rafted together to be processed in the mills downstream. This technique of flushing the tributary system reduced stream habitat complexity, destabilized banks, incised and scoured channels, destroyed riparian habitat and transported large amounts of sediment into the lower estuary habitat. As logging technology progressed into the internal combustion engine era and transportation (e.g., narrow gauge railroad, trucks and bulldozers) improved, timber harvest proceeded to progressively harder-to-reach areas, including riparian areas in steep first and second order drainages, leaving few areas in a natural state (USFS 1994). The substantial bank erosion and stream scouring from this large scale exploitation of the forests elicited concern from landowners and the practice was eventually abandoned.

Since the mid to late 1800s, a large portion of scrub-timber dominated middle and lower Coquille River Valley was diked, rip rapped or hard banked then cleared for pasture and crop production (USFS 1994). Beaver were considered a nuisance in the maintenance of dikes, drainage culverts and tide gates, agricultural fields, and roads due to their natural habits of digging soil and harvesting vegetation for dam construction, which flooded or destroyed this new infrastructure. Eventually, this keystone species was trapped out and their ecologically important effects of impounding water were eliminated throughout most of the watershed.

One of the greatest ecological effects of human disturbance within the Coquille watershed has been the construction of an extensive road network for transportation of agricultural products (e.g., timber, cattle) and commerce. The road network, estimated to be 2,383 miles, permeates throughout the watershed (Ecotrust 1997). Dirt, gravel, and asphalted roads that are poorly constructed in unstable or steep locations and/or unmaintained cause many adverse impacts downstream. The physical

characteristics of the hard surface of roads increase the volume and rate of precipitation runoff, which can compound into increased sediment, pollutants and an increase in water temperature. This in turn can cause direct and indirect mortality to fish and wildlife and fragment their habitats downstream. Much of the mainstem and major tributary channels are impinged upon by road fills. This caused many streams to deeply down-cut and become separated from their floodplains, thus increasing flow velocities, simplifying the hydrological characteristics within the channels, and expediting the flow of once-retained woody debris, sediments and nutrients out of the system. In addition, roads become conduits for the range expansion and dispersal of invasive plant and animal species by inadvertently opening new habitat and increasing the rate of colonization by people, vehicles, domestic animals and other physical and biological factors favorable to these invasive species (USFS 2003, Trombulak and Frissell 2000).

Between 1884 and the present, the U.S. Army Corps of Engineers (USACE or Corps) conducted dredging and jetty operations to improve watercraft navigability of the Coquille River above the City of Coquille and at the mouth within the City of Bandon (Osborne 2011). The Corps ceased dredging operations in the upper portion of the river after 1902 (Coquille Indian Tribe 1997). Further, local efforts to improve navigability facilitated the establishment of the Port of Coquille in 1911. The Port conducted stream-clearing operations that included riparian vegetation removal and intentional bank destabilization and incision to enable navigation between the cities of Coquille and Myrtle Point from 1915 to 1923. These activities continued on the North Fork of the Coquille River until the advent of World War II and did not resume until the mid-1960s. While these more recent actions were primarily intended to prevent flooding of adjacent towns and agricultural fields, they permitted two-way boat traffic on selected segments of the Coquille River. Up to the early 1990s, the Coquille River was navigable for commodity and recreational transport up to the town of Coquille (Gina Dearth, Port of Bandon, personal communication).

Historic commerce activities in the lower Coquille River, in the proximity of the town of Prosper, south of Bandon Marsh NWR's Ni-les'tun Unit, consisted of shipyards, lumber mills, salmon canneries, schools, and residential buildings (Byram and Shindruk 2010, Reid and Stroud 2003). These industries and activities produced quantities of debris that were deposited in local dump sites. These dump sites exist within the lower watershed and have been determined to produce contamination that is potentially hazardous to fish and wildlife (Thomas et al. 1997).

Many federal, state, county and private organizations and individuals have recently undertaken efforts to reverse the negative effects of historical alterations. Restoration of fish and wildlife in the upper Coquille River watershed has been implemented through direct restoration activities (e.g., fish and wildlife habitat enhancement) and through the development of new forest management plans and regulations that has included road construction standards, habitat buffers, and replanting efforts. The U.S. Forest Service, Bureau of Land Management, and private timber companies have implemented many of these actions. In the upper reaches of the river system, the Coquille Watershed Association (CWA) has dedicated their mission to the health of the watershed and its fish and wildlife resources. This conservation group has built fences to exclude cattle and planted hundreds of miles of riparian buffer habitat. In addition, they have replaced culverts for improved fish passage and created in-stream structures (e.g., rock weirs, large wood placement) to create pools, catch spawning gravel, increase stream complexity and create juvenile rearing habitat (Kelly Miles, personal communication). The CWA has largely worked with private landowners to implement these various projects on their lands.

From 1994 to 2002, the Port of Bandon enhanced 9 acres of historic estuarine habitat in the lower Coquille estuary by the creation of new tidal channels, placement of large wood and revegetation efforts (Port of Bandon 2002, Port of Bandon 2003). This effort has resulted in nursery habitat for coho and Chinook salmon, increased shorebird use, and also provided the public with an example of restored estuary habitat (Port of Bandon 2006). From 2005 to 2011, Bandon Biota, Ducks Unlimited and Oregon Trout (now Freshwater Trust) completed restoration of 80 acres of tidal wetlands in the estuary and the lower portion of Lowe Creek across the river from Parkersburg. This effort reconnected the historic estuary with the Coquille River and involved breaching a dike system and excavating the degraded sinuous channel to recreate tidal function (Randy Van Hoy, personal communication). These projects and others completed by the U.S. Fish and Wildlife Service's Oregon Coastal Program, Oregon Watershed Enhancement Board, Oregon Department of Fish and Wildlife Fish Restoration and Enhancement Program, Coquille Watershed Association, The Nature Conservancy, Coquille Indian Tribe, and private landowners are contributing to the restoration of the Coquille River system and estuary that will provide fish and wildlife for future generations.

4.1.3 Early Refuge Management

Bandon Marsh NWR was established to protect one of the few remaining unspoiled salt marshes in Oregon in 1983 (USFWS 1981). Soon after the Refuge was established, Refuge Management, Habitat, and Public Use plans were developed detailing the need of monitoring activities that may affect the unaltered nature of the salt marsh. From 1983 to 1999 the Refuge was included in the Western Oregon National Wildlife Refuge Complex administered out of the headquarters office at William L. Finley NWR near Corvallis, Oregon. Management involved posting of refuge boundaries, biological surveys, and monitoring by refuge staff (Roy Lowe, personal communication). A one-person coastal refuge office was established at the Hatfield Marine Science Center, Newport, Oregon in 1985. In 1992, the Refuge was expanded and the adjacent second growth forested wetland west of Riverside Drive was acquired (USFWS 1990b). In November 1999, the six National Wildlife Refuges along the Oregon Coast including Bandon Marsh NWR were separated from the refuges in the Willamette Valley and the new Coastal Refuges administrative office established in Newport, Oregon. Visitor use facilities at the Refuge including a parking lot, boardwalk, and overlook deck on the edge of salt marsh were completed in early 2002. In June 2003, a full-time staffed office was opened on Bandon Marsh NWR (Roy Lowe, personal communication).

During the late 1990s, the City of Bandon and the surrounding coastal area had a growth and development period that included the subdivision of large parcels of land within the lower Coquille River watershed. In 1998-1999, plans were developed to expand the Refuge by up to 700 acres upstream or east of the Bandon Marsh Unit. This new unit, named the Ni-les'tun Unit, was established in January 2000 with the acquisition of the 408-acre Bussmann Ranch. The Ni-les'tun Unit was established to assist the Refuge in protecting, conserving, and restoring fish, wildlife, salt marsh, and rare forested wetland habitat within the estuary (USFWS 1999a). From 2000 to 2004, 582 acres comprised of five ownerships was acquired in the Ni-les'tun Unit, with the assistance of The Nature Conservancy and the Archaeological Conservancy. The new unit was comprised mostly of diked historic salt marsh (degraded pasture) and forested wetlands (~450 acres) and second growth upland forest and pasture (~100 acres). New facilities were constructed on the Ni-les'tun Unit including an office and shop in 2002 and a bunkhouse was added in 2005.

To fully restore tidal influence to the more than 400 acres of historic salt marsh, freshwater marsh and forested wetlands within the Ni-les'tun Unit, the Service partnered during 2007-2011 with The Nature Conservancy, Federal Highway Administration, Ducks Unlimited, Oregon Watershed

Enhancement Board, Natural Resource Trustees for the M/V New Carissa Oil Spill, Coquille Indian Tribe, Confederated Tribes of the Siletz Indians, and others to implement the largest tidal marsh restoration to date within the state of Oregon. This effort restored tidal inundation to existing degraded pasture by removing artificial levees, eliminating 15 miles of interior drainage ditches, removal of three tide gates, construction of 5 miles of sinuous tidal channel, relocation of utilities, reconstruction and raising of North Bank Lane including adding fish friendly oversized culverts, installation of in-channel large wood and reestablishment of small coastal streams to the Coquille River and estuary (USFWS and FHA 2009).

4.2 Selection of Priority Resources of Concern

4.2.1 Analysis of Priority Resources of Concern

Refuge management priorities are derived from the National Wildlife Refuge System (NWRS) Mission, individual refuge purpose(s), NWRS policy that identifies NWRS Resources of Concern, and the mandate to maintain the BIDEH of the Refuge. These mandates are consistent with the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997. The management direction of Bandon Marsh NWR is driven by refuge purposes and statutory mandates, coupled with species and habitat priorities. The latter are identified in various USFWS conservation plans, as well as those developed by our state, federal, and private partners (USFWS 2008b). The step-by-step process to prioritize Resources of Concern and management priorities for a refuge is displayed in Figure 4-1.

Wildlife and habitat goals and objectives were designed directly around the habitat requirements of species designated as Priority Resources of Concern (ROCs). Resources of concern are called conservation targets in conservation planning methodologies used by other agencies and non-governmental organizations. In developing objectives, the team followed the process outlined in the Service's draft Identifying Resources of Concern and Management Priorities for a Refuge: A Handbook (USFWS 2008b). As defined in the Service's Policy on Habitat Management Plans (620 FW 1), resources of concern are:

> all plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), System mission, or international, national, regional, state, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect 'migrating waterfowl and shorebirds.' Federal or State threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts (620 FW 1.4G)…
>
> Habitats or plant communities are resources of concern when they are specifically identified in refuge purposes, when they support species or species groups identified in refuge purposes, when they support NWRS resources of concern, and/or when they are important in the maintenance or restoration of biological integrity, diversity, and environmental health.

Therefore, resources of concern for a refuge may be a species or species group, or the habitat/plant community that supports a priority species/species group.

In developing its listing of Priority ROCs, the planning team selected not only species mentioned in establishing documents for the Refuge, but also species that captured the ecological attributes of

habitats required by larger suites of species. The ecological attributes of habitats should be analyzed to meet the life history requirements of ROCs, and are therefore critical to sustain the long-term viability of the ROC and other benefitting species. Ecological attributes of habitats include vegetation structure, species composition, age class, patch size and/or contiguity with other habitats; hydrologic regime; and disturbance events (e.g., flooding, fire). These provide measurable indicators that strongly correlate with the ability of a habitat to support a given species. Tables listing the desired conditions for habitat types found on the Refuge incorporate "Desired" conditions that were based on scientific literature review and team members' professional judgment. These desired conditions for specific ecological attributes were then used to help design habitat objectives, as presented in Chapter 2. However, not all ecological attributes or indicators were deemed ultimately feasible or necessary to design an objective around. Other factors, such as feasibility and the Refuge's ability to reasonably influence or measure certain indicators, played a role in determining the ultimate parameters chosen for each habitat objective. Thus, ecological attributes should be viewed as a step in the planning process. The ultimate design of objectives was subject to further discussion and consideration.

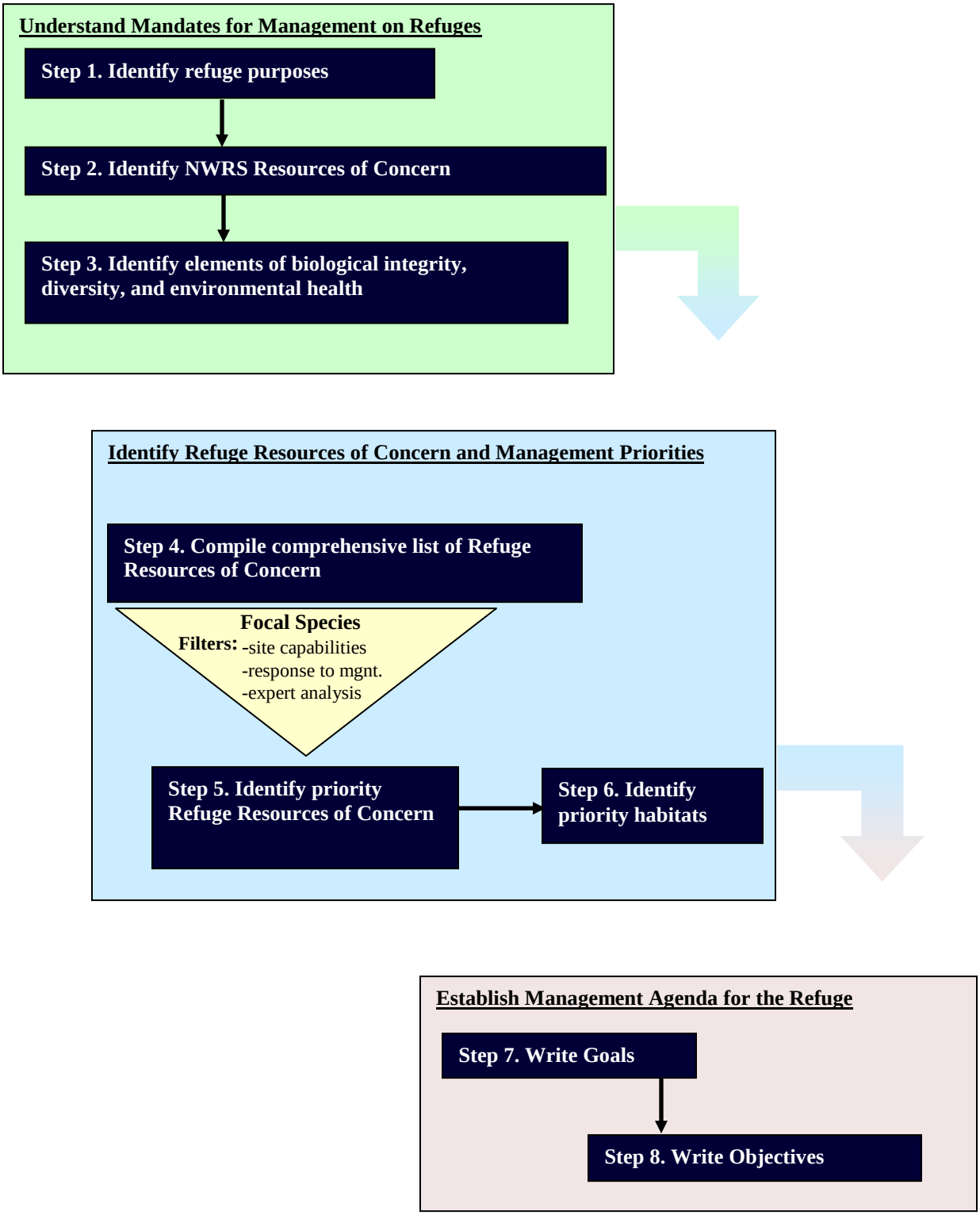
Limiting factors were also considered in developing objectives. A limiting factor is a threat to, or an impairment or degradation of, the natural processes responsible for creating and maintaining plant and animal communities. In developing objectives and strategies, the team gave priority to mitigating or abating limiting factors that presented high risk to ROCs. In many cases, limiting factors occur on a regional or landscape scale and are beyond the control of individual refuges. Therefore, objectives and strategies may seek to mimic, rather than restore, natural processes. The structure of plant communities utilized by ROCs can be created, rather than restoring the original native species composition. For example, mowing and/or grazing may be used to maintain a desirable vegetation structure, when restoring native grassland communities may be impractical. Through the consideration of BIDEH, the Refuge will provide for or maintain all appropriate native habitats and species. Refuge management priorities may change over time, and because the CCP is designed to be a living, flexible document, changes will be made at appropriate times.

Early in the planning process, the planning team cooperatively identified priority species for the Refuge, as recommended under the Service's Habitat Management Planning policy (620 FW1). These ROCs frame the development of goals and objectives for wildlife and habitat. ROCs may be species, species groups, or features that the Refuge will actively manage to conserve and restore over the life of the CCP, or species that are indicators of habitat quality for a larger suite of species. Negative features of the landscape, such as invasive plants, may demand a large part of the refuge management effort, but are not designated as ROCs.

The main criteria for selecting priority ROCs included the following requirements:

- The resource must be reflective of the Refuge's establishing purposes and the Refuge System mission;
- The resource must include the main natural habitat types found at the Refuge;
- The resource must be recommended as a conservation priority in the Wildlife and Habitat Management Review; or
- The resource must be federally or state listed as a candidate for listing, or a species of concern.

