Appendix F

Descriptions and Life History Requirements of Nearshore and Marine Species

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List of Acronyms

BRT	Biological Review Team
cm	centimeter(s)
CPS	coastal pelagic species
DPS	distinct population segment
ESA	federal Endangered Species Act
ESU	evolutionary significant unit
FMP	Fisheries Management Plan
km	kilometer(s)
MBTA	Migratory Bird Treaty Act
mi	mile(s)
mm	millimeter(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
ppt	parts per trillion
WDFW	Washington Department of Fish and Wildlife

1. INTRODUCTION

Appendix F provides general descriptions, life history requirements, and potential for occurrence in the study area for common and federally and state-listed nearshore and marine species. Summaries of species occurrence and life histories are based on available literature, consultations and coordination with federal and state agencies, and public and agency websites. Federally listed species with the potential to occur in the study area were identified through a review of the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) lists of fish and wildlife species protected under the federal Endangered Species Act (ESA). Species receiving protection under the ESA are designated as endangered or threatened. Candidate or proposed species could be included on the ESA list in the future. Areas designated as critical habitat for listed species also receive protection under the ESA. At the state level, the Washington Department of Fish and Wildlife (WDFW) maintains lists of species considered threatened, endangered, or candidates for listing.

The study area encompasses the Cooperative Vessel Traffic Service system marked north-south boundary 8 miles west of the “J” Buoy at the entrance to the Strait of Juan de Fuca to the BP Cherry Point dock, as well as vessel routes from the BP Cherry Point dock to distribution points in Puget Sound. The scope also includes the tidal zone (200 feet inland) within the defined study area.

2. MARINE MAMMALS

2.1 Protected Species

This section identifies federally and state-listed marine mammals with the potential to occur in the study area. More detailed discussions of the life histories and listing status of federally listed species are provided in the draft Biological Evaluation (Appendix G).

2.1.1 Federally Listed Species

2.1.1.1 Humpback Whale (Endangered)

Humpback whales were common in Puget Sound and the Georgia Strait in the early 1900s, but there have been few sightings of humpback whales in Puget Sound in the last 20 years (Calambokidis 2008). Although humpback whales have been recovering from commercial whaling (Carretta et al. 2011), they still are rare visitors to Puget Sound and Georgia Strait. Some sightings have been reported in recent years. A study by Calambokidis et al. (2004) found that humpback whale sightings were concentrated between the Juan de Fuca Canyon and the outer edge of the continental shelf, in an area known as *the Prairie*. The highest density of sightings all year was in a small area east of the mouth of Barkley Canyon and north of Nitnat Canyon, where water depth was from 125 to 145 meters (410 to 476 feet) (Calambokidis et al. 2004). These areas are outside of the study area for the project; therefore, although they may occur in the study area, humpback whale occurrences are not expected to be common in the study area.

2.1.1.2 Blue Whale (Endangered)

The Eastern North Pacific population of blue whales is the population occurring closest to the study area. They feed in California waters in summer/fall (from June to November) and migrate south to productive areas off Mexico in winter (Carretta et al. 2007). More recently, sightings have occurred off the coasts of Oregon, Washington, and British Columbia (Calambokidis et al. 2009). Historically, blue whales were not common along the coast of Washington; however, they did occasionally occur (Calambokidis et al. 2004). Vessel surveys conducted in Washington waters in 1996 and 2001 did not detect the presence of blue whales (Carretta et al. 2013). Consequently, although they may occur in the study area, blue whale occurrences are not expected to be common in the study area (Calambokidis et al. 2009).

2.1.1.3 Fin Whale (Endangered)

Fin whales are year-round residents off the coast of California, are summer residents off the coast of Oregon, and possibly pass through Washington waters. Aerial surveys conducted by Brueggeman et al. (1992) off the Oregon and Washington coasts observed 13 groups of 27 fin whales between June and January. All of the fin whales were observed in Oregon waters, with all but five whales in waters on the continental slope in depths from 200 to 2,000 meters (656 to 6,562 feet). The whales not observed in continental slope waters included two whales approximately 200 kilometers (km) (124 miles [mi]) offshore in November and three whales on the continental shelf just south of the Columbia River in January. The former group was traveling south, suggesting that they were migrating back to wintering grounds. Except for these two groups, all of the other whales were observed during June and July. No calves were observed with any of the whales. Green et al. (1993) reported sighting two fin whales during aerial surveys off the Oregon and Washington coasts between March and May in 1992 but did not report the location. An estimated 2,636 fin whales occur off the coasts of California, Oregon, and Washington during summer/fall based on shipboard surveys in 2001 and 2005 (NMFS 2010a). These areas are outside the study area. Therefore, although they may occur in the study area, fin whale occurrences are not expected to be common in the study area.

2.1.1.4 Southern Resident Killer Whale (Endangered)

The southern resident killer whale population is a trans-boundary population comprised of 89 animals split among three pods (J, K, and L) that are considered one stock under the Marine Mammal Protection Act and a distinct population segment (DPS) under the ESA. Southern resident killer whales reside for part of the year in the protected inshore waters of the Strait of Georgia and Puget Sound (especially in the vicinity of Haro Strait, west of San Juan Island, and off the southern tip of Vancouver Island). Southern resident killer whales occur in the area principally during late spring, summer, and fall (May through October) (NMFS 2006). Winter movements and range are poorly known for this stock; however, the J pod is more commonly sighted in inland waters, while pods K and L spend more time offshore during winter (Ford et al. 2000). The southern resident stock is differentiated from the northern and southern Alaska resident stocks, which do not inhabit waters off the Washington coast. The distribution of southern resident DPS killer whales in Puget Sound is shown in Figure 1.

Based on the natural history and habitat needs of southern resident killer whales, the following primary constituent elements of critical habitat were identified as essential to their conservation: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging.

Two critical habitat areas have been designated in the study area for southern resident killer whales: Area 1 – Summer Core Area and Area 3 – Strait of Juan de Fuca Area (Figure 2). The Summer Core Area is bordered to the north and west by the U.S./Canadian border and includes waters surrounding the San Juan Islands, the U.S. portion of the southern Strait of Georgia, and areas directly offshore of Skagit and Whatcom Counties. This area is important for all pods (J, K, and L) (NMFS 2006). The Strait of Juan de Fuca Area is bordered on the southeast by the entrance to Admiralty Inlet, Deception Pass Bridge, San Juan and Skagit Counties to the northeast, the U.S./Canadian border to the north, and Bonilla Point/Tatoosh line to the west. All pods regularly use the Strait of Juan de Fuca as a passage from the Summer Core Area and Puget Sound to access oceanic waters; however, the whales are not known to spend long periods of time in localized areas in the Strait, and sightings of southern residents in the strait are limited (NMFS 2006). Southern resident killer whales are expected to occur in the study area.

2.1.1.5 Dall’s Porpoise (Monitored)

Dall’s porpoises apparently feed at night and depend to some degree on the *deep scattering layer*, the fauna that travels upward each night from the deeper parts of the ocean’s water column. Prey species, as determined from stomach contents, include squid and schooling fishes (Walker 1996; Reeves and Leatherwood 1994). Killer whales and sharks are believed to be the primary natural predators of Dall’s porpoises. Dall’s porpoises occur only rarely in groups of mixed species, although they are sometimes seen in the company of harbor porpoises and gray whales (Reeves and Leatherwood 1994). Within the inland waters of Washington, Dall’s porpoises primarily occur in the Strait of Juan de Fuca and the San Juan Islands (Chandler and Calambokidis 2003a, 2003b). Consequently, Dall’s porpoises are expected to occur in the study area.