Figure 4-1. Overview of the process to prioritize resources of concern and management priorities for a refuge (USFWS 2008b).



Other criteria that were considered in the selection of the resources of concern included the following:

- Species groups and/or refuge features of special management concern;
- Species contributing to the biological diversity, integrity, and environmental health of the ecosystem;
- Species where it is feasible to estimate abundance (needed for future monitoring and adaptive management).

4.2.2 Priority Resources of Concern Selection

In preparing this plan, the Service reviewed other local, regional, and national plans that pertain to the wildlife and habitats of Bandon Marsh NWR (see Chapter 1). The Service also sought input from Oregon State conservation agencies, non-governmental organizations, and the general public. The refuge purposes, as stated in the enabling legislation for each refuge (see Chapter 1) were carefully reviewed as was the Refuge's contribution to maintenance of BIDEH (Appendix E) within the ecoregion. As a result of this information gathering and review process, a comprehensive list of potential ROCs was developed. From this list, those species and habitats that are most representative of refuge purposes and habitats, BIDEH, as well as other FWS and ecosystem priorities, were chosen as ROCs (habitat types) and focal resources (plant and animal species). Habitats selected as ROCs include: (1) Estuarine Habitats (Temperate Pacific Tidal Salt and Brackish Marsh, Temperate Pacific Intertidal Mudflat, and North Pacific Intertidal Freshwater Wetland), (2) Forested Wetland and Stream-Riparian Habitat (North Pacific Hardwood-Conifer Swamp, North Pacific Intertidal Freshwater Wetland, North Pacific Lowland Riparian Forest and Shrubland), and (3) Upland Forests (North Pacific Hypermaritime Sitka Spruce Forest). Vegetation type descriptions according to the International Terrestrial Ecological System Classification under development by NatureServe and its natural heritage program members (Comer et al. 2003, NatureServe 2012) are listed in parentheses.

Priority resources of concern and focal resources consist of habitats and species whose conservation and enhancement will guide refuge management into the future. Potential management actions will be evaluated on their effectiveness in achieving refuge goals and objectives for the priority resources of concern. However, many native species that are present on the Refuge will also benefit. They are referred to here as other benefiting species. See Appendix E for a completed list of priority resources of concern, focal resources, and other benefiting species.

4.3 Estuarine Habitats

One goal of the Refuge System is to conserve and restore, where appropriate, critical ecosystems and ecological processes characteristic of those ecosystems. One such critical ecosystem in the Pacific Northwest and elsewhere includes estuaries and the associated tidal wetlands. Tidal wetlands are of high ecological importance and are considered essential habitat for many marine and anadromous fish, crabs and other shellfish, and migratory birds (ODFW 2006, Seliskar and Gallagher 1983). In Oregon's seventeen largest estuaries, tidal wetland acreage has declined considerably based on pre-European-settlement (pre-1850s) estimates. Fourteen of these estuaries have experienced tidal wetland decreases of 40 percent or more (Good 2000). The Coquille River estuary has suffered the largest percentage loss of tidal marsh habitat in Oregon at 95% (Brophy 2011 using Scranton 2004 and Hawes et al. 2008). Consequently, federal, state, and local jurisdictions consider tidal wetlands a

high priority for protection, enhancement, and restoration, and many have established programs to conserve or restore this critical resource (e.g., OWJV 1994, ODFW 2006).

4.3.1 Description of Salt Marsh and Intertidal Mudflats

Salt marshes and estuaries occur where freshwater rivers meet the salty waters of the ocean. This dynamic habitat is greatly influenced by twice daily tidal flooding that affects the water levels, salinity, temperature and the amounts of sunlight penetration, which in turn relates to oxygen levels. Salt marshes provide food and nursery areas for numerous young fish, crabs, shrimp, clams, and other invertebrates when flooded (USFWS 1990b). Plant communities indicative of a salt marsh or tidal wetland include Lyngby's sedge, seashore saltgrass, pickleweed, Pacific silverweed, and tufted hairgrass. These plant communities are often associated with unaltered estuarine tidal wetlands in Oregon (USFWS 2006). Desired conditions of salt marsh are characterized by the following attributes:

- Diverse elevations ranging from about 3 feet below MLLW to 9 feet above MLLW for tidal flats and tidal marshes. Hydrological flows are affected by high flows in the rivers and tidal cycles.
- Subtidal and low elevation estuarine habitats include channel and slope bottoms and have open water above them.
- Low marsh vegetation is a mosaic of species including salt grass and pickleweed.
- High marsh vegetation includes Lyngby's sedge, slough sedge, tufted hairgrass, Pacific silverweed and Henderson's checkermallow.
- Tidal channels are highly branched, sinuous, and deep-sided of different orders with a large woody debris component.
- Completely submerged during high river flows and seasonal tidal cycles
- No *Spartina* species
- No nutria or other non-native mammals (e.g., red fox)

Diked pastures within the lower Coquille watershed are former salt marshes, which have been cut off from tidal action by the construction of levees but may retain the attributes of freshwater wetlands. Acting as a transition zone between aquatic and terrestrial sites, salt marshes and diked marshes are examples of natural vs. manipulated habitat that are in the former case, beneficial and in the latter case, detrimental to wildlife resources. Natural (undiked) marshes provide shoreline stability against wave and wind erosion, reduce flood peaks, trap nutrients, sediment, and pollutants, and sequester carbon. As one of the most productive ecosystems on earth, tidally influenced salt marshes are highly important to fish, wildlife, and society.

Intertidal mudflats are substrates flooded and exposed by tidal action. Each type of mudflat (sand, mud, gravel or combination of these) has a slightly different plant and animal composition. Algae and diatoms are the principal plant types; vascular plants are rare or absent. Species such a native eelgrass are rare within the lower Coquille estuary's mudflats, but bands of widgeon grass are common along the margins of the flats. These native intertidal grasses and algae are important habitat components within mudflats for a multitude of native fishes, smaller forms of gastropods, bivalves and crustaceans (Swayne 2004), and waterfowl. Intertidal mudflats are characterized by the following attributes:

- Diverse elevations ranging from about 3 feet below MLLW to about 4 feet MLLW that is completely inundated during two daily tidal cycles.
- Mosaic of tidal channels of variable orders that can remain inundated depending upon the seasonal tides and elevations.
- Sandy/muddy substrate that is sparsely vegetated by widgeon grass and seasonal algae blooms.
- Presence of large woody debris
- Presence of bio-film on muddy substrate
- No Japanese eelgrass
- No cordgrass (*Spartina spp*.)

4.3.2. Historic and Current Distribution

The Coquille also is one of the most extensively diked and drained estuaries of the Oregon coast, suffering a 94% loss in tidal marshes and swamps from 1870 to 1970 (Good 2000). Revised estimates by Brophy (2011) using Scranton (2004) and Hawes et al. (2008) indicate a 95% loss of tidal marsh and 93% loss of tidal swamp within the estuary. The Bandon Marsh Unit is one of the few remaining natural salt marsh ecosystems in the state of Oregon. This 289-acre salt marsh represents 3.3 percent of Oregon's fourteen major estuaries (USFWS 1980). The 582 acres within the Ni-les'tun Unit of Bandon Marsh National Wildlife Refuge provided an important opportunity for large-scale restoration of tidal wetlands. Restoration of the Ni-les'tun Unit resulted in a more than 400-acre net increase in tidal wetland habitat in the Coquille Estuary and an additional 4.3 percent of estuary within the state. Together, the Bandon Marsh NWR units represent 7.6 percent of Oregon's estuary habitat.

Most of the historic salt marsh in the lower watershed that has been diked is now in a hydrological condition such that it would be classified as palustrine emergent seasonally flooded diked wetland (Cowardin et al. 1979). The National Wetland Inventory maps most of the lower Coquille as freshwater emergent wetland. Regardless of classification, the habitat quality of these freshwater wetlands has been degraded by more than 100 years of grazing and dewatering and the wetlands are affected by a preponderance of non-native plant species.

4.3.3 Refuge-specific Sites

The only remaining large natural salt marshes in the lower Coquille watershed are located within Bandon Marsh NWR. The Refuge contains 650 acres of salt marsh (Figure 2-1). The salt marsh habitat of the Bandon Marsh Unit is a natural system that supports salt tolerant plant species such as tufted hairgrass, pickleweed, three-square bulrush, seaside arrowgrass, Lyngby's and slough sedge, Pacific silverweed, and Baltic rush. These plant communities are often associated with unaltered estuarine tidal wetlands in Oregon.

Historically, the diked marshes of the Ni-les'tun Unit were maintained for nearly 100 years (late 1800s or early 1900s to 2011) as pasture for cattle grazing and agricultural purposes. The Ni-les'tun Unit was a mixture of native and non-native plants that existed in a semi-disturbed unnatural ecological regime and habitat (Brophy 2005). Artificial levees and ditches were constructed in the past for the purpose of creating dry agricultural pastures from tidally influenced wetland. In 2011, the artificial levees and tidegates were removed to allow a natural tidal regime to re-establish within a newly created system of tidal channels. During the agricultural period, non-native plants for dairy

and cattle forage were planted; hence, the ongoing transition from degraded wetlands, un-maintained pastures, and ditches that supported a mix of native and nonnative plants, to a more natural tidally influenced habitat rich in high salinity tolerant plants. Within the Ni-les'tun Unit there is a mixture of non-native species including creeping bentgrass, tall fescue, and reed canarygrass and the native plant species found within the Bandon Marsh Unit.

A large portion of the intertidal habitat within Bandon Marsh NWR is comprised of intertidal mudflats. The Refuge contains approximately 100 acres of intertidal mudflat, located primarily at the Bandon Marsh Unit (Figure 2-1).

4.3.4 Condition, Trends, and Threats

Based on historic vegetation mapping, the Bandon Marsh Unit appears to have developed only in the past 150 years (Brophy 2005). Increased sediment loads from timber and agricultural practices in the Coquille River watershed, as well as hydrologic changes such as construction of the Highway 101 Bullard's Bridge in 1954 and historic diking of upstream pastures, may have contributed to this rapid accretion of new salt marsh. Historic riverine and estuary wetlands would have slowed floodwaters and retained large amounts of sediment. After diking, higher quantities of sediments could have been flushed downstream during flood events, later to be deposited along the edge of the wide riverbed in the vicinity of the Bandon Marsh Unit. The accretion rate of sediments in the past 50 years has continued to be high (Jones et al. 2012). The plant communities and soil characteristics at the Bandon Marsh Unit support its characterization as a young, dynamic marsh (Brophy 2005). Comparison of current plant communities to mid-1970s description of the marsh described as "low sand marsh" are now occupied by the plant community classified as "immature high marsh," dominated by a broad mixture of low and high marsh species including pickleweed, Lyngby's sedge, seashore saltgrass, and tufted hairgrass (Brophy 2005, Jefferson 1975).

In 2011, the Ni-les'tun Unit was restored, allowing the natural processes of tidal flow and sediment deposition to return to the former diked pastures where tidal flows had been blocked for nearly 100 years. The goal of this large-scale restoration effort was to restore natural processes (tidal exchange, salinity, natural temperature regimes), which in turn create the desired terrestrial and aquatic habitats, allowing native fish, wildlife, plant and invertebrate species to return to the site. The restoration project reconnected tidal flows to over 400 acres, filled nearly 15 miles of drainage ditches, restored and created over 5 miles of meandering tidal channels. The project also removed nearly 2 miles of dikes and three tidegates that blocked the tides from entering the historic wetlands and two freshwater salmonid-bearing streams. The creation of sinuous tidal channels and re-meandering of straight-line ditched tributary creeks is now allowing unimpaired conveyance of sediment from the project area to the Coquille River and tidal sediment deposition onto the Ni-les'tun Unit. The increase in tidal sediment deposition and the likelihood of increased inundation creates an eventual rise in land elevation and a return to anoxic soil conditions, which promotes the formation of productive wetlands and mudflats for fish and wildlife habitat.

Current fish and wildlife species composition of the Coquille River estuary is similar to that of 100 - 150 years ago, but with much greater reduced populations. Monitoring fish and wildlife and their habitat at both refuge units has focused on documenting key physical and biological functions integral to the salt marsh ecosystem. Refuge monitoring of key components measures responses by biological communities to large-scale management actions. Monitoring helps managers analyze linkages between restoration actions, recovery of site structure and function, native species recovery, and non-native species abundance and distribution. The results from these efforts are broadly

disseminated to assist in developing restoration plans and management for others within the estuary management community (e.g., private and public land managers). In addition, the short-term objective of these monitoring efforts is to determine the extent to which the management action has achieved its goal and to make recommendations for adaptive management should monitoring results indicate the need.

Specific salt marsh monitoring parameters have included marsh surface and channel morphology (Guntenspergen et al. 2009, Witter et al. 2003, Adamus 2005), plant communities (Brophy 2005, Bilderback and Bilderback, personal communication), non-native and invasive plant species (Dudoit 2006, Bilderback and Bilderback, personal comm.), salmonid populations and behavior (Hudson et al. 2010, van de Wetering unpublished data), avian populations and habitat use (Castelein and Lauten 2007, Hodder and Graybill 1984, USFWS unpublished data), macro invertebrates (van de Wetering, personal communication), and nutrient transport, site productivity and water quality (EPA unpublished data, Punke 2005).

The Clean Water Act of 1972 and the Safe Drinking Water Act of 1974 are the main statues regulating water quality in the United States. These acts are administered by the Environmental Protection Agency (EPA). Recent amendments to these acts, including the creation of the National Estuary Program as part of the 1987 Clean Water Act amendment, further direct the EPA and the State of Oregon to manage the Coquille River watershed in a comprehensive manner and to identify and assess nonpoint sources of pollution. The Oregon Department of Environmental Quality has identified waters that do not meet water quality standards under Section 303(d) of the Clean Water Act. The waters identified are considered to be “water quality limited.” In the 2002 and 2004/2006 reporting cycles the Coquille River was listed as “water quality limited” because it exceeded the total maximum daily load of pollutant a waterbody can contain (ODEQ 2011). The Coquille River is affected by nonpoint source pollution from water-based or land use activities including atmospheric deposition; surface water runoff from agricultural lands, urban areas (Bandon, Coquille, and Myrtle Point), and forest lands; subsurface and underground sources; and discharges from boats. These pollutants include aquatic weeds or algae, E. coli bacteria, fecal coliform bacteria, chlorophyll, levels of dissolved oxygen, pH, sedimentation, temperature, total dissolved gas, toxic substances, and turbidity. The waters within the boundary of Bandon Marsh NWR were not assessed by the state under the Clean Water Act and were not listed as impaired. The threat of impaired waters within Bandon Marsh NWR is of concern, as these waters must be of sufficient quality to support aquatic species without detrimental changes in resident biological communities.

In 2010, the presence of non-native nutria was documented at Bandon Marsh (USFWS unpublished observations). Native to South America, this semi-aquatic mammal is tolerant of mild coastal winters. Nutria is known to be expanding their range in southern coastal Oregon and within the Coquille River system (Sheffels and Sytsma 2007, Stuart Love, ODFW, personal communication). This rodent is capable of extensive damage as a result of its foraging and burrowing behaviors, which adversely impact the root mass of wetland plants that holds the wetland together. In addition to direct habitat damage to salt marshes and competition with native species (e.g., muskrat, beaver), this large rodent is capable of transporting parasites and pathogens communicable to wildlife, domestic animals and humans (Sheffels and Sytsma 2007). The high reproductive rate of the animal is a concern, as one breeding pair can result in a population of more than 16,000 after only 3 years and if left unchecked the numbers are capable of increasing to tens of thousands within a 30 year period (Sheffels and Sytsma 2007, CBNWG 2003).

The continued threat of contamination by a variety of persistent, bioaccumulative toxic chemicals and oils used in wood treatment, transportation, and processing of natural resources has been documented in the soils, sediments and animals adjacent to the Bandon Marsh Unit (Thomas et al. 1997). These toxic chemicals include trace elements and heavy metals such as cadmium, chromium, iron, lead, copper and nickel as well as total and congener-specific polychlorinated biphenyls (PCB), dioxins and furans, polyaromatic and aliphatic hydrocarbons, total petroleum hydrocarbons and pentachlorophenol. While primarily concentrated in areas around urban and industrial developments, these contaminants affect a much larger area of the ecosystem. When resident or migratory organisms live or eat within these areas of contamination, not only are they directly harmed, but they accumulate contaminants in their tissues and transfer them throughout the food web.

Large scale oil spills from offshore tankers, road gas and oil transport, as well as smaller spills from recreational and commercial boat use within the watershed, can have dramatic and significant adverse impacts (Pezeshki et al. 2000). For the lower Coquille River estuary's salt marsh and mudflats, these adverse impacts are heightened because the inherently low wave energy of the salt marsh does not physically remove oil effectively. Bandon Marsh is flooded twice daily at high tides and the complex surface of the salt marsh can trap large amounts of oil. Once these habitats are impacted by oil spills, the effort to combat the spill in many instances causes extensive damage to the habitat (Sell et al. 1995) and if heavily impacted with oil, the dense vegetation and complex structure of the marsh elongates the recovery time (Teal et al. 1992). In addition to habitat damage, the contamination of fish and wildlife by oil can have direct impacts such as mortality of animals due to smothering and toxic effects, as well as indirect adverse effects and more subtle long-term negative consequences. Oil can affect estuary-dependent marine and anadromous fish populations by both direct toxicity and by a reduction in the benthic species on which they feed (NAS 1985). Migratory and resident seabirds, shorebirds, wading birds and waterfowl that congregate on Bandon Marsh may suffer from destruction of breeding and feeding grounds.

Historic use of the Coquille River and southern Oregon estuaries for the maritime industries and aquaculture has introduced and been a vector for the transport of marine invasive species which threaten the biological diversity of Bandon Marsh (Bax et al. 2003). Due to difficulties in monitoring and jurisdictional controls, marine invasive species are some of the newest and least understood threats to Bandon Marsh NWR. Invasive plants and invertebrates such as Japanese eelgrass, smooth cordgrass, Asian tunicate, lacy crust bryozoan, Japanese orange-striped sea anemone, Harris mud crab, European green crab, Chinese mitten crab, New Zealand burrowing isopod, New Zealand mud snail, Griffen's isopod, and a variety of Asian and eastern United States clams have been recorded within the southern Oregon estuaries and within the lower Coquille watershed (Dudoit 2006, Bilderback and Bilderback personal communication, Davidson et al. 2007, USGS 2009). Many of these species have infested large areas along the outer coast of Oregon and removal has been costly. The refuge staff has begun monitoring for cordgrass and ODFW plans to expand monitoring efforts to include other exotic marine invertebrates, particularly at the nearby boat docks and marinas within the lower watershed.

A non-native invasive marine grass, Japanese eelgrass, was first observed in 1992 on the Refuge. It is currently rare at Bandon Marsh but can be found in small isolated patches along the edge of the Coquille River within both refuge units and may have an effect on native benthic communities (Dudoit 2006, Crombie 1993, Posey and Rudy 1987). Bandon Marsh NWR is the only major Oregon estuary in which Japanese eelgrass does not form contiguous meadows (Dudoit et al. 2006).

Alteration and management of the state-owned banks and waters within the Coquille River estuary is delegated to the Department of Land Conservation and Development (DLCD). Through the Land Use Planning Act, the DLCD works with and oversees the Port of Bandon and City of Bandon comprehensive plans that incorporate applicable planning goals (e.g., Goal 16 Estuary Resources) for the estuary. The Bandon Comprehensive Plan recognizes the Coquille River estuary (including Bandon Marsh NWR) as a Shallow Draft Development Estuary and the Plan requires that activities and uses remain consistent with the shallow-draft development designation and the estuarine management unit requirements of Goal 16 (City of Bandon 2011). The City protects and implements control of allowed uses and activities in the estuary through the Bandon Municipal Code (Chapter 17.64, Water Zone). Without these protection and conservation measures, the threat of adverse alterations would potentially affect the dynamic, natural, geological, and evolutionary processes of the estuary.

4.3.5 Key Species Supported

The estuarine salt marsh and tidal flats of Bandon Marsh NWR contain rich beds of algae, marine invertebrates and plant life that support hundreds of wading birds, thousands of migratory waterfowl and hundreds of thousands of shorebirds, which in turn provide an important prey base for numerous raptors (i.e., birds of prey) including the recently delisted bald eagle and the peregrine falcon (Hodder and Graybill 1984, Castelein and Lauten 2007, USFWS unpublished data). In addition, the sinuous tidal channels and mudflats, twice flooded by daily tides, provide essential habitat for numerous marine species of fish including flounders, English sole, and shiner perch, as well as important nursery habitat for anadromous species such as Chinook and coho salmon, steelhead, and coastal cutthroat trout (USFWS and FHA 2009).

Invertebrates such as snails, shrimp, clams, worms, and crabs are locally common or abundant (Simenstad 1983). The most common and important invertebrate species occupying the Bandon Marsh NWR mudflats include Dungeness crab, softshell clams, ghost shrimp, mud shrimp, and a variety of worms (Rudy and Rudy 1983, USFWS unpublished observations). Ghost and mud shrimp within the tidal flats, which are important filter feeders that affect water quality, are also being invaded in Oregon’s estuaries by a non-native species, a predator called Griffen’s isopod (USGS 2009). The direct effect on the food chain from the loss of the ghost shrimp is unknown, but is indicative of change with increased human actions and climate change. Wading birds such as great blue heron and great egret, and shorebirds such as black-bellied plover, killdeer, least and western sandpiper, dunlin, and long-billed and short-billed dowitcher make extensive use of the mudflats for foraging on macro-invertebrates and in some cases biofilm (Mathot et al. 2010, Skagen and Oman 1996). Dabbling ducks and diving ducks, gulls, and raptors such as northern harrier, peregrine falcon, and bald eagle also forage there (USFWS 2011a, Castelein and Lauten 2007, Hodder and Graybill 1984). Harbor seals forage within the waters that are present over the mudflats when they are inundated at high tide and in the lower bay they haul out on the low marsh edges to rest during the day.

4.4 Forested Wetland and Stream-Riparian Habitat

4.4.1 Description of Wet-Mesic Sitka Spruce-Western Hemlock Forest

For the purposes of this CCP, wet-mesic Sitka spruce-western hemlock forests are defined as woody habitats that consist of valley forested wetlands and riparian forest along rivers, salt marsh, or

mudflats (e.g., National Vegetation Classification Standard *Tsuga heterophylla - Picea sitchensis*/*Lysichiton americanus* Hardwood-Conifer Rich Swamp Group, NatureServe 2012). Periodic freshwater tidal and/or seasonal riparian flooding are the major natural processes that drive this system. Soils are perennially wet, usually with high organic content.

Historically, many of the areas located in the lower brackish (mesohaline to oligohaline) and freshwater tidal zones of Oregon's estuaries were likely Sitka spruce and/or shrub tidal swamp. Tidal swamps were also found on the margins of the marine salinity zone where freshwater dilutes ocean water, such as along tributary streams, on high natural levees, and in hillslope seepage zones. On higher quality, least-disturbed remnant tidal Sitka spruce swamp sites, this community has scattered to abundant Sitka spruce, often growing on islands such as downed timber and natural levees along deep well-defined tidal channels, and a mixed herbaceous-woody understory. The vegetation between forested islands or along waters' edges consists of typical high marsh or tidal freshwater wetland species like tufted hairgrass, creeping bentgrass, Pacific silverweed, Baltic rush, slough sedge, and skunk cabbage as well as brackish-tolerant wetland shrubs such as red-osier dogwood, Nootka rose, dewberry, salmonberry, black twinberry, Pacific crabapple, and Hooker willow (Brophy 2002, NatureServe 2012). Non-wetland species such as salal and huckleberry can also be fairly abundant, growing on fallen logs or spruce root platforms elevated well over the hydric soil surface. Riparian red alder is also present and is important for its role in improvement of soil nutrient cycling and soil microbiology. Tree roots stabilize river banks and help prevent erosion. Alder also adds organic matter and nutrients to the river and keeps waters cool through shading. Cool water temperatures and cover are essential for fish spawning and survival (USFWS 1990b).

The wet-mesic forests and woodlands on Bandon Marsh NWR typically consist of mixed patches of forest that contain second growth red alder, Sitka spruce, western hemlock, and a small amount of Port Orford cedar. The understory is rich with shade-tolerant shrubs and ferns, including brackish-tolerant wetland shrubs such as black twinberry, cascara, Pacific crabapple, wax myrtle, Hooker willow, salal, evergreen huckleberry, sword fern, skunk cabbage, and deer fern, as well as a high diversity of mosses and lichens (Brophy 2005, Brophy and van de Wetering 2012). The disturbance regime is mostly small-scale windthrow or other gap mortality processes (though there are occasional widespread intense windstorms) and very few fires. Many of the snags in this community are Port Orford cedars that have been adversely affected from a root disease caused by cedar root fungus. Origin of the root disease is unknown, but the complete susceptibility of Port Orford cedar suggests that the fungus evolved outside the native cedar range, perhaps in Asia.

The desired attributes of wet-mesic Sitka spruce-western hemlock forest (i.e., forested wetland and stream-riparian habitats) are the following (based on Brophy 2009, Brophy et al. 2011, Brophy and van de Wetering 2012, NatureServe 2012):

- Periodic freshwater tidal and/or seasonal riparian flooding
- Flat topography with local microrelief caused by logs, stumps, and buttressed roots of spruce trees.
- High organic content of soils (>20% organic matter)
- Woody vegetation dominated by native trees and shrubs (e.g., Sitka spruce, red alder, Hooker willow, Sitka willow, twinberry, Pacific crabapple). Dominant herbaceous species include slough sedge and skunk cabbage with non-wetland species (e.g., salal, huckleberry) growing on fallen logs or spruce root platforms.
- <5% cover of invasive plants (e.g., blackberry, gorse, Scotch broom)

- No English ivy

4.4.2. Historic and Current Distribution

Sitka spruce is commonly referred to as "tideland spruce" in historical documents due to its prominence in tideland areas of Oregon and Washington (Franklin and Dyrness 1988). Sitka spruce forms the canopy of the only major type of tidal forest in Oregon, the spruce tidal swamp. Tidal swamps were historically located in a narrow elevation band at the upslope margin of emergent tidal marsh. Once extensive, spruce tidal swamp is now rare in Oregon. Estimates by Brophy (2011) using Scranton (2004) and Hawes et al. (2008) indicate a 90% loss of tidal swamp within Oregon's estuaries. It is likely that areas along the margins of the Coquille River estuary and the middle Coquille River were once spruce tidal swamp, but like most of Oregon's tidal forest lands, these areas have probably been filled, diked, or cleared of trees for agricultural fields and urban growth areas (Brophy 2005).

4.4.3 Refuge-specific Sites

Bandon Marsh NWR contains 79 acres of wet-mesic Sitka spruce-western hemlock forest along the fringes of the Coquille River, small tributaries of Fahys and Redd creeks, salt marsh and mudflats (Figure 2-1), with the majority of the acreage being located on the Ni-les'tun Unit. Additionally, the former cranberry bogs on the Smith Tract (11 acres) were recontoured and hydrologically restored to Fahys Creek and the area planted with a mixture of Sitka spruce and other riparian trees and shrubs (e.g., willows, vine maple, crabapple, twinberry, huckleberry) in 2010-2011. Historically, the Ni-les'tun Unit had an unknown greater percentage of this plant community. The current straight-line edges of the forest are indicative of logging, ditching and draining of this forest type for the development of pasture.

Recent logging activities within the Bandon Marsh Unit boundary occurred in 1991-1992 just prior to the acquisition of 17 acres of forested wetland by the Service. This habitat was re-forested with Sitka spruce seedlings by the Service and volunteers from Shoreline Education for Awareness (William Russell, personal communication).

4.4.4 Condition, Trends, and Threats

All of Bandon Marsh's wet-mesic Sitka spruce-western hemlock forest has been logged or converted to pasture. A few remaining large diameter (>36 inches DBH) Sitka spruce exist scattered in both the Bandon Marsh and Ni-les'tun Units. Most of the existing timber is second growth or in some cases third growth (<36 inches DBH). The understory has reestablished itself into a lush mixture of wet tolerant shrubs, ferns, and skunk cabbage, interspersed with remnant stumps of old growth trees. The stumps in many cases are becoming nursery logs for a variety of shrubs and in some cases new growth of Sitka spruce. In addition, much of the forest is littered with downed and decaying layers of small diameter (<12 inches) timber and shrubs that are being out-shaded by large stature timber.

For the past 100-150 years non-native invasive plants on Bandon Marsh NWR have been introduced inadvertently or intentionally as pasture grasses, soil stabilizers or as ornamentals. These invasive species are generally found along the edges of disturbed forest habitat due in large part their intolerance to the shaded conditions within the forested canopy. The non-native species include reed canarygrass, tall fescue, creeping bentgrass, Canada thistle, Himalayan blackberry, gorse, English ivy, and Scotch broom (Brophy 2005, Bilderback and Bilderback, personal communication). This list

is not all inclusive and includes only the most problematic species; many other exotic plants have been introduced.

4.4.5 Key Species Supported

The riparian forest patches and the forested wetlands support large mammals such as black-tailed deer, and occasional Roosevelt elk, black bear and mountain lion. Small mammals including bobcat, gray fox, beaver, mink, river otter, striped skunk, raccoon, deer mouse, and vagrant shrews are common in the forest and along its edges. Amphibians and few reptiles are found in this wet-mesic habitat and include Pacific giant, northwestern, ensatina, and western red-backed salamanders, rough-skinned newt, chorus (Pacific tree) frog, southern alligator lizard, and garter snake (Mercer 2005, Kocourek 2006b, Wishnek 2011). The forest areas are also home to common Northwestern forest passerine species such as chestnut-backed chickadee, varied thrush, hermit thrush, and pileated woodpecker. Birds dependent on water and forest edges such as great blue herons, belted kingfisher, wood duck, Pacific wren, and yellow-rumped warbler can be found in this habitat (Hodder and Graybill 1984, Castelein and Lauten 2007, USFWS unpublished data).

4.5 Upland Forests

4.5.1 Description of Sitka Spruce–Western Hemlock Forest

Sitka spruce and western hemlock are the principal components of the Pacific Northwest coastal fog belt type or the *Picea sitchensis* zone found along the Oregon and Washington coasts. The tremendous potential for rapid growth and high yield of the Sitka spruce-western hemlock type ranks it among the most productive coniferous types in the world (Smith et al. 1984).

In this area of the southern Oregon coast, forest canopy is dominated by Sitka spruce, often with low to moderate cover of western hemlock, grand fir, western red cedar, or Port Orford cedar. The most prevalent broadleaf is the red alder. The understory is rich with shade-tolerant shrub, forb, and fern species including Pacific wax myrtle, salmonberry, thimbleberry, salal, evergreen huckleberry, red huckleberry, and Pacific sword fern. The composition of the moderately developed moss layer varies with the moisture regimes with more feather mosses on drier sites and more leafy mosses on wetter sites (NatureServe 2010). The desired attributes of this forested habitat include:

- 30-95% (73% average) canopy cover of Sitka spruce and western hemlock with DBH >24-36 inches with multiple distinct canopy layers also including grand fir, western red cedar, and/or Port Orford cedar.
- 25-95% (83% average) cover of a mosaic of native shrubs (e.g., salmonberry, huckleberry, salal, wax myrtle), ferns, and herbaceous species (e.g., sedges) in understory. Shrub height averages 3 meters (10 feet).
- 6/acre density of snags
- One tree per acre with significant structural defect or decadence (e.g., cavities, snapped top, mistletoe/fern infestation)
- 600+ square feet per acre density of downed logs/nurse logs of varying decay classes
- <5% cover of invasive plants (e.g., blackberry, gorse, Scotch broom)
- <1% English ivy

4.5.2. Historic and Current Distribution

Sitka spruce-western hemlock forests occur in the mountains of the Queen Charlotte Islands, the mountains and lowlands of western and northern Vancouver Island and along the outer coast and windward slopes of the Coast Mountains and Kitimat Ranges of British Columbia, at low elevations on the western Olympic Peninsula and western Willapa Hills of Washington, along a narrow outer coastal strip in Oregon, and just barely into the northwestern Cascade Range of Washington. It occurs on all slope positions on gentle to steep slopes on all aspects. At the south end of its range, it tends to occur more commonly on middle slopes (NatureServe 2010). Forests dominated by western hemlock and Sitka spruce hug the fog belt along the Oregon coast, seldom reaching more than a few miles inland or a few hundred feet above sea level. Both species are shade tolerant, but Sitka spruce is more resistant to salt spray. Sitka spruce sometimes grows in pure stands but is more commonly mixed with western hemlock, western red cedar, Douglas-fir, red alder, and lodgepole pine (commonly called shore pine along the coast).

4.5.3 Refuge-specific Sites

39 acres of Sitka spruce-western hemlock forest currently exist occurs on the Ni-les'tun Unit of Bandon Marsh NWR (Figure 2-1). Approximately 29 acres of former pasture will be restored to Sitka spruce-western hemlock forest. All of the forested areas of Bandon Marsh NWR are within the Sitka spruce zone (Franklin and Dyrness 1988), which often extends only a few kilometers inland along the Pacific coast. This zone transitions into and is a variant of the western hemlock zone, and is distinguished by the occurrence of Sitka spruce and frequent summer fog. The forested community on Bandon Marsh NWR is unique since it is located at the southern end of the range for Sitka spruce and the northern extent of the limited range of Port Orford cedar. The management goal is to assist the development of natural ecological processes that would produce late successional or old growth forests.

4.5.4 Condition, Trends, and Threats

Sitka spruce-western hemlock forests are among the most productive in the world and have been extensively managed for timber production. Harvest of old-growth and mature forests for commercial timber and paper production has resulted in loss of species diversity and forest complexity on most of the landscape due to planting of even-aged, monotypic stands, and short harvest rotations.