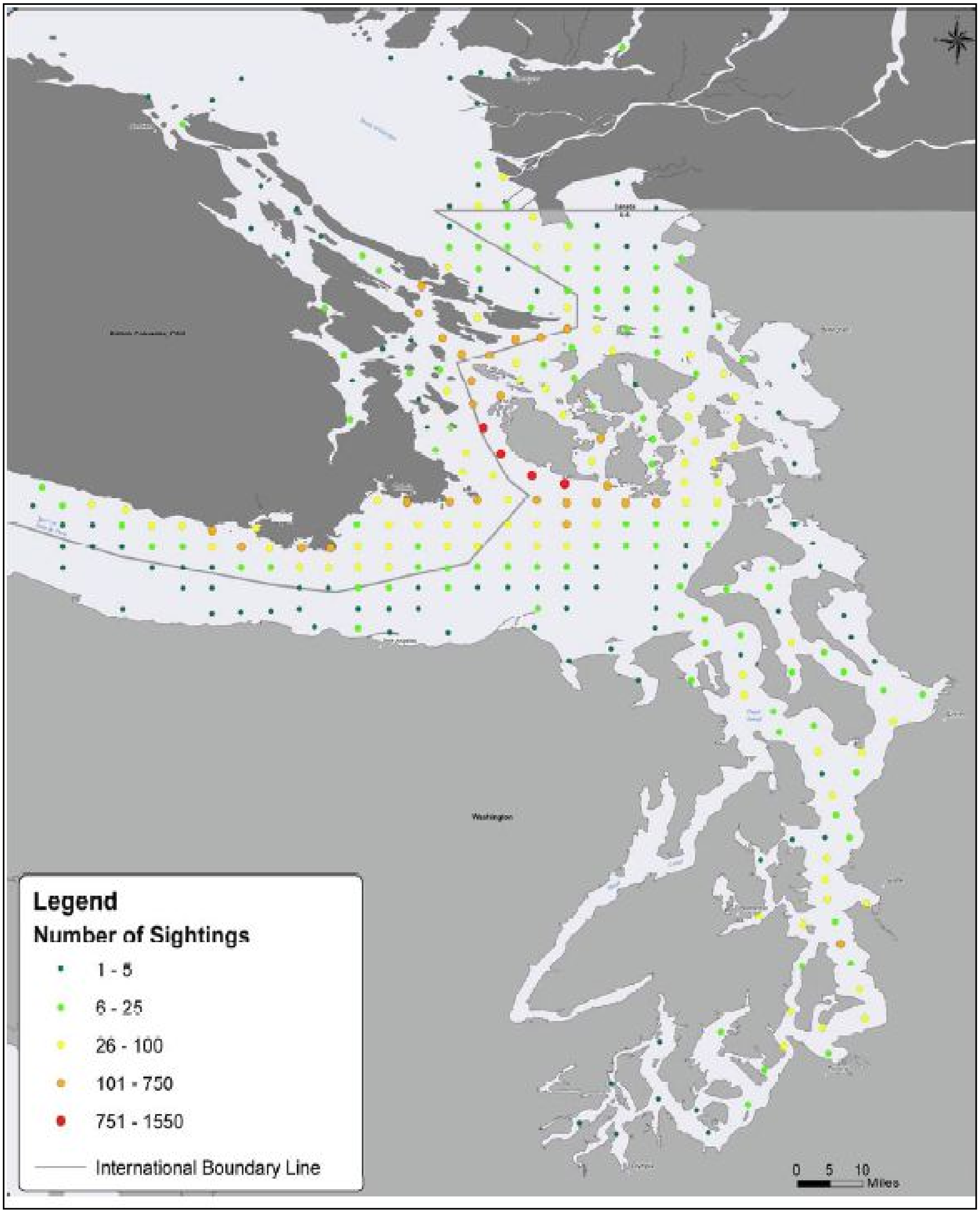

Figure 1. Distribution of Southern Resident Killer Whale Sightings from 1990 to 2005

Source: The Whale Museum 2005, as cited in NMFS 2008b.

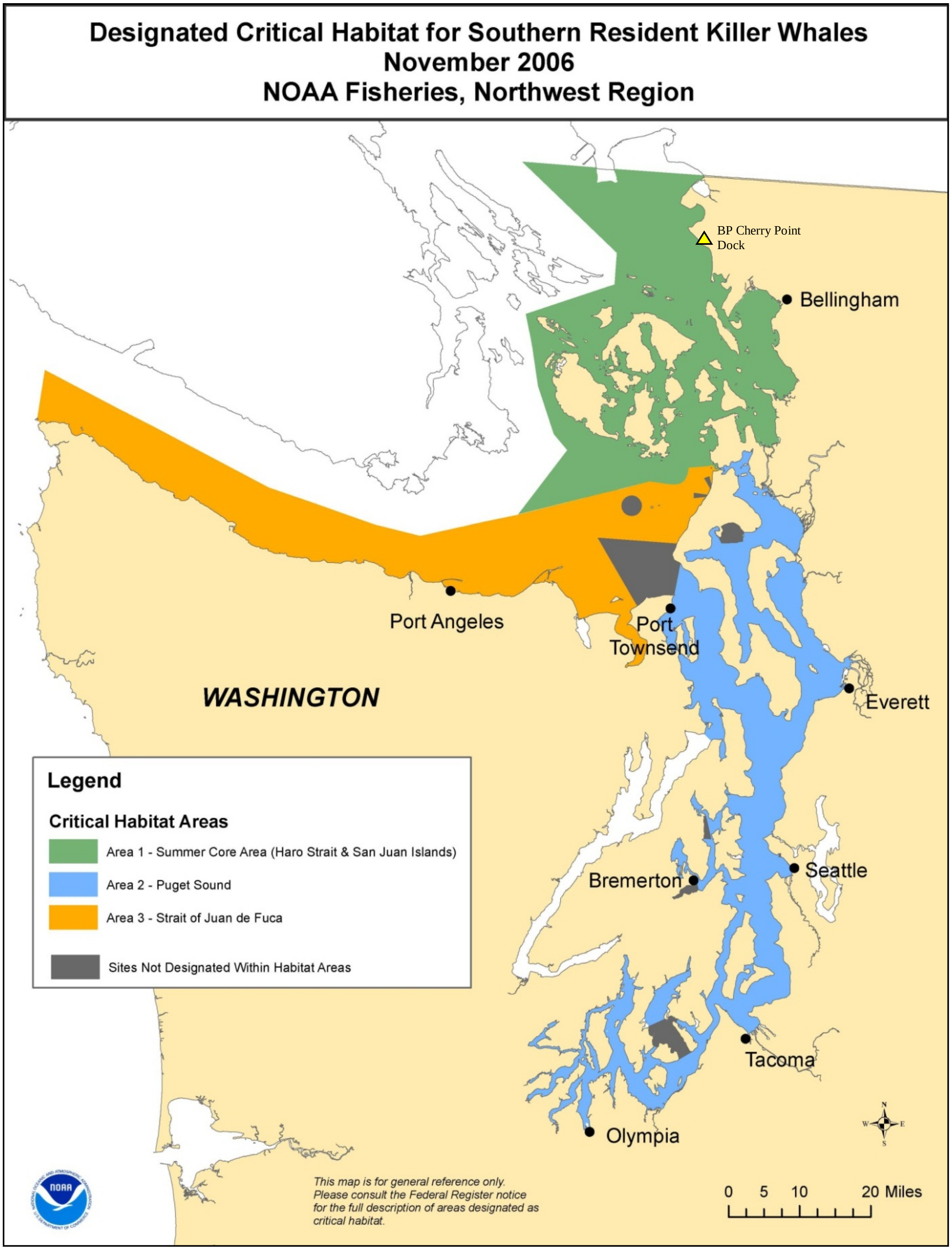

Figure 2. Designated Critical Habitat for Southern Resident Killer Whales

Source: NMFS 2006.

2.1.1.6 Gray Whale (Sensitive)

Gray whales are one of the most studied whales, resulting in an extensive understanding of their migration and general ecology. The estimated carrying capacity for the North Pacific gray whale is 22,000 and the current population is 19,126 animals; therefore, the population is currently at or near carrying capacity (Rugh et al. 2005; Wade and Perryman 2002; Carretta et al. 2013).

Gray whales seasonally migrate between summer feeding grounds in the Bering and Chukchi Seas and winter breeding grounds in the lagoons in Baja, California (Rugh et al. 1999, 2001). The southward migration can occur off the Washington coast beginning as early as November; however, recent studies indicate that gray whales begin their southward migration in early December, peaking on or about January 5 and ending in the first week of February (Rugh et al. 2001). During their migration, gray whales move past Washington in a wide corridor that extends from nearshore to over 47 km (29 mi) offshore, with a mean distance of approximately 24 km (15 mi) from shore (Green et al. 1995; Shelden et al. 2000). The southbound migration is segregated by age, sex, and reproductive status (Rice and Wolman 1971); near-term pregnant females lead the migration, followed by oestrus (sexually receptive) females and mature males, and then immature animals of both sexes.

The northward migration off the coast of Washington occurs from February through June, with females and calves dominating the migration in June. The northward migration corridor is narrower than the southward and extends from nearshore to over 19 km (12 mi) offshore, with a mean distance of approximately 11 km (7 mi), indicating that most northbound whales migrate closer to shore and in a narrower band than southbound whales (Braham 1984; Darling 1984; Brueggeman et al. 1992; Green et al. 1995). The northward migration occurs in two distinct phases segregated according to age, sex, and reproductive condition (Poole 1984; Swartz 1986). The first phase includes newly pregnant females, followed by adult males, anestrous (sexually inactive) females, and immature whales of both sexes.

Gray whales are predominantly bottom feeders, preying on small invertebrates and crustaceans (Nerini 1984); they feed primarily on large aggregations or patches of benthic amphipods (Nerini 1984). Gray whales have been observed feeding off Vancouver Island on amphipod and mysid crustaceans, and feeding on ghost shrimps off Washington coasts (Murison et al.1984; Weitkamp et al. 1992).

Most eastern North Pacific gray whales summer in the Bering Sea and in the adjacent waters of the Arctic Ocean, but some remain in Washington waters to feed from late spring into fall (Calambokidis et al. 2002). Most whales occur off the coast, but a few also occur in the inland waters. Small numbers of gray whales occasionally have been recorded throughout the inland waters in the Strait of Juan de Fuca and San Juan Islands, and off of Vancouver Island. Cow-calf pairs have not been recorded outside of the migration periods in Washington, indicating that most whales summering in the region are non-breeding. Gray whales are expected to occur in the study area.