Threats facing this habitat type include climate change, invasive species, and insect or disease infestation. Response to climate change will vary according to regional and local topography, forest type, soil moisture, productivity rates, species distribution and competition, and disturbance regimes.

Natural disturbance is primarily windthrow resulting in small gaps and an all-aged stand structure. Forest regeneration is usually rapid and forest openings can quickly develop a dense canopy of young trees with sparse understory vegetation. Other small gaps may result from insect-caused mortality or root-rot. Historically fire was a very rare occurrence, occurring approximately every 4,000 years on average (Lertzman et al. 2002). Human-induced wildfire is a potential catastrophic threat to forested habitats as well as fire suppression. Conversion of habitat to residential and non-forest uses has accelerated forest fragmentation. Introduced invasive plants (e.g., English ivy and holly) pose a significant threat to forested habitats on the Refuge. Potential insects or diseases that could affect the Refuge's forests include aphids, scale and bark beetles, root rot, leaf cast, and other fungi.

The upland forests on Bandon Marsh NWR have not been actively managed for wood production since the mid 1970-80s, when the land was under private ownership. This discontinuation of timber removal, combined with the spread of the cedar root fungus that is decimating Port Orford cedar stands on the southern Oregon coast, results in the Refuge becoming an important remaining example of this forest type.

4.5.5 Key Species Supported

The current Sitka spruce forests within the Refuge provide foraging habitat for black-tailed deer, black bear, and bobcat, as well as habitat for band-tailed pigeon, northern flicker, pileated woodpecker, pacific-slope flycatcher, American robin, Swainson's thrush, varied thrush, cedar waxwing, and house finch. Forest regeneration on the Refuge is rapid, and forest openings can quickly develop a dense canopy of young trees with sparse understory vegetation. Many species of birds, such as great horned owl, western screech owl, hairy woodpecker, Steller's jay, American crow, chestnut-backed chickadee, red-breasted nuthatch, and Pacific wren use the conifer forest because of the presence of bark, wood-boring insects, and conifer seeds. Many species of amphibians occur because of the damp litter on the floor of mature forests, including northwestern salamander, western red-backed salamander, and Ensatina salamander. The Pacific giant salamander and southern torrent salamander both require cold mountain streams or seeps in old growth or undisturbed forests as breeding habitat, and damp litter on the forest floor to survive as metamorphosed adults.

4.6 Salmonids

The Coquille watershed is a productive fishery resource for the state of Oregon (Good et al. 2005) and the open water environments are critical to the important fisheries of the Coquille River system. The mixing of fresh and salt waters within the estuary permits anadromous fish to adjust to the change in salinity and temperatures as they pass to and from the ocean environment. Anadromous fish spawning and rearing in the Coquille system include spring (rare) and fall Chinook salmon, coho salmon, summer and winter steelhead, coastal cutthroat trout, and Pacific lamprey. Seasonal migrations of anadromous fish result in year round use of the Coquille watershed by adult salmon. In addition, resident coastal cutthroat trout are found throughout the watershed.

Conserving and restoring salmonid populations is an important goal, not only for their own sake, but also because of their cultural, historical, and ecological value. Salmonids are an important food source for numerous other wildlife species. Sixty-seven wildlife species of the Pacific Northwest, including many known to inhabit the Refuge, have been known to have a "strong" or "recurrent" relationship with salmon (Cederholm et al. 2000). Salmon play an important ecological role in the transport of energy and nutrients between the ocean, estuary, and freshwater streams, supporting overall ecosystem health. All life stages provide nutrients and energy needed for healthy stream ecosystems. Today, only three percent of the marine-derived biomass once delivered by anadromous fish is currently reaching those watersheds. Research on the consumption of salmon by vertebrate wildlife has documented 137 species of birds, mammals, amphibians, and reptiles are predators or scavengers of salmon. In coastal streams, marine derived nutrients from salmon carcasses increase the overall productivity of the system (Cederholm et al. 2000).

4.6.1 Description of Coho Salmon and Coastal Cutthroat Trout

The Oregon Coast coho salmon evolutionarily significant unit (ESU) found in the Coquille River system is listed as a threatened species under the Endangered Species Act (NOAA 2008). The size of an adult coho may measure more than 2 feet (61 centimeters) in length and can weigh up to 36 pounds (16 kg). However, the average weight of adult coho is 8 pounds (3.6 kg). Coho salmon have dark metallic blue or greenish backs with silver sides and a light belly and there are small black spots on the back and upper lobe of the tail while in the ocean. The gumline in the lower jaw is white while in Chinook salmon it is black. Spawning fish in inland rivers are dark with reddish-maroon coloration on the sides. Coho salmon adults migrate from a marine environment into freshwater streams and rivers of their birth in order to mate (called anadromy; i.e., anadromous). They spawn only once and then die. Adults return to their stream of origin to spawn and die, usually at around three years old. Some precocious males known as “jacks” return as two-year-old spawners. Spawning males develop a strongly hooked snout and large teeth. Females prepare several redds (nests) where the eggs remain for six to seven weeks until they hatch. As the time for migration to the sea approaches after spending a year in freshwater, juvenile coho salmon lose their parr marks, a pattern of vertical bars and spots useful for camouflage, and gain the dark back and light belly coloration used by fish living in open water. Their gills and kidneys also begin to change at this time so that they can process salt water. In their freshwater stages, coho feed on plankton and insects, and switch to a diet of small fishes as adults in the ocean (NOAA 2010). Parr have 8-12 narrow parr marks centered along the lateral line. The marks are narrow and widely spaced. The adipose fin is finely speckled, imparting to it a gray color, but the other fins lack spots and are tinted orange. They have 9-12 dorsal fin rays, 12-17 anal fin rays, and 9-11 pelvic fin rays. Lateral line scales number from 121-148 and the scales are pored. There are 11-15 branchiostegal rays on either side of the jaw. Gill rakers are rough and widely spaced, with 12-16 in the lower half of the first arch (Moyle 1976).

Throughout their native and introduced range, coastal cutthroat trout vary widely in size, coloration, and habitat selection. Though their coloration can range from golden to gray to green on the back, depending on subspecies strain and habitat, all populations universally feature distinctive red, pink, or orange marks on the underside of the lower jaw or below the gill plates; usually the easiest diagnostic of the species for the casual observer. These markings are responsible for the formation of the typical name “cutthroat.” At maturity, different populations and subspecies of cutthroat can range from 6 to 40 inches in length, depending on habitat and food availability, making size an ineffective indicator as to species identity. Anadromous cutthroat may reach weights of 20 pounds but those fish which remain permanently in fresh water may only reach a weight of 2 pounds (Eddy and Underhill 1978). Cutthroat will readily interbreed with the closely related rainbow trout, producing fertile hybrids commonly called “cutbow.” As this species generally bears similar coloration and overall appearance to the cutthroat, retaining the characteristic orange-red slash, these hybrids often pose a taxonomical difficulty (Connolly et al. 2008).

Coastal cutthroat trout exhibits anadromous, stream-dwelling, lake-dwelling, and headwater stream-resident life history forms. Anadromous fish spawn in small tributaries from late winter through spring, depending on the locality. Juveniles remain in streams for two or more years and congregate during their early months in habitats along stream edges. Later, they move to pools unless coho salmon are present, in which case they are driven to riffles. Most anadromous coastal cutthroat trout juveniles smolt are age 3 or 4 when they migrate to sheltered saltwater areas. Seaward migration peaks in May, and the fish remain close inshore while in salt water. The fish seldom overwinter at sea but return to rivers in the fall or winter of the year they go to sea. In some instances, these are overwintering migrations only, because anadromous female coastal cutthroat trout seldom spawn

before age four. Stream-dwelling forms migrate to mainstem rivers or to lakes; otherwise, their life history characteristics are much like those of the anadromous form. Headwater stream-resident coastal cutthroat trout become sexually mature as early as age two, but seldom live beyond age four or five. These fish exhibit only limited instream movements and generally live out their lives within 200 meters (656 feet) of their birthplace (Trotter 1989).

4.6.2. Historic and Current Distribution

Coho salmon are a widespread species of Pacific salmon, occurring in most major river basins around the Pacific Rim from central California to Korea and northern Hokkaido, Japan. In the United States distribution is from Point Hope, Alaska to the San Lorenzo River in Santa Cruz County. The historic range of the coho in the lower 48 states included coastal streams of California, Oregon and Washington, plus the much larger Sacramento and Columbia river systems, reaching as far inland as Idaho. It also occurs in rivers throughout coastal British Columbia and western Alaska. Published investigations have reported that a number of local populations of coho salmon in Washington, Oregon, Idaho, and California have become extinct and that abundance and productivity of many others is depressed (Brown and Moyle 1991, Frissell 1993, Nehlsen et al. 1991, Good et al. 2005, NOAA 2008).

We have very limited direct information about the spatial structure of the Oregon Coast coho salmon populations. Previous analyses (Nickelson and Lawson 1998, Nickelson 2001) assumed that spawners from major river basins are largely isolated, and that each basin comprises at least one population. The Umpqua River is large and diverse enough to hold several populations, but for analysis purposes it was considered as one. Three coastal lakes, Siltcoos, Tahkenitch, and Tenmile, are considered to be a single population, but may actually be separate. Genetic analyses are being conducted to resolve these questions, but results were not available at the time of this review (Good et al. 2005). This is a change from the status review update in 1997 (Schiewe 1997), when the Oregon coast was considered to consist of four populations, called gene conservation groups. Three of these groups (north/mid coast, mid/south coast, and Umpqua) were in the Oregon Coast coho salmon ESU and the fourth (south coast) was in the Southern Oregon/Northern California Coast coho salmon ESU (Good et al. 2005).

The following ESUs are “likely to become endangered in the foreseeable future:” Snake River fall-run Chinook, Snake River spring/summer-run Chinook, Puget Sound Chinook, Lower Columbia River Chinook, Upper Willamette River Chinook, California Coastal Chinook, Central Valley spring-run Chinook, Snake River steelhead, Lower Columbia River steelhead, Upper Willamette River steelhead, Northern California steelhead, Central California Coast steelhead, South-Central California Coast steelhead, Oregon Coast coho, Southern Oregon/Northern California Coast coho, Ozette Lake sockeye, Hood Canal summer-run chum, and Lower Columbia River chum (Good et al. 2005).

Cutthroat trout are native to western North America. The species has evolved through geographic isolation into many subspecies, each native to a different major region or specific drainage basin. Native cutthroat species are found along the Pacific Northwest coast, in the Cascade Range, the Great Basin, and throughout the Rocky Mountains. For the coastal cutthroat trout subspecies, some populations have anadromous individuals, living for periods in the Pacific Ocean as adults and returning to freshwater from fall through early spring to feed on insects and spawn (Trotter 1989). Most populations, however, stay in fresh water throughout their lives and are known as non-migratory, stream-resident, or riverine populations.

The coastal cutthroat trout occurs over the broadest geographical range of any of the recognized cutthroat trout subspecies (Behnke 1979, Johnston 1981). The subspecies is distributed along the Pacific coast from the Humboldt Bay area of California to Prince William Sound, Alaska, a distance of about 3,025 kilometers (1,880 miles). It occurs inland to the crest of the Cascade Mountain Range in Oregon and Washington and to the Coast Range crest in British Columbia and southeast Alaska, an average distance of 160 kilometers (99 miles; Trotter 1989). Its native range coincides quite closely with the coastal rain forest belt defined by Waring and Franklin (1979).

4.6.3 Condition, Trends, and Threats

The status of most anadromous fish within the Oregon Coast coho ESU has been in decline for decades. Currently, coho salmon on the Oregon Coast (Oregon Coast ESU) are listed as "Threatened" on the federal Threatened and Endangered Species List. Oregon Coast coho ESU was originally listed threatened in 1998, set aside due to the Alsea case and commitment to conduct status review; proposed threatened in 2004, found not warranted in 2006, contested and listed in 2008 (73 FR 7816); contested and new status review conducted; threatened finding published in Federal Register in 2011 (superseded 2008 finding) and kept critical habitat and protective regulations from 2008 in place. The State of Oregon lists coho salmon as a Threatened species for the entire state. Oregon Coast steelhead was found not warranted for listing in 1998 and considered a "species of concern" by NOAA in 2004 due to specific risk factors. Oregon Coast Chinook ESU found not warranted for listing in 1998 because populations appear healthy and stable in some areas of the coast and are declining in others. There are very little data available for searun and native coastal cutthroat trout and their population status and needs are unclear.

In 2003 the Oregon Workgroup of the Oregon Northern California Coast Technical Recovery Team convened to review and analyze information that could shed light on historical populations of Oregon Coast coho salmon. Documentation of life history traits, distribution, or abundance of Oregon Coast coho salmon prior to 1940 is limited. Considerable biological information has been gathered during the past 30 years, and particularly the past 12 years; however, it is difficult to relate the biological characteristics of modern populations to those that existed historically in the same basin. Human activities over the past 200 years have altered every aspect of salmon habitat on the coast, harvest has changed abundance patterns, and hatcheries may have blurred the distinctions among stocks. Coho salmon have adapted their behavior to many of these changes and, as a result, present-day Oregon Coast coho salmon populations function differently than they did historically (Lawson et al. 2007).

The abundance and productivity of Oregon Coast coho since the status review completed in 1997 (NMFS 1997) represented some of the best and worst years on record (NOAA 2008). Yearly adult returns for the Oregon Coast coho ESU were in excess of 160,000 natural spawners in 2001 and 2002, far exceeding the abundance observed for the past several decades. These encouraging increases in spawner abundance in 2000–2002 were preceded, however, by three consecutive brood years (the 1994–1996 brood years returning in 1997–1999, respectively) exhibiting recruitment failure (recruitment failure is when a given year class of natural spawners fails to replace itself when its offspring return to the spawning grounds 3 years later). These 3 years of recruitment failure were the only such instances observed thus far in the entire 55+ year abundance time series for Oregon Coast coho salmon (although comprehensive population-level survey data have only been available since 1980). The encouraging 2000–2002 increases in natural spawner abundance occurred in many populations in the northern portion of the ESU, populations that were the most depressed at the time of the 1997 review (NMFS 1997). Although encouraged by the increase in spawner abundance in

2000–2002, the long-term trends in ESU productivity were still negative due to the low abundances observed during the 1990s (NOAA 2008).

The Oregon Coast coho salmon ESU total natural spawner abundance was estimated based on stratified random survey (SRS) techniques, broken down by ODFW's monitoring areas (MAs), for 11 major river basins and for the coastal lakes system. These data are for the return years 1990–2002 and are expressed in terms of naturally produced fish, rather than the standard of naturally spawning fish used in other status review updates. Total recent average (3-year geometric mean) spawner abundance for this ESU is estimated at about 140,600, up from the 5-year geometric mean of 52,000 in the 1997 update and higher than the estimate at the time of the most recent status review (Good et al. 2005). In 2001, the ocean run size was estimated to be about 178,000; this corresponds to one-tenth of ocean run sizes estimated in the late 1800s and early 1900s, and only about one third of those in the 1950s (ODFW 1995). In 2002, the ocean run size increased to 304,500, fourth highest since 1970 and perhaps 25% of historical abundance. Present abundance is more evenly distributed within the ESU than it was in 1997. Escapement in the relatively small mid/south coast monitoring area was the strongest in the ESU until 2001. In 2002, escapements in the mid/south were down about 25%, while the north and mid-coast monitoring areas showed strong gains. The Umpqua monitoring area is up by a factor of 4 since 1996 (Good et al. 2005).

The population of coho salmon in the Coquille River is one of the larger populations in southern Oregon. Population estimates ranged from 2,712 natural-origin spawning adults in 1990 to 8,488 spawning adults in 2002 (Good et al. 2005) and to more than 28,500 spawning adults in 2006. The number of adults returning to spawn is a direct result of the number of juveniles that migrate into the ocean. Estimates of juvenile production for three brood years in the late 1990s indicate that total juvenile production for the Coquille River was between about 120,000 and 300,000 individuals. Spawning adult population associated with these estimates was about 3,000 to 5,700 fish. Historical abundance of coho for the Oregon Coast coho ESU is estimated at approximately 2 to 3.3 million fish and within the Coquille River watershed 310,000 fish to 417,000 fish depending upon the methodology and data used to derive the estimate (Lawson et al. 2007).

Threats currently facing the Oregon Coast coho ESU include the present or threatened destruction, modification, or curtailment of its habitat or range. In many Oregon coastal streams, past human activities (e.g., logging, agriculture, gravel mining, urbanization) have resulted in impediments to fish passage, degradation of stream complexity, increased sedimentation, reduced water quality and quantity, loss and degradation of riparian habitats, and loss and degradation of lowland, estuarine, and wetland coho rearing habitats. The relevant issues are whether current habitat conditions are adequate to support the ESU's persistence and whether habitat conditions are likely to worsen in the future. There is uncertainty about the adequacy of current habitat conditions, and this uncertainty contributed to the finding that the ESU was likely to become an endangered species within the foreseeable future. Also, if the long-term decline in productivity of the Oregon Coast coho ESU reflects deteriorating conditions in freshwater habitat, this ESU could face very serious risks of local extinction during the next cycle of poor ocean conditions. With respect to population growth and urbanization, approximately 3.4 percent of "high intrinsic potential" habitat areas for coho (e.g., lowland stream reaches particularly important to juvenile coho rearing and overwintering survival) are within currently designated urban growth areas, suggesting that future human population growth may not represent a significant threat to the ESU (NOAA 2008). With respect to lowland and upland habitat areas under various types of land use and ownership, NOAA found that some areas are likely to improve, some are likely to decline, and others are likely to remain in their current condition. Overall, there is a high level of uncertainty associated with projections of future habitat conditions

due to underlying economic and sociopolitical factors influencing forest harvest and restoration rates, urban conversion of agricultural and forest lands, and the enforcement and implementation of land-use plans and regulations. Based on their analysis, NMFS found that there is insufficient evidence to conclude that the Oregon Coast coho ESU was more likely than not to become an endangered species because of the "threatened destruction, modification, or curtailment of its habitat or range." It remains uncertain whether future freshwater habitat conditions will be adequate to support a viable coho ESU, particularly during periods of unfavorable ocean conditions and poor marine survival.

Another identified threat is overutilization for commercial, recreational, scientific, or educational purposes. Harvest rates on Oregon Coast coho populations ranged between 60 and 90 percent between the 1960s and 1980s (Good et al. 2005). Modest harvest restrictions were imposed in the late 1980s, but harvest rates remained high until most directed coho salmon harvest was prohibited in 1994. These restrictive harvest regulations, developed concurrently with the Oregon Plan and subsequently revised, have imposed conservative restrictions on direct and incidental fishery mortality, and appropriately consider marine survival conditions and the biological status of naturally produced coho populations. Under these revised regulations, harvest rates are stipulated to be between 0 and 8 percent during critically low spawner abundance, and may increase to a maximum exploitation rate of 45 percent under high survival and abundance conditions. Empirical data over the last 10 years show that harvest mortality for Oregon Coast coho has been maintained below 15 percent since the adoption of the revised regulations (NOAA 2008).

Diseases, predation, past species introductions, and habitat modifications have resulted in increased non-native predator populations, notably in coastal lake habitats. Predation by increased populations of marine mammals (principally sea lions) may influence salmon abundance in some local populations when other prey species are absent and where physical conditions lead to the concentration of adults and juveniles (Cooper and Johnson 1992). However, the extent to which marine mammal predation threatens the persistence of Oregon coast coho populations is unknown. Infectious disease is one of many factors that can influence adult and juvenile salmon survival. Salmonids are exposed to numerous bacterial, protozoan, viral, and parasitic organisms in spawning and rearing areas, hatcheries, migratory routes, and the marine environment. Specific diseases such as bacterial kidney disease, ceratomyxosis, columnaris, furunculosis, infectious hematopoietic necrosis virus, redmouth and black spot disease, erythrocytic inclusion body syndrome, and whirling disease, among others, are present and known to affect West Coast salmonids (Rucker and Ordall 1953, Wood 1979, Leek 1987, Foott et al. 1994, Gould and Wedemeyer undated). In general, very little current or historical information exists to quantify trends over time in infection levels and disease mortality rates. However, studies have shown that naturally spawned fish tend to be less susceptible to pathogens than hatchery-reared fish (Buchanan et al. 1983, Sanders et al. 1992). Native salmon populations have co-evolved with specific communities of these organisms, but the widespread use of artificial propagation has introduced exotic organisms not historically present in a particular watershed. Habitat conditions such as low water flows and high temperatures can exacerbate susceptibility to infectious diseases. Aggressive hatchery reform efforts implemented by the State of Oregon have reduced the magnitude and distribution of hatchery fish releases in the ESU, and, consequently, the interactions between hatchery- and natural-origin fish and the potential transmission of infectious diseases. Additionally, regulations controlling hatchery effluent discharges into streams have reduced the potential of pathogens being released into coho habitats.

There are numerous introduced fish species that inhabit the Coquille River and adjacent aquatic habitats, many of which pose predation or competition impacts to juvenile salmonids. These include the following: striped bass, largemouth bass, yellow perch, bluegill, brown bullhead, mosquito fish,

and American shad. The State introduced largemouth bass to the Tenmile Lakes and this species is now widely distributed within southwestern Oregon. This non-native bass has been documented in the Coquille River and within Fahys Creek of Bandon Marsh NWR (Christopher Claire, ODFW, unpublished data). Sportsmen have reported catching smallmouth bass in the Coquille River, but their presence is currently unconfirmed by ODFW. With the exception of striped bass and American shad, these introduced fish are adapted to a slow-moving, warm-water environment and have physiological mechanisms that enable them to tolerate higher pollution and lower levels of dissolved oxygen that can be found in the agriculturally impacted historic estuaries.

Natural or human-caused factors may affect the coho's continued existence. Natural variability in ocean and freshwater conditions has at different times exacerbated or mitigated the effects on Oregon Coast coho populations of habitat limiting factors. There is considerable uncertainty in predicting ocean-climate conditions into the foreseeable future and estimating their biological impacts on the Oregon Coast coho ESU. Variability in ocean-climate conditions is expected, and coho productivity and abundance are similarly expected to fluctuate in response to this natural environmental variability. It is unknown whether unfavorable ocean conditions will predominate in the foreseeable future.

During the twentieth century, the coho decreased to as little as 1% of its former abundance in its southern range (in California and Oregon). It is extirpated in more than half of its native rivers in that region. The decline of the coho stocks of California and Oregon has been caused by several interacting factors. Much of their freshwater habitat has been degraded by siltation and temperature increases caused by logging and other disturbances in the watersheds of their breeding and rearing habitats in headwater streams. Clear-cut logging in the riparian (or stream-side) zone results in large increases in the summertime water temperature, which can be lethal for these cool-water fish. In addition, the erosion of soil from destabilized stream-banks and at road crossings results in the deposition of silt into the gravel spawning and larval-rearing habitat of salmon, which smothers the eggs and larvae. Moreover, many rivers have had hydroelectric dams constructed on them, and this prevents or impedes the migration of coho to and from the sea. Other threats to coho include erosion associated with overgrazing of livestock, in-river mining of gravel or gold, urban and industrial pollution, agricultural diversions, and urbanization. These factors have affected coho salmon throughout their range on the Pacific coast, but the damages have been most intense for stocks breeding on coastal rivers in California and Oregon. Overall, the coho has become extirpated over about 56% percent of its historic range in the lower 48 states, endangered in about 13%, threatened in about 20%, and of special concern in 5%. The coastal rivers of Oregon produced about 1.4-million coho in 1900, but fewer than 20,000 in the 1990s. In Washington, the 1.2 million coho that once lived in the Columbia basin are virtually extinct (NOAA 2000).

NOAA Fisheries' 1999 review of West Coast coastal cutthroat trout populations identified six ESUs, including the Oregon Coast Coastal Cutthroat Trout ESU that includes the Coquille River watershed. The 1999 analysis by NOAA was evenly divided on whether the Oregon Coast cutthroat trout ESU is likely to become endangered in the foreseeable future. Currently, coastal cutthroat trout of the Oregon Coast ESU is not listed on the state or federal Threatened and Endangered Species List. Current or historical abundance information, especially for adult coastal cutthroat trout, is available for only a very small proportion of the known populations within any ESU. Biologists familiar with coastal cutthroat trout generally believe that, in some areas (e.g., Lower Columbia River Basin, Puget Sound, Northern California), anadromous coastal cutthroat trout populations have experienced significant recent declines relative to historical levels of abundance (NOAA 1999). Coastal cutthroat trout have a very plastic life history and are wide-spread in coastal areas; however, very little specific

data have been collected to assess trends. Coastal cutthroat trout is subject to many of the same factors as coho and other salmon species, in addition to factors affecting isolated resident populations upstream of salmon distribution in watersheds.

The Oregon Coast coastal cutthroat trout Species Management Unit (SMU) includes 24 historical populations of coastal cutthroat trout inhabiting ocean tributary streams from the Necanicum River south to the Sixes River. All four life history types are present with the SMU, and several populations exhibit all four life history types. A status assessment of coastal cutthroat trout within the SMU determined all historical populations were found to be in existence and not at risk of extinction in the near future. An assessment for the Oregon Coast coastal cutthroat trout SMU found all populations passed all of the interim criteria and therefore, the conservation of the SMU was not at risk (Connolly et al. 2008).

4.6.4 Key Habitats Used

Coho salmon spawn in the headwaters of tributaries, rivers, or streams in beds with clean gravel. The freshwater habitat of the headwater is characterized by cool clean water, with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. These features are essential in the environment because without them the species cannot successfully spawn and produce offspring (NOAA 2008). After hatching from eggs, coho salmon fry spend one year in freshwater habitat, specifically in backwater pools and stream edges. As juveniles, coho salmon depend on deep water pools, off-channel alcoves, ponds, beaver dam pools, and complex cover for rearing and refuge during high winter runoff events (Barczak 1998, Pollock et al. 2004). Estuarine areas are also important to coho and in some cases smolts spend months in this transition zone, where the salt and fresh water meet. The estuaries need to be free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and saltwater. Submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels provide natural cover. Juveniles and adults forage on aquatic invertebrates and fishes which supports growth and maturation. These features are essential in the estuary because without them juveniles cannot reach the ocean in a timely manner and use the variety of habitats that allow them to avoid predators, compete successfully, and complete the behavioral and physiological changes needed for life in the ocean. Similarly, these features are essential to adult salmonids because they provide a final source of abundant forage that will provide the energy stores needed to make the physiological transition to fresh water, migrate upstream, avoid predators, and develop to maturity upon reaching spawning areas (NOAA 2008).

Coho migrate from the freshwater to the ocean, where they feed and grow for several years. During the marine phase of their life history, coho live in open-water (or pelagic), cool-temperate regions of the northeastern Pacific Ocean. When they reach sexual maturity, they return to the headwaters of their natal stream, where they breed, and die. Coho salmon migrate from the ocean to freshwater in September-January, and they spawn in October-January.

Resident coastal cutthroat trout grow, mature, and spawn often very close to the location from which they hatched. Fluvial and adfluvial cutthroats migrate to spawning streams in the spring, usually to the streams in which they hatched (natal streams), and spawn in spring or summer. For successful production, juvenile coastal cutthroat trout that live at the edges of streams or in backwater areas depend on the presence of streambank vegetation and abundant instream structure created by logs and root wads.

Anadromous coastal cutthroat trout migrate into freshwater in late summer to late fall, usually to their natal streams, and spawn from late winter to spring. The adults migrate back to the ocean shortly after spawning. Sea-run cutthroat fry migrate to lower reaches of streams after emerging from the gravel in spring or summer. As early as the following spring, but more often two to four springs later, juvenile coastal cutthroat trout migrate to estuaries and the ocean as seawater-adapted "smolts." In the marine environment, coastal cutthroat trout tend to grow about an inch every month, feeding on a variety of small crustaceans and fish. Their residency in seawater is brief, usually lasting only a few months, and they tend to stay close to the freshwater streams and rivers from which they came. The fish return to freshwater later the same year in autumn to spawn or to spend another year growing and developing before undertaking another seaward migration (Fitzpatrick 1999).

4.6.5 Refuge-specific Sites

Critical habitat was designated for the Oregon Coast coho salmon ESU at the time they were federally listed as a threatened species (73 FR 7816). The definition of critical habitat is that area necessary for the survival and persistence of a species. Critical habitat is categorized by primary constituent elements (PCEs) that describe the habitats required by the species. The PCEs for coho salmon include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, estuarine areas, and near shore marine habitats (73 FR 7816). The Coquille River and its tributaries are considered critical habitat; the PCEs within the Coquille are freshwater rearing areas, freshwater migration corridors, and estuarine areas. Most of the aquatic habitat within Bandon Marsh NWR or the lower Coquille River is considered estuarine habitat. The important elements within an estuary for rearing salmonids are salinity and water quality conditions that support both adult and juvenile life stages. These habitats support juvenile coho and Chinook salmon as they undergo the physiological transformation that allows them to survive in salt water.

Within the Bandon Marsh NWR, juvenile coho and Chinook salmon have been observed in the tributaries and estuary waters of the lower Coquille River. No known salmon spawning habitat is within creeks on the Refuge. Surveys from 2005-2011 of Spring, Redd, No Name, and Fahys Creeks documented the year-round presence of juvenile coho and Chinook salmon (Hudson et al. 2010, USFWS unpublished data).

Bandon Marsh NWR provides spawning and rearing habitat for coastal cutthroat trout. Surveys from 2005-2011 of Redd, No Name, and Fahys Creeks documented the year-round presence of adult and juvenile coastal cutthroat trout (Hudson et al. 2010, USFWS unpublished data). Cutthroat trout spawning habitat has been documented within the recently restored (2011) portion of Fahys Creek and is suspected on off-refuge lands within Fahys, Redd, Simpson, and Spring Creeks.

4.7 Shorebirds

Shorebirds spend the majority of their time near the water, though most species prefer mudflats, some use upland pastures, plowed fields, and even forest habitats (Long and Ralph 2001, O'Brien et al. 2006). Most shorebirds forage on a diversity of invertebrates, including mollusks, small crustaceans, worms, and insects (Skagen and Oman 1996). Recent studies have found that dunlin and western sandpipers feed on biofilm (sediment laden with a mixture of broken and unbroken diatoms plus organic detritus) (Tomohiro et al. 2008, Mathot et al. 2010). Bandon Marsh NWR plays an important role in the life cycle of migrating shorebirds by providing stop-over habitat rich in invertebrates and biofilm.

The migration of many shorebird species to their breeding grounds in the Arctic is constrained to a narrow band of time (Evans and Pienkowski 1984, Farmer and Parent 1997). If the birds arrive too early, there is the risk of dying due to extreme cold weather or lack of emerging insects and if they arrive too late, they run the risk of not acquiring a suitable territory (Evans and Pienkowski 1984). In addition, these migrations often include nonstop flights exceeding thousands of miles. To complete these long distance flights, shorebirds accumulate large fuel reserves. In many of the more common Pacific Northwest shorebird species, these fuel reserves are accumulated in the form of fat at food-rich stop-over areas. In some cases, large proportions (>50%) of entire migrating populations of shorebirds (e.g., western sandpiper at Yukon Delta, Alaska) use a single site, indicating that any loss of critical stop-over areas could reduce hemispheric shorebird numbers. Since many stop-over areas are relatively restricted along coasts or within estuaries they are particularly vulnerable to various forms of degradation, development, and industrialization.

4.7.1 Description of Shorebirds (Western Sandpiper)

Shorebirds include phalaropes, plovers, sandpipers, snipes, and turnstones. In general, they have long thin legs with little to no webbing on their feet. They are usually small bodied with long thin bills. The differences in their bill lengths and shape allow the different shorebird species to forage for food within their habitat either on dry soil, mud, or in shallow water.

The western sandpiper is one of the most common shorebirds in the Pacific Northwest and within the Western Hemisphere. This small shorebird (length 5.5- 6.5 inches, wingspan 14-15 inches, weight 22-35 grams) breeds in a restricted range of the arctic tundra and winters mainly along the western coast of North and South America. In migration, this species stages in huge, spectacular flocks, particularly along the Pacific Coast from San Francisco Bay to the Copper River Delta in Alaska. Estimates suggest that millions of individuals pass through the critical stop-over habitat of Copper River Delta during just a few weeks each spring. Most western sandpipers migrate along the Pacific Coast, although significant numbers move through interior North America. Relatively little is known of the biology of wintering birds, particularly those in the southeastern United States, the West Indies, Central America, and South America (Wilson 1994).

At the breeding site males build a nest scrape to hold the typical four-egg clutch. Both members of the pair incubate eggs and tend young until they fledge. This species eats a varied diet, although insect larvae comprise the majority of its food on the breeding grounds. Along coastal and estuary stop-over habitat during migration, biofilm, crustaceans and polychaete worms make up the bulk of this species diet.

4.7.2 Historic and Current Distribution

The Bandon Marsh estuary is located in the Pacific Flyway and is an important resting stop and wintering area for many migratory shorebirds. Shorebird migration spans great distances from the Arctic to South America. The migratory paths are influenced by geography, wind, and weather patterns. During the spring, summer, and fall migration, shorebirds rest and feed at stop-over locations including the coast of Oregon. The estuary is also important for other types of birds, including bald eagles and band-tailed pigeons.