2.1.1.7 Harbor Seal (Monitored)

The harbor seal is the most common marine mammal in Washington (NMFS 1992), with a stable population that numbers 10,430 seals off the Washington coast and 14,612 in inland waters (Carretta et al. 2004, 2007). The species occurs year-round in Washington. Harbor seals give birth on shore and nurse their pups for 4 to 5 weeks. After the pups are weaned, they disperse widely in search of food. Pupping seasons vary geographically, with pups born along the Olympic Peninsula from May through July, in the San Juan Islands and eastern Bays of Puget Sound from June through August, and in Hood Canal from August through January (Jeffries et al. 2000). Breeding occurs in the water shortly after the pups are weaned. Females produce one pup per year, beginning at age 4 or 5. Common prey includes sole, flounder, sculpin, hake, cod, herring, squid, octopus, and to a much lesser degree salmon (Newby in Haley 1978).

The study area contains hundreds of harbor seal haul-out sites (Jeffries et al. 2000). Numerous haul-out sites occur on intertidal areas around islands, rocks, and reefs along the Washington coast—particularly in the vicinity of Cape Johnson, Cape Alava, Bodelteh Island, and Ozette Island. Scattered harbor seal haul outs are found along rocks, reefs, and ledges along the Strait of Juan de Fuca and Vancouver Island; large numbers haul out at Dungeness Spit, Protection Island, and the Smith/Minor Islands. Numerous haul-out sites occur throughout the San Juan Islands, such as Rosario and Haro Straits and the San Juan Channel including Vendovi, Clark, Battleship, and Goose Islands, to name a few. Peak numbers of harbor seals use haul-out sites during the pupping and molting seasons (mid-June to October). Harbor seals are expected to occur in the study area.

2.2 Non-Listed Common Marine Mammal Species off the Washington Coast

2.2.1 Toothed Whales

2.2.1.1 Harbor Porpoise

Harbor porpoises are common year-round residents off the coast and within the inland waters of Washington. An estimated 10,682 harbor porpoises occur in Washington inland waters, and 37,745 occur off the coasts of Oregon and Washington (Carretta et al. 2007). Harbor porpoise abundance is particularly high in fall and winter, low in summer, and intermediate in spring (Brueggeman et al.1992; Carretta et al. 2004). While abundances vary seasonally, harbor porpoises do not appear to be migratory (NMFS 1992). They are widespread throughout the inland and coastal waters of Washington, with the exception of southern Puget Sound (NMFS 1992). High concentrations have been recorded in the central Strait of Juan de Fuca and northern San Juan Islands, and low numbers in the central and northern Strait of Georgia (Chandler and Calambokidis 2003 a, 2003b).

Scheffer and Slipp (1948) provide a historical account of this species in Washington. Harbor porpoises are known to calf and breed in Washington, and generally give birth in summer from May through July. Calves remain dependent on their mothers for at least 6 months (ADFG 2008a). Their primary prey is small fish and squid, including herring (Leatherwood and Reeves in Haley 1978). Because harbor porpoises are usually shy and avoid vessels, they are difficult to approach. The species frequents inshore areas, shallow bays, estuaries, and harbors. They are found almost exclusively shoreward of the 100-fathom (600-foot) contour line along the Pacific coast, with the vast majority found inside the 25-fathom (150-foot) curve (Green et al. 1992). Harbor porpoises are expected to occur in the study area.

2.2.1.2 Pacific White-Sided Dolphin

The Pacific white-sided dolphin population is estimated at 25,233 animals for the California, Oregon, and Washington stock and is one of the most abundant dolphins occurring year-round off the coast of Washington (Brueggeman et al. 1992; Green et al. 1993; Carretta et al. 2007). Seasonal habitat shifts occur off Oregon and Washington, where dolphins are more common in offshore waters during spring and shift to slope waters during summer and fall, in rough synchrony with the movements of prey (Van Waerebeek 2002). There also may be seasonal north-south movements of Pacific white-sided dolphins (Forney and Barlow 1998). Peak abundance of the Pacific white-sided dolphin off the Oregon and Washington coasts has been reported during May (Buckland et al. 1993; Brueggeman et al. 1992). Pacific white-sided dolphins consume a wide variety of fishes and cephalopods. Off the coast of British Columbia, Canada, herring was the most commonly occurring prey species, followed by salmon, cod, shrimp, and capelin (Heise 1997). Pacific white-sided dolphins have been known to occur in association with other marine mammals, including Dall's porpoise, Risso's dolphin, northern right-whale dolphin, humpback whale, and gray whale (Brueggeman et al. 1992). Pacific white-sided dolphins are expected to occur in the study area.

2.2.1.3 Risso's Dolphin

The Risso's dolphin population for the California, Oregon, and Washington stock is estimated at 12,093 animals (Carretta et al. 2007). Risso's dolphins are common off the coast of Washington, where they are present year-round (Brueggeman et al. 1992). They are most common during spring and summer, lowest in winter, and intermediate in fall (Brueggeman et al. 1992). Calves have been observed off the Oregon and Washington coasts during May, July, and November. Risso's dolphins primarily inhabit slope waters, but they also occur in lower numbers near the edge of the continental shelf. Risso's dolphins consistently are found in the continental slope and shelf edge waters throughout the year, suggesting that there is no inshore-offshore movement pattern. However, some seasonal north-south movement of Risso's dolphins may occur between Oregon/Washington and California based on the shifts in abundance between the two regions, possibly related to prey movements. Their prey mainly includes cephalopods and fish (NMFS 2012a). Risso's dolphins have been known to occur in association with other marine mammals, including Pacific white-sided and northern right whale dolphins (Brueggeman et al. 1992). Risso's dolphins are expected to occur in the study area.

2.2.1.4 Northern Right Whale Dolphin

The California, Oregon, and Washington stock of the northern right whale dolphin is estimated at 20,362 animals (Carretta et al. 2004). It is relatively common off the coast of Washington, which is toward the northern end of its range in the eastern North Pacific Ocean (Brueggeman et al. 1992), and has been reported in Washington waters during all seasons except winter (Brueggeman et al. 1992). Abundance of northern right whale dolphins is highest in fall and lowest during spring and summer. Northern right whale dolphin's use of the slope waters is considerably higher than the offshore water, and few dolphins occur in shelf waters. While northern right whale dolphins show a seasonal abundance pattern off Washington that is somewhat opposite that in California, it is not clear if they move between the two areas. The primary prey for this species is fish and squid. The northern right whale dolphin has been frequently reported in association with Pacific white-sided dolphins (Brueggeman et al. 1992; Leatherwood and Walker 1979). Northern right whale dolphins are expected to occur in the study area.

2.2.2 Baleen Whales

2.2.2.1 Minke Whale

Minke whale surveys (2001 and 2005) off the coast of California, Oregon, and Washington have estimated the population at 898 whales (Carretta et al. 2007). Minke whales reside off the Washington coast year-round (Carretta et al. 2007). They typically occur as single animals rather than in groups. Brueggeman et al. (1992) encountered four single minke whales, including three off the Oregon coast and one off the Washington coast. Most were on the continental shelf. Minke whales are also known to enter shallow bays and estuaries (NMFS 2012b). Green et al. (1993) reported 10 groups of 12 minke whales off the Oregon and Washington coasts between March and May but did not give their locations or distributions between the two states. Minke whales typically prey on small fish and squid (NMFS 2012b). Minke whales are expected to occur in the study area.

2.2.3 Pinnipeds

2.2.3.1 Steller Sea Lion

The Steller sea lion occurs year-round in Washington, with peak numbers (approximately 1,000 animals) in late summer, fall, and winter (Jeffries et al. 2000). The species does not breed in Washington; the closest rookeries are in northern British Columbia and central Oregon, where pupping occurs in May and June. Within Washington waters, Steller sea lions occur primarily along the outer coast, with smaller numbers in the inside waters of the Strait of Juan de Fuca and Puget Sound. Occurrence of the Steller sea lion in inland water is primarily limited to male and sub-adults in fall, winter, and spring months (NMFS 2008a).

Steller sea lion haul-out sites tend to be located on exposed rocky shorelines and wave-cut platforms (NMFS 2008a). There are several commonly used haul-out sites in the study area; these sites occur along the coast and a few near the entrance to the Straits of Juan de Fuca (Jefferies et al. 2000). (Maps of haul-out sites are available at the WDFW website [http://wdfw.wa.gov/publications/00427/wdfw00427.pdf].) These include sites around Neah Bay that are occupied during all months of the year but are more commonly used during late August through April. The west end of Tatoosh Island is a year-round haul-out site, with numbers peaking during fall and winter. South of Cape Alava, large numbers (more than 1,000) of Steller sea lions have been observed hauled out on the Bodelteh Islands and on Guano Rock. Farther south, large numbers also haul out on Carroll Island along with California sea lions, and at the Split Rock complex north of Taholah. Steller sea lions also occur on Vancouver Island near Carmanah and Sombrio Point, and off Victoria at Race Rocks and Trial Island. Small numbers of sea lions also use haul-out sites in the Gulf Islands at the Belle Chain and Sand Heads. Sea lion occasionally may use navigation buoys in the San Juan Islands and elsewhere in Puget Sound. Breeding habitat does not occur in the study area; however, haul-out sites are near the study area. Therefore, Steller sea lions may be swimming or feeding in the study area.

2.2.3.2 California Sea Lion

The California sea lion occurs seasonally in Washington waters (NMFS 1992). The total population is estimated at 296,750 sea lions and growing at 5.4 percent per year (Carretta et al. 2013). Of this total, an estimated 3,000 to 5,000 occur in Washington State and British Columbia (Jeffries et al. 2000). Males migrate northward along the coast following the summer breeding season in California. Beginning in August, California sea lions appear along the outer Washington coast, and some move into Puget Sound and into British Columbia. California sea lions remain in Washington waters through winter and early spring before returning to California in May and June. The migration can be characterized as a feeding migration, consisting primarily of adult and sub-adult males. California sea lion females and younger animals less than 4 to 5 years old tend to remain near their home rookeries throughout the year, or move only as far north as central California. Their main diet includes anchovies, sardine, whiting, mackerel, rockfish, and market squid (NMML 2013a).

Within the study area, California sea lions are most common off the coast and in the western extreme of the Strait of Juan de Fuca (Jeffries et al. 2000). The main haul-out sites off the coast are Carroll Island, Bodelteh Island, Cape Alava, and Tatoosh Island. As many as 4,000 to 5,000 California sea lions have been observed on the Bodelteh Islands during fall. Farther south on Carroll Island, 200 to 300 sea lions may haul out during the migration peak. Along the western Strait of Juan de Fuca, sea lions haul out at Waadah Island and Sombrio Point. There are no known sea lion haul-out sites in the eastern Strait of Juan de Fuca. Small numbers of sea lions haul out on navigation buoys in the San Juan Islands and adjoining San Juan Channel and Haro and Rosario Straits. The primary haul-out sites in British Columbia are at

Race Rock and Trial Island off Victoria, and during spring at the Belle Chain off Saturna Island and at Sand Head off the Frazer River. Male California sea lions are expected to occur in the study area.

2.2.3.3 Northern Elephant Seal

Northern elephant seals, estimated to number 124,000 animals, breed off Mexico and California during winter, and move northward to feed from Baja California to northern Vancouver Island and far offshore of the Gulf of Alaska and Aleutian Islands (Carretta et al. 2013). Solitary seals are occasionally recorded in the inland waters of Washington. A few individuals, some with pups, occasionally have been seen on the beaches at Destruction, Protection, and Smith/Minor Islands. Brueggeman et al. (1992) encountered elephant seals off the Washington coast primarily during summer and early fall, but none in spring. Most of the elephant seals they encountered were over the continental shelf and slope, at a mean distance of almost 64 km (40 mi) from the coast. Elephant seals prey on deep water and bottom-dwelling organisms, including fish, squid, crab, and octopus (NMML 2013b). No haul-out sites occur along the Washington coast or in the Strait of Juan de Fuca (Jeffries et al. 2000); however, northern elephant seals occasionally have been sited and may occur in the study area.

2.2.3.4 Northern Fur Seal

The Eastern Pacific stock of the northern fur seal, estimated to number 611,617,935 animals, is a seasonal migrant off the Washington coast (Angliss and Outlaw 2008; Carretta et al. 2013). The species does not breed in Washington; the closest rookeries are in the Bering Sea and the Channel Islands of California. During the breeding season in summer months, most of the population is found on the Pribilof Islands in the southern Bering Sea. Females and juveniles of both sexes migrate south into waters over the continental shelf and slope of the eastern North Pacific Ocean, while adult males stay in Alaska waters. The migration ranges as far south as 30 to 32 degrees north latitude off southern California and northern Baja, Mexico. Fur seals begin their return migration northward in mid-spring; by early summer, most have returned to their breeding islands. They feed on pollock, herring, capelin, squid, and small schooling fishes (ADFG 2008b).

In Washington, Brueggeman et al. (1992) reported that northern fur seals primarily inhabited the deep offshore waters, but they also use shelf and slope waters. They have been observed off the Washington coast year-round, but most (more than 90 percent) have been encountered from January through May. Sightings of northern fur seals in the Strait of Juan de Fuca or Puget Sound are rare but do occasionally occur (Gearin and Scordino 1995). Northern fur seals may occur in the study area.

3. MARINE TURTLES

Sea turtles are highly adapted for life in the marine environment with the aid of powerful, modified forelimbs that allow continuous swimming for extended periods of time. Sea turtles are among the longest and deepest diving of the air-breathing marine vertebrates, with some species spending as little as 3 to 6 percent of their time at the water's surface. Sea turtles often travel thousands of miles between their nesting beaches and feeding grounds. The only species of marine turtle with the potential to occur in the study area is the leatherback. A general overview of leatherbacks in the study area is provided below; a more thorough discussion of their life history and listing status is provided in the draft Biological Evaluation (Appendix G).

3.1 Leatherback Turtle (Endangered)

The leatherback turtle is the only extant member of the taxonomic family Dermochelyidae, distinguishable by their unique slightly flexible, leathery, barrel-shaped carapace (top shell). Other sea turtle species have bony, plated carapaces and belong to the Cheloniidae family. Leatherbacks subsist almost entirely on jellyfish but also have been known to opportunistically forage on other gelatinous organisms and small invertebrates. They generally consume from 20 to 30 percent of their body weight daily to gain their required nutritional value (Eckert et al. 2012).

Leatherback turtles regularly occur off the coast of Washington, especially off the mouth of the Columbia River during summer and fall, when large aggregations of jellyfish form (WDFW 2012). Observations, telemetry data, and gillnet captures of leatherbacks off the Washington coast identified turtles south of Cape Flattery and in deeper offshore water (WDFW 2012). Leatherback turtles could occur in the study area; however, occurrences are not expected to be common. Critical habitat for leatherback turtle has been designated at the western extent of the study area in the vicinity of "J" Buoy (77 FR 4170) and does not extend into the Strait of Juan de Fuca or Puget Sound.

4. BIRDS

4.1 Protected Species

This section identifies federally and state-listed bird species with the potential to occur in the study area. A more through discussion of the life history and listing status of the federally listed marbled murrelet is provided in the draft Biological Evaluation (Appendix G).

4.1.1 Federally Listed Species

4.1.1.1 Marbled Murrelet (Threatened)

There are six marbled murrelet conservation zones (WDFW 2014), one of which occurs in the study area. Zone 1 includes the Strait of Juan de Fuca, Hood Canal, and the San Juan Islands; it is monitored by the Pacific Northwest Research Station and the U.S. Department of Agriculture Forest Service. The most recent murrelet population estimate for Zone 1 is 4,393 birds, with the majority occurring around the southern end of the San Juan Islands and along the northern coast of the Olympic Peninsula (WDFW 2014). Primary fish prey of marbled murrelets includes Pacific sand lance, Pacific herring, northern anchovy, and smelts. Documented smelt and sand lance spawning locations occur throughout the Strait of Juan de Fuca and in the vicinity of the BP Cherry Point dock. Herring and smelt spawning occurs along the shoreline from Blaine, Washington south to Bellingham, and the BP Cherry Point dock falls within this area (WDFW 2014). Sand lance spawning occurs within the study area but has not been documented near the dock (WDFW 2014). While the presence of forage fish suggests that marbled murrelets may feed within the study area, nesting habitat is limited by a lack of the required old-growth forests. It is possible that marbled murrelets could be present within the study area, but only for foraging.

4.1.2 State-Listed Species

4.1.2.1 Brown Pelican (Endangered)

The brown pelican is a coastal bird that is rarely found away from the sea. Brown pelicans occur in substantial numbers (7,000 to 10,000) in Washington’s outer coastal waters from late April through October (Wahl 2005 as cited in WDFW 2012), with small numbers occurring in the Strait of Juan de Fuca and Puget Sound (WDFW 2012). Brown pelicans feed primarily on schooling marine forage fish that can be found in the study area. The Puget Sound Seabird Survey indicates that this species has been sighted at Cape Flattery; no other occurrences within the study area have been recorded (BirdWeb 2014). Brown pelicans could occur at the western extent of the study area from April through October. Additional information on the distribution and habitat use of seabirds is provided in Section 4.3.

4.1.2.2 Streaked Horned Lark (Endangered)

The streaked horned lark historically bred in prairie and open coastal habitats in the Puget trough and Willamette Valley; recent surveys indicate that larks no longer breed in the northern Puget trough (San Juan Islands and coastal areas north of Tacoma), nor do they winter in the area (Pearson and Altman 2005; BirdWeb 2014). Therefore, it is highly unlikely that streaked horned lark would occur in the study area.

4.1.2.3 Common Loon (Sensitive)

Historical and current population levels of the common loon in Washington are not well known. It is a rare breeder and a common migrant and wintering species in the state (Richardson et al. 2000). Common loons typically breed on forest lakes with deep inlets or bays and on numerous islands. Historical breeding records (pre-1950) indicate that common loons had previously used habitat in the San Juan Islands, while more recent surveys (1979–1999) indicate that loons are no longer present (Richardson et al. 2000). Common loons use protected marine waters in Washington during migration and for winter habitat. Christmas bird counts report their highest numbers for protected marine waters, such as Sequim-Dungeness, Port Townsend, San Juan Islands, and Padilla Bay (Richardson et al. 2000). The Puget Sound Seabird Survey indicates that the species occurs along the Olympic Peninsula and north though Rosario Strait to Anacortes (BirdWeb 2014). Wintering common loons are expected to occur in the study area. Additional information on the distribution and habitat use of seabirds is provided in Section 4.3.