In the Americas the breeding range of the western sandpiper is mainly in the tundra of Alaska, from the mouth of the Kuskokwim River north to the vicinity of Point Barrow and Camden Bay. The winter range of this small shorebird is primarily along the Pacific coast from California to Peru, with

small numbers wintering as far north as Washington. This species is locally common along the Atlantic Coast from south New Jersey south to the Gulf Coast. Also, found locally inland at the Salton Sea, CA, to the interior of northern and central Mexico to elevations of 2,500 meters (8,202 feet). These birds are common locally along the Caribbean coast of Central America, Colombia, Venezuela, Surinam, and the West Indies. The species is rare in Canada except for where abundant during migration in coastal British Columbia. Outside of the Americas a small breeding population is located in eastern Siberia on the Chukotski Peninsula. Accidental observations of the species have been documented in Ireland, Britain, France, Spain, Denmark, Sweden, and the Azores, with one specimen collected at Kultuk, Russia on the southwestern shore of Lake Baikal (Wilson 1994). The combination of a restricted breeding range and a broad non-breeding distribution means that some western sandpipers migrate much farther than others. Western sandpipers are differential migrants; males spend the winter farther north than females, and juveniles are disproportionately represented on the northern and southern edges of the distribution. There is also a life history difference as a function of migratory distance. Western sandpipers spending their juvenile non-breeding season in northern Mexico migrate northward in their first spring, but many juveniles in Panama remain on the non-breeding grounds until their second spring.

Although no races or discrete breeding populations of the species are recognized, genetic differences based on random amplified polymorphic DNA analyses were found between wintering grounds in Humboldt Bay, California, and South Island, South Carolina (Haig et al. 1997). Interestingly, the rather limited breeding distribution of western sandpipers does not suggest that this should occur. The extent of genetic differentiation between the small population on the Chukotski Peninsula of Siberia and the North America population is currently unknown.

The estimated total population of western sandpipers is 3.5 million birds (range = 2.8–4.3 million) (Bishop et al. 2000, Morrison et al. 2001). The data used to derive the population estimate were collected in 1992–1995. Although it is possible that a population decline is occurring (Brown et al. 2001), the magnitude of any change in population size is unknown. During spring migration, high concentrations of western sandpipers have been observed in the San Pablo-San Francisco Bay area of California when 473,963 western sandpipers were counted between 16 and 18 Apr, 1988 (Stenzel and Page 1988). During spring migration, nearly 75,000 - 100,000 western sandpipers were estimated to have stopped over at Bandon Marsh NWR on a single day in mid-May, 2006 (USFWS unpublished data). It has been estimated that nearly 2.4 million western sandpipers pass through British Columbia annually on fall migration (Butler et al. 1987).

4.7.3 Condition, Trends, and Threats

The Pacific Northwest region extends from Cook Inlet on the south coast of Alaska through coastal Alaska, British Columbia, Washington, and Oregon to northern California. The important shorebird habitats tend to be similar estuarine, riverine, and forested wetland landforms throughout the region. However, the intensity of land use and future threats to shorebird conservation are extremely different between, for example, the wilderness of Alaska and the urbanized Fraser River delta. Strategic plans for this region have been prepared in three sections: Alaska, British Columbia, and the Pacific Northwest of the United States.

Threats to shorebirds and associated habitat include: (1) wetland loss due to urban sprawl and human expansion, (2) contamination of the estuarine habitat by industry, (3) aquatic beds' destruction or reduction because of shellfish mariculture, (4) wetland drainage and water quality problems, and (5) sea level rise, which may reduce the amount of suitable shallow water habitat.

Pacific coast wetlands have been degraded by urban sprawl and human expansion. Large-scale timber harvest and development of agricultural lands have resulted in direct wetland loss, sedimentation of bays and degradation of water quality and submergent plant beds. Extensive urbanization and industrialization has eliminated entire wetlands and reduced the value of other coastal wetlands to waterbirds. Many of the estuaries along the Pacific coast have been diked and drained, primarily for agricultural development. Losses of 80-95% of intertidal marsh habitat in Oregon's estuaries have resulted from diking for farmland conversion (Thomas 1983, Brophy 2010, USFWS unpublished data).

Western sandpipers appear to be declining across their range, and it has been suggested that threats at stop-over areas and on the wintering grounds play a significant role in this decline. Anthropogenic impacts may prevent birds from engaging in normal feeding and roosting activities. Marine, estuarine, and upland habitats in western Washington and Oregon provide essential conditions for hundreds of thousands of wintering and migratory western sandpipers and other shorebird species along the Pacific Flyway. The loss of habitat important to shorebirds has been particularly dramatic in the last 100 years (Page and Gill 1994, Dahl 1990). Wetland loss in Oregon has been severe with an 80-95% reduction of intertidal marsh habitats (Brophy 2010, USFWS unpublished data). Other potential threats to shorebirds in the Oregon include disease, non-point oil spills, contamination of habitat or food resources caused by agricultural and industrial chemicals, invasion of non-native vegetation and invertebrates in migratory habitat, and direct human disturbance (Buchanan 2005). Catastrophic impact events such as an oil spill (e.g., Exxon Valdez in Prince William Sound, Alaska) would potentially affect the viability of the species, as virtually the entire population of western sandpipers stops in at one migratory location (e.g., Copper River Delta, Alaska) on its way north to breeding grounds.

Potential effects of global warming are serious concerns in many areas and in all seasons. Of concern in the subarctic and Arctic breeding grounds of the western sandpiper is the unknown effect of global warming on breeding success. It is well documented that major breeding areas in Alaska are being affected by reduced snow cover and warmer days. It is not well understood how this warming may affect the reproduction or survival of western sandpipers. An increase in sea level has the potential to reduce available tidal flat foraging areas for shorebirds on their breeding grounds and during migration. The effects of rapid climate change, including potential consequences such as an increase in sea level and increased severe weather events, may affect conditions on breeding, migration, and wintering grounds of the western sandpiper in a manner far beyond present comprehension (Fernández et al. 2010).

4.7.4 Key Habitats Used

The breeding range for the western sandpiper includes subarctic and low-arctic from coast to uplands, occasionally on lower mountain slopes where well-drained, elevated ground occurs amid wet areas (Bent 1927, Holmes 1971). Favored nesting habitat is dominated by dwarf birch, dwarf willow, crowberry, various ericaceous shrubs, tussock grasses, and bryophytes. Proximity of elevated areas for nesting and wetland areas for feeding is a requisite. On arrival in the spring, birds are found in snow-free areas waiting for snow to melt to expose potential nesting sites. During spring and fall migration, from the center of the breeding range east of the Yukon-Kuskokwim Delta, Alaska, post-breeding birds and juveniles stage along the coastal flats of the Delta (Gill and Handel 1990). At coastal stop-over areas (e.g., Bandon Marsh NWR), birds frequent intertidal mudflats and river edges. At interior stop-over sites, the margins of lakes and ponds are preferred habitat. Winter range habitat generally is within coastal areas with fine sand to muddy substrates (e.g., intertidal mudflats)

where the birds generally follow receding and rising tide line for foraging. In the interior of Mexico, western sandpipers are uncommon to common locally along lakeshores, up to 2,500 meters (8,202 feet) in elevation (Wilson 1994).

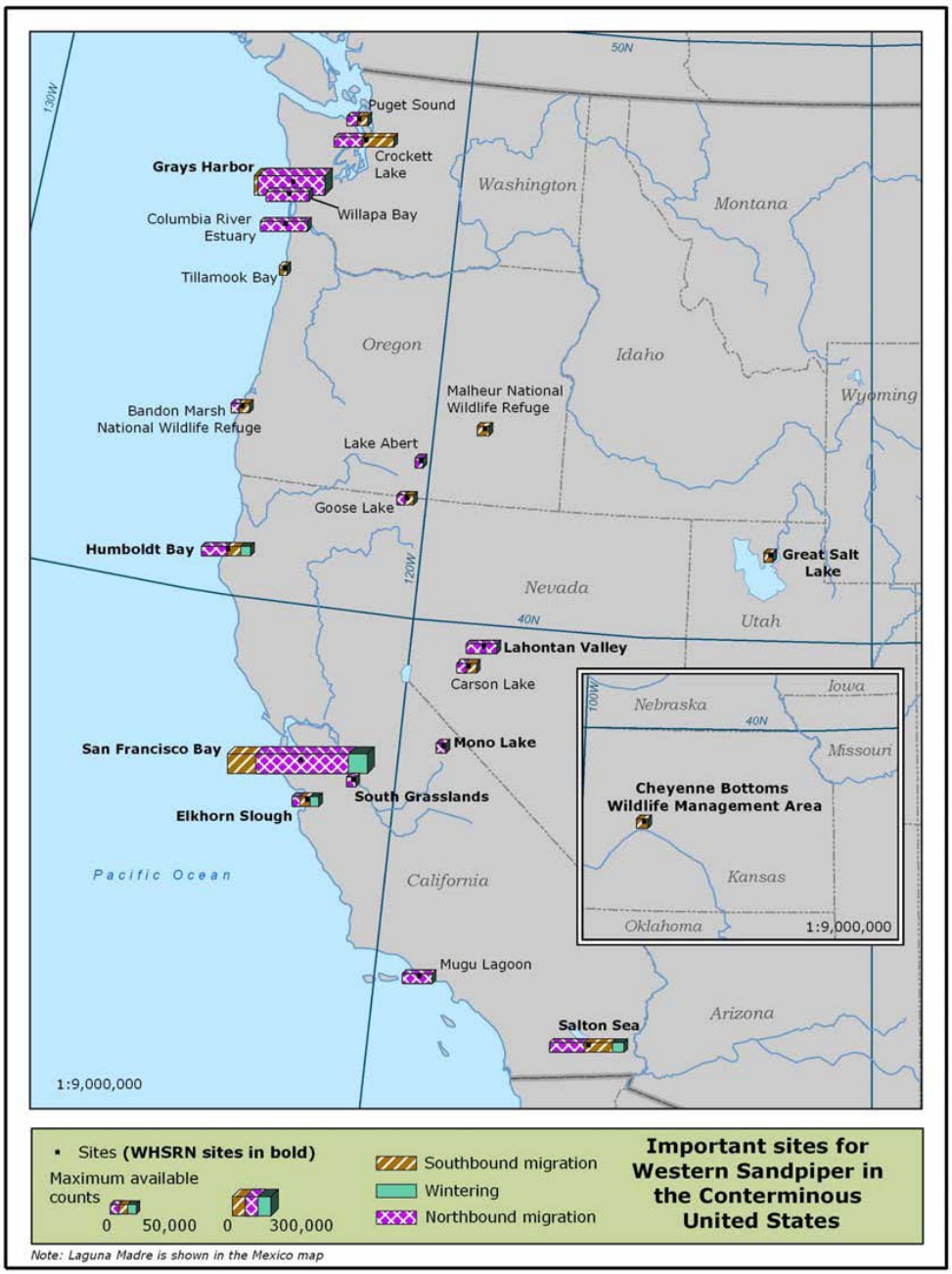
4.7.5 Refuge-specific Sites

The wetlands and intertidal mudflats within Bandon Marsh NWR are protected and allowed to function naturally since they receive intensive use by shorebird species throughout the year. Shorebirds by the thousands utilize the area as a stop-over site to feed and rest during spring and fall migration.

Western sandpipers migrate north through temperate latitudes (Bandon Marsh NWR) generally between mid-April and mid-May, and males mostly migrate ahead of females (Butler et al. 1987). Once the spring migration has begun the birds move quickly north with length of stay at migratory stop-over sites typically ranging between 1 and 5 days (Bishop and Warnock 1998; Bishop et al. 2004). In comparison to the northward migration, the southbound movement from the breeding grounds is more prolonged. Western sandpipers migrate south from mid-June to November, arriving at Bandon Marsh generally early to mid-July. The length-of-stay during southward migration is about 1–5 days at temperate coastal sites (Butler et al. 1987). At Bandon Marsh NWR western sandpipers have been observed in all months of the year, with peak numbers during April/May and August/September during migration (Hodder and Graybill 1984, Castelein and Lauten 2007, USFWS unpublished data).

Stop-over habitat use by western sandpipers at Bandon Marsh NWR is generally restricted to tidal mudflats, edges of the tidally influenced salt marsh channels and the banks of the lower Coquille River estuary. During stop-over migration western sandpipers feed on a variety of mudflat mollusks, polychaete or marine worms, small invertebrates, and biofilm in mixed shorebird flocks with dunlin, least sandpiper, semi-palmated and black-bellied plovers, long and short-billed dowitchers, and greater and lesser yellowlegs. Spring migration of western sandpipers initiates at Bandon Marsh NWR with small groups of 15-35 individuals arriving early to mid-April followed by large groups of 5,000 to 30,000 individuals in late April (Nehls 1994, Hodder and Graybill 1984, Castelein and Lauten 2007). Peak counts of western sandpipers at Bandon Marsh were recorded in May 2006 with an estimated 400,000 individuals migrating north along the Bandon coast on May 2 and approximately 75,000 individuals observed foraging and resting on the refuge tidal wetlands on May 3 (Castelein and Lauten 2007, USFWS unpublished data). Fall migration starts in July and peaks in early to mid-September with the largest flocks ranging from 1,500 to 7,000 birds. The number of individuals observed is variable year-to-year and season-to-season as flight patterns of migrating western sandpipers and other species of shorebirds is highly influenced by the strength of northwest winds in the spring. During periods of high winds birds are driven off the near-shore waters and coastal mountain ridgelines to gather along the coastal strand.

Figure 4-2. Important sites for western sandpipers in the conterminous United States. (Fernández et al. 2010).



Bandon Marsh NWR is recognized within the Western Hemisphere Shorebird Reserve Network's Conservation Plan for the Western Sandpiper as one of twenty-five most important migratory stop-over habitats for the species. These 25 sites, 23 of which are on the west coast of the United States, support a large proportion of the western sandpiper global population. Bandon Marsh is documented in the Plan due to its importance as stop-over habitat for the species during both migration periods (north and south migrations). In addition, this Plan supports the restoration of historic estuary and mudflat habitat, for western sandpipers, that has been degraded through the development of water-

use systems, including the construction of channels and dikes (e.g., diked pastures within the Coquille estuary).

4.8 Waterfowl (Ducks)

Waterfowl include ducks, geese, and swans and are part of the worldwide family Anatidae. These are aquatic, web-footed, gregarious birds that mostly feed on water but some also graze on land. Ducks are classified in the tribe Anatini which contains three genera and 40 species throughout the world. In North America there is but one genus, *Anas*, embracing 10 species of "dabbling or puddle ducks" (Bellrose 1986). Dabbling ducks or puddle ducks are surface-feeders that occur in freshwater shallows or salt marshes. Some of the more commonly found dabbling ducks in the Coquille River estuary include mallard, gadwall, northern pintail, American wigeon, northern shoveler, and green-winged teal. Although a dabbling duck in general appearance, the wood duck belongs to the tribe Cairinini. This species belongs to a group called "perching ducks" which are surface feeding woodland ducks that nest in tree cavities or nest boxes. There are nine genera representing 13 species worldwide. Only one species, the wood duck, inhabits North America north of Mexico (Bellrose 1986).

The remaining ducks are placed in three tribes embracing 12 extant genera around the world and are generally referred to as "diving ducks." The tribe Aythyini is represented by the "pochards or bay ducks" (Bellrose 1986). In North America all belong to one genus, *Aythya*, composed of the canvasback, the redhead, the ring-necked duck, and the scaups (greater and lesser). Members of the tribe Mergini are termed "sea ducks" and although most of them frequent the ocean during the winter, many also inhabit freshwater areas. These species breeds in the far north and migrate in large compact flocks to and from their coastal wintering grounds. Common sea ducks include the scoters (surf, and white-winged), common goldeneye, bufflehead, and mergansers (common, red-breasted, and hooded). Lastly, the tribe Oxyurini make up the "stiff-tailed duck" group, which consists of one genus and two species that frequent North America (Bellrose 1986). The most common species of this group is the ruddy duck.

4.8.1 Description of Waterfowl

Surface-feeding members of the genus *Anas* are termed "dabbling or puddle ducks." Dabblers feed by tipping tail-up to reach aquatic plants, seeds, and snails. They require no running start to take off but spring directly into flight. Members of this group have their feet set forward underneath their body and their hind toes are smooth without a lobe of skin. Most species show a distinguishing swatch of bright color, or speculum, on the secondary feathers. Many are known to hybridize. "Perching ducks" (wood duck) are equipped with sharp claws for perching in trees, well-developed hind toes, and broad wings.

The "diving ducks" consist of "pochards or bay ducks, sea ducks, and stiff-tailed ducks." These diving ducks have legs set far back and far apart (a location that facilitates diving), which makes walking awkward. These heavy-bodied birds require a running start on water for takeoff. This group also has a lobe of skin on their hind toes. Sea ducks are stocky and have short necks. Mergansers have long, thin, serrated bills which help to catch fish, crustaceans, and aquatic insects. The ruddy duck is the most distinct species among all ducks and is termed "stiff-tailed duck." Their feathers are long, stiff, and pointed and their legs are farther back on their bodies than other ducks. Their necks

are short and thick. They lay the largest eggs among waterfowl, considering their size. They perform a bizarre courtship display, unique among waterfowl.