4.1.2.4 Bald Eagle (Sensitive)

Bald eagles can be found in the forested parts of Washington year-round but are most abundant in the cooler, maritime region west of the Cascade Mountains; their nests are most numerous near marine shorelines (Stinson et al. 2007). Their winter distribution is similar to the breeding distribution but is more concentrated at salmon spawning streams and waterfowl wintering areas. Bald eagle surveys (2005) indicate that the species nest along the Washington shoreline and in the San Juan Islands. Bald eagles are expected to occur in the study area. Additional information on the distribution and habitat use of raptors is provided in Section 4.4.

4.1.2.5 Peregrine Falcon (Sensitive)

In Washington, peregrine falcons can be found nesting from the cooler, maritime region west of the Cascade Mountains to the more arid, dry climate of eastern Washington. The greatest number of breeding sites occurs in the San Juan Islands and lowlands of northern Puget Sound, within approximately 61 meters (200 feet) of freshwater (Hayes and Buchanan 2002). In these regions, peregrines nest on islands, “sea stacks,” or shoreline cliffs. Western Washington is noted for its high density of wintering peregrines due to the mild maritime climate and high prey density. Habitats used by peregrines during the non-breeding season include beaches, tidal flats, islands, and marshes that support high densities of shorebirds, waterfowl, and other small- to medium-sized birds. Wintering areas in the study area include Puget Sound estuaries and Willapa Bay (Hayes and Buchanan 2002). Peregrine falcons are expected to occur in the study area. Additional information on the distribution and habitat use of raptors is provided in Section 4.4.

4.1.2.6 Tufted Puffin (Candidate)

Tufted puffin populations have declined significantly in Washington waters during the 1980s and 1990s, including the Strait of Juan de Fuca, Puget Sound, and Strait of Georgia (WDFW 2012). Surveys conducted during the 2007–2008 breeding season indicate that approximately 50 percent of historically occupied breeding sites in Washington were active (WDFW 2012). Colony occupation within the study area has been recorded on Smith and Protection Islands (WDFW 2012); therefore, it is possible that tufted puffins could occur in the study area. Additional information on the distribution and habitat use of seabirds is provided in Section 4.3.

4.1.2.7 Western Grebe (Candidate)

In summer, the western grebe is found on inland freshwater lakes and marshes in eastern Washington, which is outside the study area. During fall (October), the western grebe moves to the Pacific coast and occupies nearshore marine waters during winter months (WDFW 2012). The Puget Sound Seabird Survey indicates that this species occurs along the Olympic Peninsula and north though Rosario Strait to Anacortes (BirdWeb 2014). The western grebe is expected to use habitat in the study area for wintering and foraging; it would not be present in the study area during the breeding season. Additional information on the distribution and habitat use of seabirds is provided in Section 4.3.

4.1.2.8 Brandt's Cormorant (Candidate)

The Brandt's cormorant inhabits marine environments along the Pacific coast and can be found along rocky shorelines and the open ocean. They are mostly permanent residents, with some local movement (BirdWeb 2014). The Puget Sound Seabird Survey indicates that Brandt's cormorants occur west of Port Angeles along the Olympic Peninsula, with the highest concentrations recorded at the mouth of the Strait of Juan de Fuca (BirdWeb 2014). Brandt's cormorant are expected to occur in the study area. Additional information on the distribution and habitat use of seabirds is provided in Section 4.3.

4.1.2.9 Common Murre (Candidate)

Common murre typically nest on wide, open ledges on rocky cliffs. Most colonies are located on sea stacks and flat-topped islands that are partially vegetated or bare. They spend most of their time in the open ocean and large bays; they are found closer to rocky shorelines during the breeding season and farther offshore during the non-breeding season (BirdWeb 2014). The Puget Sound Seabird Survey indicates that the species occurs along the Olympic Peninsula and north though Rosario Strait to Anacortes, with the highest concentration occurring at the mouth of the Strait of Juan de Fuca (BirdWeb 2014). Common murre are expected to occur in the study area. Additional information on the distribution and habitat use of seabirds is provided in Section 4.3.

4.1.2.10 Cassin's Auklet (Candidate)

Cassin's auklet is a non-migratory bird that comes inland during the breeding season and nests on islands with shrubby habitat and cliffs. A breeding pair builds a burrow and uses it year after year (BirdWeb 2014). During the non-breeding season, auklets are found in the open ocean, at the outer edge of the continental shelf. The Puget Sound Seabird Survey indicates the species occurs in southern Puget Sound during the breeding season. No birds have been observed in the study area. Therefore, this species is not expected to occur in the study area. Additional information on the distribution and habitat use of seabirds is provided in Section 4.3.

4.1.2.11 Purple Martin (Candidate)

The purple martin is a long-distance migrant that can be found from mid-April to late-August in localized areas of open land near water in Washington. Purple martins have been observed in Island, King, and Kitsap Counties (BirdWeb 2014); therefore, the species could occur within the study area from April through August. Additional information on the distribution and habitat use and distribution of "other coastal birds" is provided in Section 4.6.

4.2 Waterfowl

Waterfowl are medium to large plump-bodied birds with long necks and short wings commonly found on or near water. Waterfowl feed while on the water by diving or tilting their bodies so that their heads and necks are submerged to search for fish, plants, and invertebrates. Waterfowl typically have large clutches with precocial young that can swim and eat on their own almost immediately after hatching. Twenty-eight species of waterfowl, four goose species, two swan species, six dabbling duck species, and sixteen diving duck species frequent the study area (Table 1).

Table 1. Occurrence by Month in the Puget Trough Ecoregion for Waterfowl That Commonly Use Coastal Habitats in the Study Area

	Occurrence by Month[a]											
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Geese												
Snow goose	C	C	C	C	U				R	C	C	C
Brant	C	F	F	C	U	R	R	R	R	F	C	C
Canada goose	C	C	C	C	C	C	C	C	C	C	C	C
Swans												
Trumpeter swan	C	C	F	U						R	C	C
Tundra swan	C	C	C	U						U	C	C
Dabbling Ducks												
Gadwall	C	C	C	C	C	C	C	C	C	C	C	C
American wigeon	C	C	C	C	U	R	R	U	C	C	C	C
Mallard	C	C	C	C	C	C	C	C	C	C	C	C
Northern pintail	C	C	C	C	U	R	R	U	C	C	C	C
Green-winged teal	C	C	C	C	F	R	R	F	C	C	C	C
Diving Ducks												
Pochards												
Canvasback	F	F	U	U	R				R	U	C	F
Greater scaup	C	C	C	F	F	-	-	-	U	F	C	C
Lesser scaup	C	C	C	C	U	U	U	U	U	F	C	C
Sea Ducks												
Harlequin duck	F	F	F	U	U	U	F	F	F	F	F	F
Surf scoter	C	C	C	C	C	F	F	F	F	C	C	C
White-winged scoter	C	C	C	C	C	F	U	U	F	F	C	C
Long-tailed duck	C	C	C	U	U	-	-	-	-	F	C	C
Bufflehead	C	C	C	C	C	R	R	R	U	C	C	C
Common goldeneye	C	C	C	F	U	-	-	R	R	U	C	C
Barrow’s goldeneye	C	C	C	C	R	R	R	R	R	U	C	C
Mergansers												
Common merganser	C	C	C	C	C	C	C	C	C	C	C	C
Red-breasted merganser	C	C	C	C	U	R	R	R	U	F	C	C
Ruddy duck	C	C	C	C	F	U	U	U	U	F	C	C

[a] Occurrence:
C = Common; F = Fairly Common; U = Uncommon; R = Rare; I = Irregular (Seattle Audubon Society 2008).

Sources: Seattle Audubon Society 2008; Wahl et al. 2005.

4.2.1 Geographic Distribution

Most waterfowl are migrants or winter visitors. Non-breeding individuals, including sub-adult birds, may remain in the study area year-round; and some waterfowl may breed in the study area.

4.2.2 Seasonal Distribution in Study Area

The most commonly occurring waterfowl, their group associations, and seasonal occurrence in the study area are listed in Table 1.

Four waterfowl species are common year-round: Canada goose, gadwall, mallard, and common merganser.

4.2.3 Uses, Status and Trends, and Regulatory Issues

All waterfowl are protected by the Migratory Bird Treaty Act (MBTA), and all waterfowl species occurring in the study area are harvested by sportsmen in Washington (USFWS 2007a). The most commonly harvested species (more than 10,000/year) include Canada goose, snow goose, mallard, wigeon, green-winged teal, and northern pintail (USFWS 2007a).

Breeding waterfowl population status and trends are reported from USFWS (2007b) and Wilkins et al. (2007). Snow geese occurring within the Pacific Flyway nest in the western and central Arctic and on Wrangel Island. These populations have increased 10 percent per year over the last 10 years; the U.S. population in 2007 was 734,000 birds. Brant geese occurring within the Pacific Flyway nest in the western and central Arctic United States and in the western high arctic in the Canadian Northwest Territories. These populations have shown no annual trend over the past 10 years; the total population estimate was 140,000 in 2007.