4.8.2 Historic and Current Distribution

Migratory waterfowl use four major migratory routes (Pacific, Central, Mississippi, and Atlantic flyways) in North America. The Pacific Flyway includes Alaska, Arizona, California, Idaho, Nevada, Oregon, Utah, Washington, and those portions of Colorado, Montana, New Mexico, and Wyoming west of the Continental Divide. Because of the unique biological characteristics and relative number of hunters in these regions, state and federal wildlife agencies adopted the flyway structure for administering migratory bird resources within the United States. Each flyway has its own council that is an administrative body that forges cooperation among public wildlife agencies for the purpose of protecting and conserving migratory birds in western North America. Flyway councils have responsibilities in the annual process of setting migratory bird policy and regulations within the United States and they conduct and contribute to migratory bird research and management throughout the United States, Canada, and Mexico.

4.8.3 Conditions, Trends, and Threats

Ducks are plentiful in late fall through the winter months, utilizing refuge wetlands and flooded lowland pastures. Waterfowl numbers vary greatly depending on habitat conditions and yearly variables such as weather and breeding production. Using mid-winter waterfowl survey numbers as an index, the number of wintering ducks in Bandon Marsh is highly variable and no trends can be inferred. However, tidal salt marsh restoration at the Ni-les'tun Unit has provided over 400 acres of additional good quality wetland habitat within the Refuge and can support large numbers of waterfowl. The most abundant duck species identified at Bandon Marsh/Coquille River estuary during the 2010-11 mid-winter waterfowl survey are bufflehead, green-wing teal, and mallard (USFWS unpublished data). Some of the duck species that can be found wintering in the Bandon Marsh area have been documented as breeders on refuge lands.

Waterfowl hunting occurs on the Refuge and on adjacent lands which may influence bird distribution and behavior. Hunting, by its nature, results in the intentional take of individual animals, as well as wounding and disturbance (DeLong 2002). Indirect impacts such as displacement of animals by hunters or disturbance from gunfire also occurs in and adjacent to, areas opened for hunting. It can also alter behavior (e.g., foraging time), population structure (young birds are generally more susceptible), and distribution patterns of wildlife (Owens 1977, Raveling 1979, White-Robinson 1982, Thomas 1983, Bartlett 1987, Madsen 1985, and Cole and Knight 1990). Prolonged and extensive disturbances may cause large numbers of waterfowl to leave disturbed areas and migrate elsewhere (Madsen 1985).

Every year, the U.S. Fish and Wildlife Service conducts surveys that are used to estimate waterfowl hunting activity, success, and harvest by species. Results are used by the Service and State wildlife agencies, in part, to establish season lengths and bag limits designed to maintain healthy, sustainable waterfowl populations. During 2010-11 season, waterfowl hunters in Oregon harvested an estimated 419,100±18% (Raftovich et al. 2011) ducks. On the Bandon Marsh Unit of Bandon Marsh NWR during 2010-11, hunters harvested very few ducks and the harvest numbers are considered to be below reportable levels (B. Reishus, ODFW, personal observation). Waterfowl harvest data are unavailable because only a small number of hunters pursue waterfowl in the Bandon Marsh area and no hunters were surveyed in 2010-11. At any given time there are only 1-3 hunting parties in the

marsh because of space and hunting quality is best at only a few spots (e.g., the mouth of the sloughs). Waterfowl hunters tend to self-limit their numbers. Most hunting occurs in October and November and tides influence hunting times. After November the birds disperse further inland and there is almost no hunting occurring in the marsh.

The most heavily harvested duck species in Oregon are mallard, American wigeon, northern pintail, green-winged teal, and northern shoveler (Raftovich et al. 2011). In 2011, continental populations of northern shoveler, green-wing teal, and mallard were all above their long-term averages (USFWS 2011b). American wigeon were 20% below their long-term average and northern pintails were similar to the long-term average. Hunters are permitted to harvest coots, but this species is not common on the Refuge and are not popular with hunters. Given the low harvest rates of these species relative to the State harvest, the refuge hunt program will not significantly contribute to the population changes of these species and the refuge will continue to conform to State bag limits for ducks.

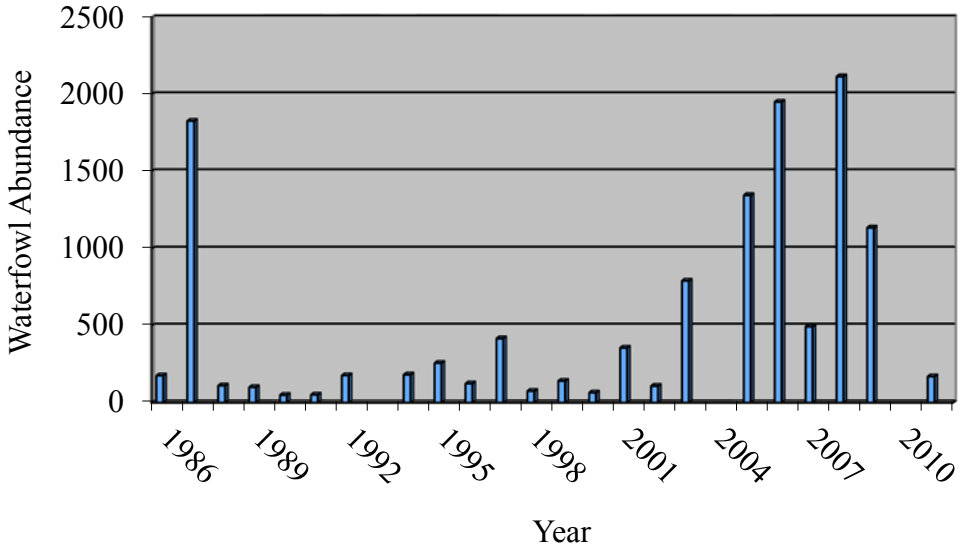
4.8.4 Waterfowl Population Trends

The Waterfowl Breeding Population and Habitat Survey is the most extensive and most important of North America's waterfowl population surveys. This survey is a cooperative effort of the U. S. Fish and Wildlife Service, the Canadian Wildlife Service, and state, provincial, and tribal agencies. It currently covers more than 2.1 million square miles of the northern United States and Canada, and includes most of the primary duck nesting areas in North America. Each year, air crews (a pilot biologist and an observer) fly fixed-wing aircraft at low altitude (150 feet) over transect lines through waterfowl habitat areas. Over 55,000 miles of transects are flown every year. Estimates of breeding populations for all waterfowl species observed are derived by taking the aerial counts, adjusting them based on the visibility correction factors, and expanding them over the survey area. Final results from the 2011 Waterfowl Breeding Population and Habitat Survey indicate a total duck population estimate of 45.6 million birds in the traditional survey area, which is an 11% increase over last year's tally of 40.9 million and 35 percent above the long-term average. Continental populations of northern shoveler, green-wing teal, and mallard were all above their long-term averages. American wigeon were 20% below their long-term average and northern pintails were similar to the long-term average (USFWS 2011b).

Biologists from state and federal agencies annually conduct the Midwinter Waterfowl Survey to provide a measure of the relative numbers or trends of duck populations. The survey identifies winter waterfowl distribution and habitat use throughout the United States. The survey also provides estimates of the size of goose and swan populations and tracks population trends of duck species that nest outside of breeding survey areas. Midwinter Waterfowl Surveys are conducted during the first two weeks in January along the Oregon coast. Observers count divers, dabblers, geese, swans, and American coots from a fixed-wing aircraft and an overall abundance is estimated (USFWS unpublished data). Data were compiled for all waterfowl observed at Bandon Marsh NWR and Coquille River Estuary Bay during the midwinter waterfowl surveys from 1986 to 2011 and are displayed in Figure 4-3. The overall mean count was 531 individuals and the lowest count was 49 individual birds recorded in 1990 and the largest was 2,116 in 2008. These data are collected from a fixed-wing aircraft at an altitude of 200-300 feet and traveling 80-120 mph, which limits ability to survey all areas and all habitats and count every individual present. However, general abundance and population trends can be inferred and obviously Bandon Marsh and the Coquille River estuary are important use areas for waterfowl. Waterfowl abundance is usually lower during the January mid-winter survey compared to fall months, when birds are concentrated on the bay prior to dispersing

throughout the area due to field and seasonal wetland flooding. (R. Lowe, personal obs.). It should be noted that the mid-winter waterfowl survey serves as an index for comparative purposes and is not necessarily representative of the number of ducks that may be present within the entire geographic area. Refuge counts for ducks have generally ranged from 500 to 2,100 over the past several winters, with the exception of the 2011 count.

Figure 4-3. Waterfowl abundance at Bandon Marsh NWR and Coquille River Estuary, Oregon from 1986 to 2011 (USFWS unpublished data).



4.8.5 Key Habitats Used

Surveys have indicated waterfowl make significant use of the open bay, mud flats, and tidal marsh with heaviest use occurring from September through January and again during spring migration. Dabbling ducks use freshwater shallows and the edge of salt marshes. Waterfowl utilize both private and refuge lands.

4.8.6 Refuge-specific Sites

Waterfowl are observed on the Bandon Marsh Unit, the Ni-les'tun Unit and Coquille River estuary. In 2011 over 400 acres of tidal salt marsh was restored on the Ni-les'tun Unit and already waterfowl use of the area is increasing and it is anticipated large numbers of waterfowl will utilize this area in the near future.

4.9 Threatened, Endangered, and Candidate Species

4.9.1 State or Federally Listed Species Known to Occur on the Refuge

One goal of the Refuge System is "To conserve, restore where appropriate, and enhance all species of fish, wildlife, and plants that are endangered or threatened with becoming endangered." In the policy clarifying the mission of the Refuge System, it is stated, "We protect and manage candidate

and proposed species to enhance their status and help preclude the need for listing." In accordance with this policy, the CCP planning team considered all species with Federal or State status. Tables 4-1 and 4-2 list state or federal endangered and threatened species that are known to occur on the Refuge. Other listed species may occur but have not been documented. Discussion follows the tables in Section 4.9.2.

Table 4-1. Federal or State Listed Bird Species Known to Occur on the Refuge

Common Name	Federal Status	State Status	Current Occurrence on Refuge
Marbled murrelet	Threatened	Threatened	Potential Flyover

Table 4-2. Federal or State Listed Fish Species Occurring on the Refuge or in Surrounding Waters

Common Name	Federal Status	State Status	Current Occurrence on Refuge
Coho salmon	Threatened		Bandon Marsh and Ni-les'tun Units/Coquille River/coastal streams
Pacific smelt (eulachon)	Threatened		Coquille River
Green sturgeon	Threatened		Coquille River

4.9.2 Description and Status of Listed Species Known to Occur on the Refuge

Marbled Murrelet

The marbled murrelet is a small, robin-sized, diving seabird that feeds primarily on fish and invertebrates in near-shore marine waters. It spends the majority of its time on the ocean, roosting and feeding, but comes inland up to 80 kilometers (50 miles) to nest in forest stands with old growth forest characteristics. These dense shady forests are generally characterized by large trees with large branches or deformities for use as nest platforms. Murrelets nest in stands varying in size from several acres to thousands of acres. However, larger, unfragmented stands of old growth appear to be the highest quality habitat for marbled murrelet nesting. Nesting stands are dominated by Douglas-fir in Oregon and Washington and by old-growth redwoods in California (USFWS 2012d).

Salmonids

See Salmonid Section 4.6.

Pacific Smelt (eulachon)

Eulachon (commonly called smelt, candlefish, or hooligan) are a small, anadromous fish from the eastern Pacific Ocean. They are distinguished by the large canine teeth on the "vomer" and 18 to 23 rays in the anal fin. Like Pacific salmon they have an "adipose fin"; it is sickle-shaped. The paired fins are longer in males than in females. All fins have well-developed breeding tubercles (raised tissue "bumps") in ripe males, but these are poorly developed or absent in females. Adult coloration is brown to blue on the back and top of the head, lighter to silvery white on the sides, and white on the ventral surface; speckling is fine, sparse, and restricted to the back. They feed on plankton but only while at sea.

Eulachon typically spend 3 to 5 years in saltwater before returning to freshwater to spawn from late winter through mid-spring. During spawning, males have a distinctly raised ridge along the middle of

their bodies. Eggs are fertilized in the water column. After fertilization, the eggs sink and adhere to the river bottom, typically in areas of gravel and coarse sand. Most eulachon adults die after spawning. Eulachon eggs hatch in 20 to 40 days. The larvae are then carried downstream and are dispersed by estuarine and ocean currents shortly after hatching. Juvenile eulachon move from shallow nearshore areas to mid-depth areas. Within the Columbia River Basin, the major and most consistent spawning runs occur in the mainstem of the Columbia River as far upstream as the Bonneville Dam, and in the Cowlitz River.

Eulachon occur in nearshore ocean waters and to 1,000 feet (300 meters) in depth, except for the brief spawning runs into their natal (birth) streams. Spawning grounds are typically in the lower reaches of larger snowmelt-fed rivers with water temperatures ranging from 39 to 50° F (4-10° C). Spawning occurs over sand or coarse gravel substrates (NOAA 2012a).

Green Sturgeon

Green sturgeon are long-lived, slow-growing fish and the most marine-oriented of the sturgeon species. Mature males range from 4.5-6.5 feet (1.4-2 meters) in “fork length” and do not mature until they are at least 15 years old, while mature females range from 5-7 feet (1.6-2.2 meters) fork length and do not mature until they are at least 17 years old. Maximum ages of adult green sturgeon are likely to range from 60-70 years. This species is found along the west coast of Mexico, the United States, and Canada.

Green sturgeon are believed to spend the majority of their lives in nearshore oceanic waters, bays, and estuaries. Early life-history stages reside in freshwater, with adults returning to freshwater to spawn when they are more than 15 years of age and more than 4 feet (1.3 meters) in size. Spawning is believed to occur every 2-5 years. Adults typically migrate into fresh water beginning in late February; spawning occurs from March-July, with peak activity from April-June (Moyle et al. 1995). Females produce 60,000-140,000 eggs. Juvenile green sturgeon spend 1-4 years in fresh and estuarine waters before dispersal to saltwater. They disperse widely in the ocean after their out-migration from freshwater (NOAA 2012b).

4.10 Invasive and Exotic Plant Species

One of the largest threats to wildlife and habitat of the Refuge is exotic or invasive plants. Invasive plant species displace native vegetation, altering the composition and structure of vegetation communities, affecting food webs, and modifying ecosystem processes (Olson 1999). Ultimately, invasive plant species can result in considerable impact to native wildlife and the habitat they are dependent upon.

Several non-native invasive plants found on Bandon Marsh National Wildlife Refuge include reed canarygrass, Himalayan blackberry, English ivy, Scotch broom, and gorse. *Spartina* spp. are not currently found on the Refuge; however, monitoring for this species is conducted to detect outbreaks or infestation and control efforts would be implemented immediately upon the species’ detection. Many exotic and invasive plants have been introduced to the Refuge; therefore, this list is not all inclusive and includes only the most problematic species.

Invasive marine plants such as Japanese eelgrass and smooth cordgrass, have been recorded within the southern Oregon estuaries (Dudoit 2006, Bilderback and Bilderback, personal communication, Davidson et al. 2007).

4.10.1 Description and Status of Reed Canarygrass

A highly variable species, reed canarygrass is a rhizomatous perennial grass that can reach three to six feet in height. The sturdy, often hollow stems can be up to ½ inch in diameter, with some reddish coloration near the top. The leaf blades are flat and hairless, ¼ to ¾ of an inch wide. The flowers are borne in panicles on culms high above the leaves. The panicles are generally three to six inches in length. The species flowers in June and July (Weinmann et al. 1984, Hitchcock et al. 1969).

Reed canarygrass is extremely aggressive and often forms dense, highly productive single species stands that pose a major threat to many wetland ecosystems. The species grows so vigorously that it is able to inhibit and eliminate competing native species. In addition, areas that have existed as reed canarygrass monocultures for extended periods may have seed banks that are devoid of native species (Apfelbaum and Sams 1987). Unlike native wetland vegetation, dense stands of reed canarygrass have little value for wildlife. Few species eat the grass, and the stems grow too densely to provide adequate cover for small mammals and waterfowl (Maia 1994). The species is considered a serious weed along irrigation banks and ditches because infestations can increase siltation (Marten and Heath 1973). When in flower, the species produces abundant pollen and chaff, which aggravate hay fever and allergies (Weinmann et al. 1984). Once established, reed canarygrass is difficult to control because it spreads rapidly by rhizomes.

4.10.2 Description and Status of Himalayan Blackberry

Himalayan blackberry is a robust, perennial, sprawling, more or less evergreen, shrub of the Rose family. Leaves are large, round to oblong and toothed, and typically come in sets of three (side shoots) or five (main stems). The most characteristic feature is probably the robust stems supporting large stiff prickles. The shrubs first appear as individual canes, then groups of canes, gradually increasing to become great mounds or banks with individual canes reaching up to 3 meters (10 feet). Trailing canes spread up to 20-40 feet, frequently taking root at the tips. The white flowers and then the roundish black and shiny 2 centimeters (less than 1 inch) fruit forms on second year (secondary) canes that grow off of first year canes. The fruit ripens from midsummer to autumn; late when compared with native blackberries.

Himalayan blackberry readily invades riparian areas, forest edges, oak woodlands, meadows, roadsides, clear-cuts, and any other relatively open area, including all open forest types. Once it becomes well established, it out competes low stature native vegetation and can prevent establishment of shade intolerant trees (e.g., Douglas-fir), leading to the formation of blackberry thickets with little other vegetation present. The resulting dense thickets can limit movement of large animals from meadow to forest and vice versa, reducing the utility of small openings and meadows as foraging areas. Although the fruit is widely consumed by native animals, it is a poor functional replacement for a diverse native forest understory, meadow, or riparian floodplain. Seeds from the fruit are spread widely by birds via their feces.

4.10.3 Description and Status of English Ivy

English ivy is an evergreen climbing vine that attaches to the bark of trees, buildings, and other surfaces by way of small root-like structures which exude a sticky substance that helps the vines adhere to various surfaces. Older vines have been reported to reach 1 foot in diameter. Leaves are dark green with white veins, waxy to somewhat leathery, and arranged alternately along the stem.

Leaf forms include a 3 to 5-lobed leaf (the most common) and an unlobed rounded leaf often found on mature plants in full sun that are ready to flower. Vines may grow for up to ten years before producing flowers. Under sufficient light conditions, terminal clusters of small, pale yellow-green flowers are produced in the fall. The flowers are attractive to flies and bees in search of late season nectar sources. The black-purple fruits have a thin fleshy outer covering, contain one to three hard stone-like seeds, and may persist through the winter if not eaten first. The leaves and berries of English ivy contain the glycoside hederin which could cause toxicosis if ingested. Symptoms include gastrointestinal upset, diarrhea, hyperactivity, breathing difficulty, coma, fever, polydipsia, dilated pupils, muscular weakness, and lack of coordination. This feature also helps ensure effective seed dispersal by birds (NPS 2011).

English ivy is a vigorous growing vine that impacts all levels of disturbed and undisturbed forested areas, growing both as a ground cover and a climbing vine. As the ivy climbs in search of increased light, it engulfs and kills branches by blocking light from reaching the host tree's leaves. Branch dieback proceeds from the lower to upper branches, often leaving the tree with just a small green "broccoli head." The host tree eventually succumbs entirely from this insidious and steady weakening. In addition, the added weight of the vines makes infested trees much more susceptible to blow-over during high rain and wind events and heavy snowfalls. Trees heavily draped with ivy can be hazardous if near roads, walkways, homes, and other peopled areas. On the ground, English ivy forms dense and extensive monocultures that exclude native plants (NPS 2011). Ivy will only flower and set fruit on climbing vines therefore, as a first defense it is advisable to prevent the plants from climbing or removing climbing vines first to prevent fruit production. English ivy fruit is eaten by birds and spread widely in their feces.

4.10.4 Description and Status of Scotch Broom

Scotch broom is a perennial evergreen shrub in the legume family. It reaches heights up to 10 feet and has stiff, angled, more or less erect, dark green, broom-like branches. Many branches are leafless or have few leaves. Upper leaves are simple, but lower leaves are trifoliate (three-parted). The bright yellow flowers are about ¾ inch long, shaped like pea flowers, and bloom from April to June. The brown or black pods are flat with hairs on the margins only. Each contains several seeds. Seeds are oval, about ⅛ inch long, dark greenish-brown, and have a shiny surface. Seeds can last for 60 years in the soil (Hulting et al. 2008).

Scotch broom was introduced as a garden ornamental by early settlers of the Pacific Coast. It has spread far beyond the bounds of cultivation and now covers many acres west of the Cascades from British Columbia to California. Scotch broom is moving rapidly into forest lands of western Oregon and Washington, where it is interfering increasingly with re-establishment of conifer seedlings on harvested lands. Scotch broom also is being found more frequently in areas east of the Cascades. Wherever it grows, this aggressive plant spreads to form pure stands at the expense of desirable forbs, grasses, and young trees. Because it is a threat to native plant species and indirectly to animals that feed on the displaced plants, Scotch broom is a Class B noxious weed in Washington and Oregon (Hulting et al. 2008).

4.10.5 Description and Status of Gorse

Gorse is native to western and central Europe where it was cultivated as hedgerows and as a reserve for livestock forage. In southern coastal Oregon, gorse was introduced by early European emigrants and planted as an ornamental shrub. This invasive non-native plant grew in monotypic stands and

became an established exotic shrub in most coastal habitats. This species is extremely competitive, displaces native plants, and impoverishes the soil. In addition, it creates an extreme fire hazard due to oily, highly flammable foliage and seeds, and abundant woody material in the plant's center. The city of Bandon was almost completely destroyed by a fire fueled in part by gorse in 1936. All but 16 buildings out of 500 were completely burned to the ground.

4.10.6 Description and Status of Spartina

Smooth cordgrass or saltmarsh cordgrass is a perennial deciduous grass, which is found naturally in intertidal wetlands, especially salt marshes on the East Coast. However on the West Coast, smooth cordgrass is viewed as an aggressive exotic that alters estuarine structure and function, excludes native salt marsh and mudflat vegetation, and eliminates native habitat for shorebirds, waterfowl, and certain shellfish and finfish (USFWS 1997).

This long-lived, warm season perennial typically grows from 1-2.3 meters tall (3.3-7.5 feet), and has smooth, hollow stems which bear leaves up to 20-60 centimeters long and 1.5 centimeters wide at their base, which are sharply tapered and bend down at their tips. The flowers are a yellowish-green, turning brown in the winter, and are wind pollinated. Like its relative saltmeadow cordgrass it produces flowers and seeds on only one side of the stalk and spreads extensively by long hollow rhizomes. Soft, spongy stems up to ½ inch in diameter emerge from the rhizomes. The rhizoidal roots, when broken off, can result in vegetative asexual growth. In September and October seedheads, which are 10 to 12 inches long, emerge at the end of the stem. Each spike holds from twelve to fifteen 2 or 3 inch long spikelets (USDA 2008). Smooth cordgrass can become an invasive species either by itself or by hybridizing with native species and preventing propagation of the pure native strain.

Smooth cordgrass dynamically alters West Coast physical, hydrological, chemical, and biological estuarine functions and is noted for its capacity to act as an environmental engineer. It grows out into the water at the seaward edge of a salt marsh and can appear on mudflats far from nearby marshes. Sediment accumulates in the cordgrass infested area and enables other habitat-engineering species to settle. This accumulation of sediment and other substrate-building species gradually builds up the level of the mudflats and tidal channels are deepened. This in turn eliminates the gently sloping bare intertidal zone that lies between the salt marsh and the tidal channels (USFWS 1997). As the marsh accretes, smooth cordgrass moves still further out to form a new edge. Smooth cordgrass grows in tallest forms at the outermost edge of a given marsh, displaying shorter morphologies up onto the landward side of the cordgrass belt.

Cordgrass may affect habitat structure for native wetland animals, benthic invertebrate populations, and shorebird and wading bird foraging areas. As a result of smooth cordgrass growth, benthic invertebrate species composition and abundance in the intertidal zone changes substantially as their habitat is overgrown. In turn, food sources shrink for birds who feed on those invertebrates. Smooth cordgrass also displaces eelgrass on mudflats and native vegetation in salt marshes (USFWS 1997).

Smooth cordgrass was introduced into Willapa Bay, Washington in 1894 as packing material for oyster shipments from the East Coast. From 1945 to 1988, the plant spread rapidly throughout Willapa Bay. In 1999 it covered 6,000-10,000 hectares (15,000-25,000 acres) of land. Currently, approximately 10 acres are considered to be infested at Willapa Bay according to a 2012 estimate. It is also making inroads into Puget Sound and Grays Harbor in Washington.

4.10.7 Description and Status of Japanese Eelgrass

The non-native Japanese eelgrass was first introduced to the Pacific Northwest in the 1950s as a packing material for non-native Japanese oysters (Harrison and Bigley 1982). This invasive species was first established in estuaries in the state of Washington and subsequently became established from British Columbia, Canada south to Humboldt Bay in northwestern California. Colonization of habitat occurs on bare, unvegetated tidal flats with elevations between 0.3 and 2.4 meters (1.0 and 7.9 feet) above mean lower low water. The rhizomes of this eelgrass stabilize soft substrate (e.g., mudflats) while the vegetative blades trap suspended sediment that facilitates succession of estuary habitat to higher elevation terrestrial habitats. The altering of habitat elevation and structure by colonization affects the availability of clams, worms, and biofilm to migrating shorebirds (Baldwin and Lovvom 1994, PIBC 2004).

4.10.8 Refuge-specific Sites

Reed canarygrass is found throughout the Bandon Marsh NWR, with major infestations at restored salt marsh on the Ni-les'tun Unit, along the fringe of the Bandon Marsh Unit near Riverside Drive and Highway 101, and within the converted upland forest that is currently grassland. However, a decrease in extent and decline in condition of the reed canarygrass infestations at the Ni-les'tun Unit restoration site has been observed since tidal function was restored in 2011 (USFWS unpublished data). A mix of salt tolerant native species typical southern Oregon tidal marshes is replacing reed canarygrass within the newly restored salt marsh.

Invasive species treatment has been concentrated on the Himalayan blackberry that infests much of the refuge uplands, roadsides, and trail edges. The blackberry was primarily hand-cut by volunteers at various locations on the Refuge.

Intensive efforts to remove English ivy have been completed at the Refuge. Volunteers and school groups spent many hours each year since 2007 cutting, chopping, and removing ivy that had infested wooded areas of the Refuge.

Scotch broom has formed dense thickets along U.S. Highway 101 near the refuge boundaries, ditch banks and fences, and forested borders. Efforts to control Scotch broom have been erratic and only partially successful. Plants re-sprout if root systems are not removed or killed and will quickly reoccupy the sites.

Gorse is currently found in two locations on the Refuge. One small patch is currently under control on the Bandon Marsh Unit through the use of volunteer labor performing mechanical removal. This infestation is being supported by a larger infestation on adjacent private lands to the south. Recent efforts to assist the neighbor with controlling this invasive plant are underway. The other more pervasive infestation of gorse is located on the northern boundary of the Ni-les'tun Unit in an area historically used by the previous landowners as a borrow pit that supplied material for the exterior fringing dikes and pasture road system. This degraded forest habitat is devoid of top soil and is in need of reclamation. The gorse in the area is mixed with Scotch broom and a variety of early native successional plants (e.g., red alder, Pacific madrone, and Sitka spruce). Control efforts in this area have included mechanical removal by hand and limited chemical spraying efforts to reduce and control the spread of the invasive non-native plants.

Invasive Japanese eelgrass was first observed and documented in the Coquille River estuary in 1992. It is currently rare at Bandon Marsh but can be found in small isolated patches along the edge of the Coquille River within both refuge units and may have an effect on native benthic communities and migrating shorebirds (Dudoit 2006, Crombie 1993, Posey and Rudy 1987). The Coquille River estuary is the only major estuary in Oregon where Japanese eelgrass does not form contiguous meadows (Dudoit et al. 2006). In 2006, the limited and sparsely distributed beds of Japanese eelgrass at Bandon Marsh were the site of a research study to determine the feasibility of manually controlling colonization to adjacent habitat. Results of the study indicated that the vegetative growth of the plants can be controlled but the remaining seed source may reestablish the infestation. In addition, the study area was a site of hydraulic harvesting of mud shrimp used as fishing bait. The action of turning over the substrate with pumps creates pits and mounds of sediment. If done regularly and repeated over the years, it was theorized that the eelgrass would be prevented from establishing large contiguous beds (Dudoit et al. 2006).

4.11 Invasive and Exotic Animal Species

One of the largest threats to wildlife and habitat of the Refuge is pest animals. Introduced native and non-native animal species are usually in direct competition with native wildlife species for food, shelter, and breeding areas and often cause existing native species populations to decline or become extirpated. Ultimately, animal invasive species can result in considerable impact to native wildlife and the habitat they are dependent upon. For example, introductions of Arctic and red foxes for fur farming purposes resulted in widespread extirpation of breeding of the Aleutian Canada goose in the Aleutian Islands, Alaska due to predation (USFWS 1993, Bailey and Trapp 1984). The fox decimated goose populations by preying upon vulnerable nesting adults, chicks, and eggs. The Aleutian Canada goose inhabits refuge lands in Alaska during the summer and Oregon during the winter - spring. Because of cooperative recovery efforts that included removing invasive foxes from the breeding islands, the USFWS officially delisted this species from threatened status in 2001 (USFWS 2001). The following list is not all-inclusive and includes only the most problematic species; many other exotic animals have been introduced.

4.11.1 Description and Status of Nutria

The nutria is a large, dark-colored, semiaquatic rodent that is native to southern South America. At first glance, a casual observer may misidentify nutria as either a beaver or a muskrat, especially when it is swimming. This superficial resemblance ends when a more detailed study of the animal is made. Other names used for the nutria include coypu, nutria-rat, South American beaver, Argentine beaver, and swamp beaver.

Nutria are members of the family Myocastoridae. They have short legs and a robust, highly arched body that is approximately 24 inches (61 centimeters) long. Their round tail is from 13 to 16 inches (33 to 41 centimeters) long and scantily haired. Males are slightly larger than females; the average weight for each is about 12 pounds (5.4 kg). Males and females may grow to 20 pounds (9.1 kg) and 18 pounds (8.2 kg), respectively. The dense grayish underfur is overlaid by long, glossy guard hairs that vary in color from dark brown to yellowish brown. The forepaws have four well-developed and clawed toes and one vestigial toe. Four of the five clawed toes on the hind foot are interconnected by webbing; the fifth outer toe is free. The hind legs are much larger than the forelegs. When moving on land, nutria may drag its chest and appear to hunch its back. Like beavers, nutria have large incisors that are yellow-orange to orange-red on their outer surfaces. In addition to having webbed hind feet,

nutria have several other adaptations to a semiaquatic life. The eyes, ears, and nostrils of nutria are set high on their heads. Additionally, the nostrils and mouth have valves that seal out water while swimming, diving, or feeding underwater. The mammae or teats of the female are located high on the sides, which allows the young to suckle while in the water. When pursued, nutria can swim long distances under water and see well enough to evade capture (ICWDM 2011).

Nutria construct burrows in banks of rivers, sloughs, and ponds, sometimes causing considerable erosion. Burrowing is a commonly reported damage caused by nutria. Burrows can weaken roadbeds, stream banks, dams, and dikes, which may collapse when the soil is saturated by rain or high water. Rain action can wash out and enlarge collapsed burrows and compound the damage. Nutria depredation on crops is also well documented. Crops that have been damaged include corn, sugar and table beets, alfalfa, wheat, barley, oats, various melons, and a variety of vegetables from home gardens and truck farms. Nutria girdle fruit, nut, deciduous and coniferous forest trees, and ornamental shrubs. They dig up lawns when feeding on the tender roots and shoots of sod grasses. At high densities and under certain adverse environmental conditions, foraging nutria can also significantly impact natural plant communities. Overutilization of emergent marsh plants can damage stands of desirable vegetation used by other wildlife. Nutria are aggressive competitors with the native muskrat which is smaller. Muskrats have been largely eliminated or greatly reduced where nutria have become established (ODFW 2011a).

Nutria is a semi-aquatic South American mammal, tolerant of mild coastal winters, and is known to be expanding its range in southern coastal Oregon wetlands and within the Coquille River system (Sheffels and Sytsma 2007, Stuart Love, ODFW, personal communication). This rodent is capable of extensive damage as a result of its foraging and burrowing behaviors which adversely impacts the root mass of wetland plants that hold the wetland together. In addition to direct habitat damage to salt marshes and competition with native species (e.g., muskrat, beaver), this large rodent is capable of transporting parasites, and pathogens communicable to wildlife, domestic animals and humans (reviewed in Sheffels and Sytsma 2007). The high reproductive rate of the animal is a concern, as one breeding pair can result in a population of more than 16,000 after only 3 years. If left unchecked, numbers are capable of increasing to tens of thousands within a 30 year period (Sheffels and Sytsma 2007, CBNWG 2003).

In 2010, non-native nutria was documented at the Ni-les’tun Unit of Bandon Marsh NWR with the sighting of a few individuals (USFWS unpublished observations). The habitat damage associated with this expanding nutria population on the Refuge is not currently assessed. Future control efforts will involve working with the ODFW to control, and if possible, eliminate this threat within the lower Coquille River estuary.

4.11.2 Description and Status of Invasive Aquatic Species

Historic use of the Coquille River and southern Oregon estuaries for the maritime industries and aquaculture has introduced and been a vector for the transport of marine invasive species (Carlton and Geller 1993) which threatens the biological diversity of Bandon Marsh (Bax et al. 2003). These are some of the newest and least understood threats to Bandon Marsh NWR due to difficulties in monitoring and jurisdictional controls.

Invasive marine invertebrates such as Asian tunicate, lacy crust bryozoan, Japanese orange-striped anemone, Harris mud crab, European green crab, European saltmarsh snail, Chinese mitten crab, New Zealand burrowing isopod, New Zealand mud snail, Griffen’s isopod, and a variety of Asian

and eastern United States clams, have been recorded within the southern Oregon estuaries and within the lower Coquille watershed (Dudoit et al. 2006, Bilderback and Bilderback, personal communication, Davidson et al. 2007, USGS 2009).