Four populations of Canada geese migrate through or winter in the study area, and resident Canada geese also occur in the study area. Ten-year population trends and 2007 estimated populations for the four migratory populations are: dusky Canada geese – no trend, 10,000 birds; cackling Canada geese – no trend, 173,000 birds; lesser and Taverner's Canada geese – 4 percent annual decline, 74,000 birds; Aleutian Canada geese – 10 percent annual increase, 119,000 birds. Western tundra swans have increased an average of 2 percent per year over the past 10 years; the estimated population in 2007 was 109,000 birds.

Most dabbling and diving ducks that migrate through or winter in the study area originate from nesting areas along the Pacific Flyway in Alaska, British Columbia, Yukon Territory, and western Alberta; breeding population estimates and trends from these regions are reported in Table 2 (USFWS 2007b; Wilkins et al. 2007).

Dabbling ducks generally feed on or near the water's surface in bays and estuaries, although the American wigeon, mallard, and northern pintail also use nearshore habitats. Dabbling ducks are considered to be primarily herbivorous, but they consume a greater variety of foods than geese and swans, including gastropods, bivalves, and other invertebrates from coastal marshes and shallow waters along shorelines (Verbeck and Butler 1989). Ruddy ducks are considered diving ducks, but they are more similar to dabbling ducks in their diet than most diving ducks. In addition to the food sources described for dabbling ducks, ruddy ducks include bivalves in their winter diets (NatureServe 2013).

Table 2. Breeding Population Estimates and Trends for Ducks That Migrate Through or Winter in the Study Area

Species (Status)	Regional Population Estimate and Long-Term Average (in thousands)			
	Alaska-Yukon Territory – Old Crow Flats		Alberta – Northeast British Columbia – Northwest Territories	
	2007 Estimate	Ten-Year Average	2007 Estimate	Ten-Year Average
Dabbling Ducks				
Gadwall	3	2	100	49
American wigeon	1,113	517	843	906
Mallard	581	360	887	1,075
Northern pintail	1,135	915	234	374
Green-winged teal	823	366	862	752
Diving Ducks				
Pochards				
Canvasback	92	91	139	73
Scaup	1,191	914	1,261	2,599
Sea Ducks				
Harlequin duck (unknown/stable)	--	--	--	--
Scoters (declining)	396	333	516	518
Long-tailed duck (declining/stable)	128	86	29	81
Bufflehead (stable/increasing)	61	45	359	338
Goldeneyes (stable/declining)	38	79	182	50
Mergansers (variable/declining)	36	25	92	78
Ruddy duck	0	0	4	28

Sources: USFWS 2007b; Mallek and Groves 2007; Ferguson and Benning 2007; Sea Duck Joint Venture 2003.

Harlequin ducks wintering in the study area also are known to nest along headwater streams in the Rocky Mountains. Summer and winter waterfowl distribution and abundance were monitored during 1992–1999 on marine waters in the study area and compared to previous results from surveys during the late 1970s (Table 3). In general, diving duck abundance has been in decline during the last decade.

4.2.4 Habitat Use by Life History Stages

Specific shoreline habitats used by waterfowl that commonly occur in the study area are indicated in Table 4. Geese and swans are primarily herbivorous and use bays and estuaries for feeding, especially during migration. Snow geese obtain most of their food by grubbing for rhizomes of bulrushes in tidal marshes, while swans feed on eelgrass leaves and rhizomes of bulrush along with grasses and sedges (Verbeck and Butler 1989).

Table 3. Summer and Winter Waterfowl Counts, Density, and Winter Trends in Puget Sound, Washington

Species	Abundance by Season					
	Summer Count (1992–1999)	Summer Density[a] (1992–1999)	Winter Count (1992–1999)	Winter Density[a] (1992–1999)	Historical Winter Density[a] (1978–1979)	Winter Trend
Geese	-	-	2,000	-	-	-
Snow goose	-	-	-	-	-	-
Brant	-	-	-	2.0	5.9	-66%
Canada goose	800	0.9	-	-	-	+ 9,000%
Swans (2 spp.)	-	-	160	-	-	-
Dabbling Ducks	600	0.7	80,000	60.7	-	-
Gadwall	-	-	160	0.1	-	-
American wigeon	-	-	43,000	32.2	-	-
Mallard	-	-	31,000	23.8	-	-
Northern pintail	-	-	4,000	3.3	-	+ 95%
Green-winged teal	-	-	1,400	1.1	-	-
Diving Ducks	-	-	72,000	45.0	-	-
Pochards	-	-	-	-	-	-
Canvasback	-	-	375	-	-	-
Greater scaup (2 spp.)	60	<0.1	5,700	7.6	27.3	-72%
Sea ducks	-	-	-	-	-	-
Harlequin duck	600	0.7	860	12.5	4.3	189%
Scoter (3 spp.)	3,300	3.8	26,500	32.0	74.6	-57%
Long-tailed duck	-	-	761	1.2	13.8	-91%
Bufflehead	-	-	16,800	59.8	49.8	20%
Goldeneye (2 spp.)	60	<0.1	11,900	14.1	18.3	-23%
Mergansers	-	-	4,500	12.4	8.0	55%
Common merganser	260	0.3	480	-	-	-
Red-breasted merganser	-	-	950	-	-	-
Ruddy duck	-	-	1,800	-	-	-

spp = species

[a] Density: Number of birds per square kilometer.

Source: Nysewander et al. 2005.

Table 4. Shoreline Habitats and Their Use by Waterfowl That Commonly Occur in the Study Area

Species	Habitats[a]											
	Eelgrass Beds	Kelp Beds	Rocky Shores	Unconsolidated Shores	Mudflats and Sandflats	Rocky Subtidal	Unconsolidated Subtidal	Estuaries	Salt Marsh	Nearshore Riparian	Backshore Spray	Cherry Point[b]
Geese												
Snow goose	F	-	-	-	F	-	-	F/O	F/O	F	-	-
Brant	F	F	F	F	F	F	F	F	F	F	-	-
Canada goose	F	-	-	-	F	-	-	F	F	F	-	-
Swans												
Trumpeter swan	F	-	-	-	F	-	-	F	F	F	-	-
Tundra swan	F	-	-	-	F	-	-	F	F	F	-	-
Dabbling Ducks												
Gadwall	F	-	-	-	F	-	-	F	F	F	-	-
American wigeon	F	F	F	F	F	F	F	F	F	F	-	-
Mallard	F	F	F	F	F	F	F	F	F	F	-	-
Northern pintail	F	F	F	F	F	F	F	F	F	F	-	-
Green-winged teal	F	-	-	-	F	-	-	F	F	F	-	-
Diving Ducks												
Pochards												
Canvasback	F	F	F	F	F	F	F	F	F	F	-	-
Greater scaup	F	F	F	F	F	F	F	F	F	F	-	-
Lesser scaup	F	F	F	F	F	F	F	F	F	F	-	W
Sea Ducks												
Harlequin duck	F	-	-	-	F	-	-	F	F	F	-	R
Surf scoter	F	F	F	F	F	F	F	F	F	F	-	W
White-winged scoter	F	F	F	F	F	F	F	F	F	F	-	W
Long-tailed duck	-	F	F	F		F	F	-	-	-	-	W
Bufflehead	F	F	F	F	F	F	F	F	F	F	-	-
Common goldeneye	F	F	F	F	F	F	F	F	F	F	-	W
Barrow's goldeneye	F	F	F	F	F	F	F	F	F	F	-	-
Mergansers												
Common merganser	F	-	-	-	F	-	-	F	F	F	-	-
Red-breasted merganser	F	F	F	F	F	F	F	F	F	F	-	W
Ruddy duck	F	-	-		F	-	-	F	F	F	-	-

[a] Habitat use: B = Feeds and Reproduces; F = Feeds; R = Reproduces; O = Other (Wahl et al. 2005). For cross reference between the listed specific habitats, those described in the text, and those listed in Wahl et al. (2005); eelgrass beds, mudflats and sandflats, estuaries, salt marsh and nearshore riparian are considered primarily bay and estuary habitats (light gray headings in table); kelp beds, rocky shores, unconsolidated shores, rocky subtidal, unconsolidated subtidal, and backshore spray are considered primarily marine nearshore (dark gray headings in table) but also occur in coastal dune and beaches habitats or headland and islet habitats.

[b] Cherry Point habitat use: W = winter, R = Resident, S = summer.

Sources: Wahl et al. 2005; Bower et al. 2008.

Diving ducks are a diverse group that includes pochards, sea ducks, and mergansers. Diving ducks generally dive completely beneath the water's surface during feeding. Diving ducks are diverse in their foraging habits. All diving ducks that occur in the study area, except the long-tailed duck, use bays and estuaries; 11 of 16 species use nearshore habitats; and 6 of 16 species also use inland marine deep water habitats for feeding (Wahl et al. 2005). The bufflehead, goldeneye, and scaup are found primarily in bays where they feed on bivalves, crabs, barnacles, shrimp and other invertebrates, herring eggs, and some fish, in addition to algae and vascular plants. Scoters feed primarily on bivalves; black and surf scoters feed more on blue mussels while white-winged scoters feed more on clams. All scoters also feed on snails, crabs, shrimp and other invertebrates, and herring spawn (Vermeer and Ydenberg 1989). Surf scoters feed opportunistically on herring spawn during March, gathering in the tens of thousands at spawning areas (Vermeer and Ydenberg 1989). Long-tailed ducks feed on bivalves and snails during summer; bivalves, shrimp, isopods, amphipods, and crabs during winter; and herring eggs in spring (Vermeer and Ydenberg 1989). Harlequin ducks have a very diverse diet dominated by snails, limpets, fish and fish eggs, crabs, chiton, algae, bivalves, and crustaceans. Blue mussels are the only bivalve known to be consumed by harlequin ducks (Vermeer and Ydenberg 1989). Mergansers are primarily fish-eating ducks that consume sculpins, herring, rockfish, shiner perch, pipefish, blennies, and salmon, in addition to some shrimp and crabs (Vermeer and Ydenberg 1989).

4.3 Seabirds

Seabirds include a diverse assemblage of birds that are tied to marine habitats for at least a portion of their life cycle. Loons, grebes, cormorants, auks, and puffins feed by diving deeply for fish or invertebrates, while gulls and terns feed near the water surface or shoreline. Albatrosses, shearwaters, and petrels spend much of their life at sea; feeding from the water’s surface and coming to land only to nest.

4.3.1 Geographic Distribution

Seabirds occurring in the study area generally belong to species that are widely distributed throughout the Pacific coast from Alaska to California. Loons and grebes are generally migrants or winter visitors, as are some of the arctic breeding gull and tern species. Cormorant, ring-billed gull, glaucous-winged gull, common murre, and pigeon guillemot are common year-round resident seabirds. Caspian tern and rhinoceros auklet move into the study area during spring and summer to nest and to rear their young.

4.3.2 Seasonal Distribution in Study Area

Of the 41 species of seabirds potentially occurring in the study area, 18 are commonly found during 3 or more months of the year (Table 5). Seabirds dominate the birds occurring in the study area during summer months while they account for less than a quarter of all birds recorded during winter (Nysewander et al. 2005). Table 5 shows occurrence by month in the Puget Trough ecoregion for seabirds that commonly use coastal habitats in the study area.

Major seabird nesting colonies in the study area occur at Protection Island, at islets within the San Juan Islands, and off Cape Flattery (Figure 3).

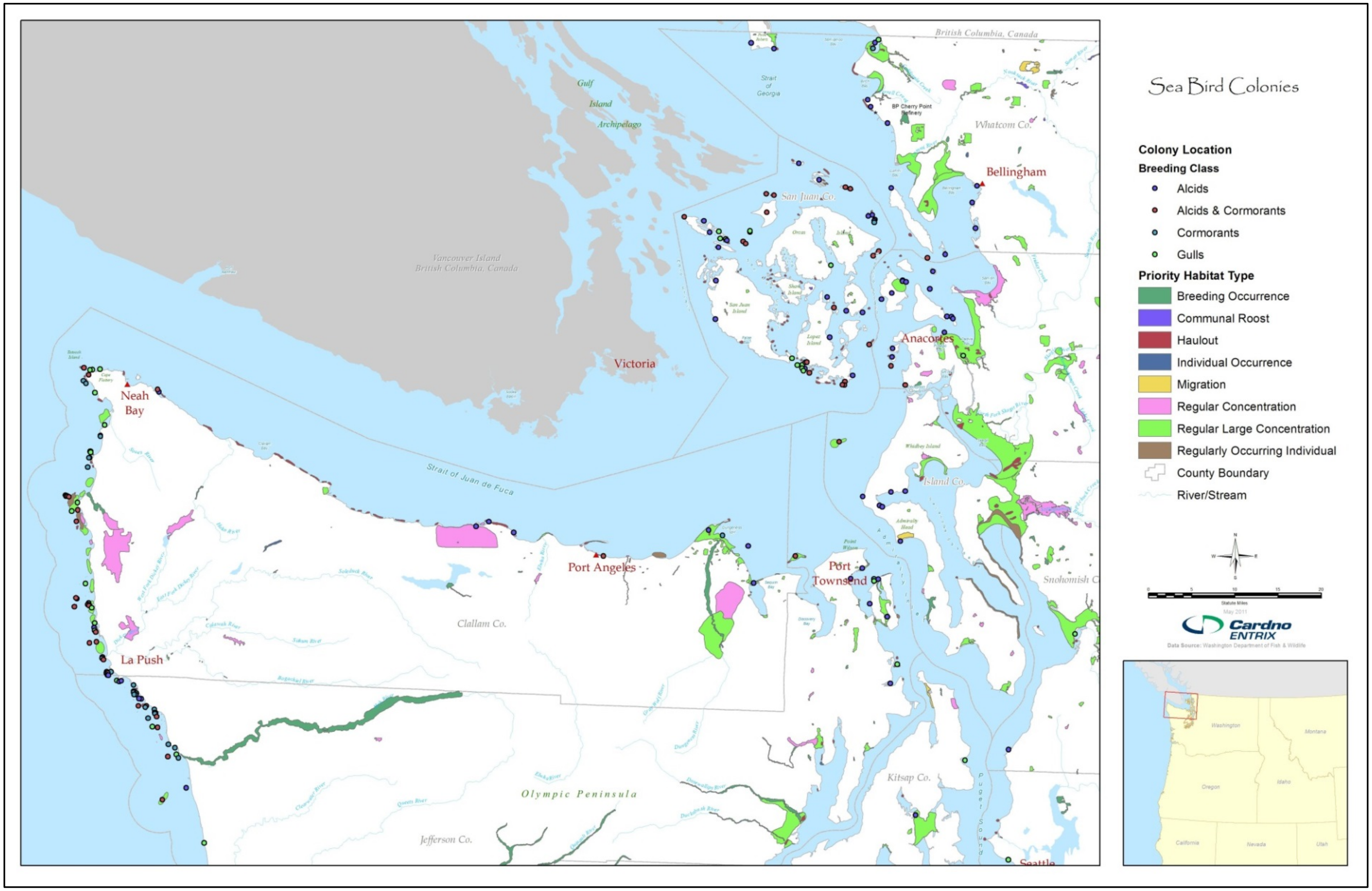

Figure 3. Species and Recent Relative Abundance of Seabird Nesting Colonies in the Study Area

Table 5. Occurrence by Month in the Puget Trough Ecoregion for Seabirds That Commonly Use Coastal Habitats in the Study Area

Species	Occurrence by Month[a]											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Loons												
Red-throated loon	C	C	C	C	F	R	R	R	C	C	C	C
Pacific loon	C	C	C	C	C	R	R	R	F	C	C	C
Common loon	C	C	C	C	C	F	F	F	C	C	C	C
Grebes												
Horned grebe	C	C	C	C	R	-	-	R	F	C	C	C
Red-necked grebe	C	C	C	F	U	-	R	F	F	C	C	C
Western grebe	C	C	C	C	U	R	U	U	F	C	C	C
Cormorants												
Brandt's cormorant	C	C	C	C	C	C	C	C	C	C	C	C
Double-crested cormorant	C	C	C	C	C	C	C	C	C	C	C	C
Pelagic cormorant	C	C	C	C	C	C	C	C	C	C	C	C
Gulls and Terns												
Bonaparte's gull	C	C	C	C	F	-	R	F	C	C	C	C
Heermann's gull	R	-	-	-	-	-	U	F	F	F	U	R
Mew gull	C	C	C	C	U	-	R	U	C	C	C	C
Ring-billed gull	C	C	C	C	C	C	C	C	C	C	C	C
California gull	R	R	R	U	U	F	C	C	C	C	F	R
Glaucous-winged gull	C	C	C	C	C	C	C	C	C	C	C	C
Caspian tern	-	-	R	C	C	C	C	C	F	R	-	-
Auks and Puffins												
Common murre	C	C	C	C	C	C	C	C	C	C	C	C
Pigeon guillemot	C	C	C	C	C	C	C	C	C	C	C	C
Rhinoceros auklet	F	F	F	C	C	C	C	C	F	F	F	F

[a] Occurrence:
C = Common; F = Fairly Common; U = Uncommon; R = Rare; I = Irregular (Seattle Audubon Society 2008)

Sources: Seattle Audubon Society 2008; Wahl et al. 2005.

4.3.3 Uses, Status and Trends, and Regulatory Issues

All seabirds are protected by the MBTA. Few seabirds are harvested for food, although historically seabird nesting colonies provided a subsistence food source for humans. Some seabirds such as pelicans, gulls, cormorants, and loons may be considered nuisance species as they are attracted to aquaculture facilities, fisheries processing plants, fishing vessels, and solid waste facilities where they opportunistically forage on wastes. Caspian terns and brown pelicans in particular have been identified as a major threat to the recovery of Pacific salmon stocks, as they forage heavily on salmon smolts emigrating to estuaries where these birds nest or aggregate. In general, loon and grebe populations may be declining, while most gull, tern, and pelican populations are considered to be increasing. Cormorant populations may have variable trends depending on the species; and murre, guillemot, and auklet populations are considered to be declining. Table 6 includes summer and winter seabird counts, density, and trends in Puget Sound. Figure 3 shows species and recent relative abundance of seabird nesting colonies in the study area.

Table 6. Summer and Winter Seabird Counts, Density, and Trends in Puget Sound, Washington

Species	Abundance by Season[a]					
	Summer Count (1992–1999)	Summer Density[a] (1992–1999)	Winter Count (1992–1999)	Winter Density[a] (1992–1999)	Historical Winter Density[a] (1978–1979)	Winter Trend
Loons	-	-	2,300	1.7	8.0	-79%
Red-throated loon	√	-	620	-	-	-72%
Pacific loon	√	-	700	-	-	-55%
Common loon	√	Most abundant	370	0.8	2.3	-64%
Grebes	-	-	24,900	-	-	-
Horned grebe	-	-	660	1.8	10.1	-82%
Red-necked grebe	-	-	500	0.5	4.3	-89%
Western grebe	-	-	21,300	1.1	22.2	-95%
Cormorants	2,000	2.7	-	8.3	17.6	-53%
Brandt's cormorant	350	0.5	-			
Double-crested cormorant	1,100	1.5	-	1.9	5.0	-62%
Pelagic cormorant	500	0.7	-			+95%
Gulls and terns	41,600	59.4	-	75.7	133.9	-43%
Bonaparte's gull	2,300	3.3	-	-	-	-
Heermann's gull	1,500	2.1	-	-	-	-
Mew gull			-	-	-	-
Ring-billed/California gull	1,000	1.4	-	-	-	-
Glaucous-winged gull	9,800	13.9	-	-	-	-
Caspian tern	1,000		-	-	-	+40,000%
Auks and puffins	4,200	5.9	-	-	-	-
Common murre	1,300	1.8	-	-	-	-93%
Pigeon guillemot	1,200	1.7	-	0.7	1.5	-55%
Rhinoceros auklet	1,500	2.1	-	-	-	-

[a] Density: Number of birds per square kilometer

Source: Nysewander et al. 2005.

4.3.4 Habitat Use by Life History Stages

Shoreline habitats used by commonly occurring seabirds in the study area are indicated in Table 7. Loons and grebes occur in bays and estuaries (8 of 9 species), nearshore marine (7 of 9 species), and inland marine habitats (6 of 9 species) (Wahl et al. 2005). They feed on fish and aquatic insects; both loons and grebes primarily nest on freshwaters and winter on saltwater. Wintering loon diets are probably dominated by fish including herring shiner perch, smelt, and sand lance, although common loons also forage on invertebrates (Vermeer and Ydenberg 1989). Wintering grebes forage on herring and herring eggs, shrimp, and other invertebrates (Vermeer and Ydenberg 1989).

Cormorants occur in bays and estuaries (3 of 3 species), nearshore marine (3 of 3 species), and headlands and islets (3 of 3 species) (Wahl et al. 2005). Cormorants feed on herring, shiner perch, gobies, rockfish, anchovy, plainfin midshipman, saury, sanddab, sole, shrimp, and squid (Vermeer and Ydenberg 1989).

Table 7. Shoreline Habitats and Their Use by Seabirds That Commonly Occur in the Study Area

Species	Habitats[a]											
	Eelgrass Beds	Kelp Beds	Rocky Shores	Unconsolidated Shores	Mudflats and Sandflats	Rocky Subtidal	Unconsolidated Subtidal	Estuaries	Salt Marsh	Nearshore Riparian	Backshore Spray	Cherry Point[b]
Loons												
Red-throated loon	F	F	F	F	F	F	F	F	F	F	-	-
Pacific loon	F	F	F	F	F	F	F	F	F	F	-	W
Common loon	F	F	F	F	F	F	F	F	F	F	-	-
Grebes												
Horned grebe	F	F	F	F	F	F	F	F	F	F	-	-
Red-necked grebe	F	F	F	F	F	F	F	F	F	F	-	-
Western grebe	F	F	F	F	F	F	F	F	F	F	-	W
Cormorants												
Brandt's cormorant	F	F	R	F	F	R	F	F	F	F	-	R
Double-crested cormorant	F	F	R	F	F	R	F	F	F	F	-	R
Pelagic cormorant	F	F	R	F	F	R	F	F	F	F	-	R
Gulls and Terns												
Bonaparte's gull	F	F	F	F	F	F	F	F	F	F	F	S
Heermann's gull	F	F	F	F	F	F	F	F	F	F	F	-
Mew gull	F	F	F	F	F	F	F	F	F	F	F	W
Ring-billed gull	F	F	F	F	F	F	F	B	B	B	F	W
California gull	F	F	F	F	F	F	F	F	F	F	F	-
Glaucous-winged gull	F	F	B	F	F	B	B	F	F	F	B	R
Caspian tern	F	F	F	F	F	F	F	F	F	F	F	S
Auks and Puffins												
Common murre	F	F	B	F	F	B	F	F	F	F	-	-
Pigeon guillemot	F	F	B	F	F	B	F	F	F	F	-	-
Rhinoceros auklet	F	F	B	F	F	B	F	F	F	F	-	-

[a] Habitat use: B = Feeds and Reproduces; F = Feeds; R = Reproduces; O = Other (Wahl et al. 2005). For cross reference between the listed specific habitats, those described in the text and those listed in Wahl et al. (2005); eelgrass beds, mudflats and sandflats, estuaries, salt marsh and nearshore riparian are considered primarily bay and estuary habitats (light gray headings); kelp beds, rocky shores, unconsolidated shores, rocky subtidal, unconsolidated subtidal, and backshore spray are considered primarily marine nearshore (dark gray headings) but also occur in coastal dune and beaches habitats or headland and islet habitats.

[b] Cherry Point Habitat Use: W = winter, R = Resident, S = summer.

Sources: Wahl et al. 2005; Bower et al. 2008.

Gulls and terns occur in nearshore marine (18 of 18 species), dunes and beaches (17 of 18 species), bays and estuaries (16 of 18 species), headlands and islets (13 of 18 species), and inland marine habitats (12 of 18 species) (Wahl et al. 2005). The diets of gulls and terns vary with the species but include bivalves, barnacles, mussels, sea urchins, limpets, shrimp, crabs, herring and herring spawn, salmon, blennies, lampreys, and sculpins (Vermeer and Ydenberg 1989).

Auks and puffins are diving birds that spend most of their time at sea, coming to land primarily for nesting. Auks and puffins occur in nearshore marine (7 of 7 species), inland marine (7 of 7 species), headlands and islets (5 of 7 species), and bays and estuary habitats (4 of 7 species) (Wahl et al. 2005). Auks forage primarily on fish and invertebrates including herring, sand lance, shiner perch, smelt, rockfish, sculpins, flatfish, squid, shrimp, and crab; but they may feed their chicks primarily fish and probably feed more on invertebrates during winter (Vermeer and Ydenberg 1989).

4.4 Raptors

For the purposes of this discussion, raptors include vultures, osprey, eagles, harriers, kites, hawks, merlins, falcons, and owls. Hawks, eagles, harriers, and falcons are medium to large birds with upright posture and strong, short, hooked beaks and acute vision that they use to catch live vertebrate prey. Vultures share these characteristics but feed primarily on carcasses of large animals. Ospreys are large diving hawks that subsist on a diet of live fish. Six species of raptors that use shoreline habitats are common or fairly common in the study area. Kites, merlins, and owls do not commonly occur in the study area.

4.4.1 Geographic Distribution

All raptors present in the study area occur throughout North America. Common species are most abundant in the study area either during winter (i.e., northern harrier and rough-legged hawk), nesting (i.e., turkey vulture and osprey), migration (i.e., peregrine falcon), or year-round (i.e., bald eagle). Peregrine falcons also nest in the study area.

4.4.2 Seasonal Distribution in Study Area

The six species of raptors occurring in the study area are common or fairly common during two or more months of the year (Table 8). The bald eagle is the most common raptor and occurs throughout the study area. Bald eagles and osprey nest in large shoreline trees during early spring and summer. The density of wintering bald eagles recorded in the study area during December to February from 1993 to 1999 was 0.6 bald eagle per km^2 (Nysewander et al. 2005). Turkey vultures are most common during spring and fall migrations, when they account for 3 percent of spring migrant raptors (Wahl et al. 2005). Northern harriers are ground-nesting birds and are a fairly common migrant and resident bird within portions of the study area (Wahl et al. 2005). The rough-legged hawk is a fairly common migrant and winter resident within portions of the study area (Wahl et al. 2005). Peregrine falcons may occur year-round in the study area but are most common during fall migrations (Wahl et al. 2005). This species nests on cliffs, bridges, and buildings (Wahl et al. 2005).

4.4.3 Uses, Status and Trends, and Regulatory Issues

All raptors are protected by the MBTA, and the bald eagle also is protected by the Bald and Golden Eagle Protection Act. The bald eagle and peregrine falcon formerly were protected under the ESA. Nearly all species of raptors declined in the 1950s and 1960s due to the use of pesticides that accumulated in predatory birds and resulted in lost or reduced productivity and survival. Since widespread bans on the use of pesticides, nearly all previously reduced raptor populations have increased. Within the study area, commonly occurring raptors, with the possible exception of the rough-legged hawk, are considered to have increased in abundance since the 1950s (Wahl et al. 2005).

Table 8. Occurrence by Month in the Puget Trough Ecoregion for Raptors That Commonly Use Coastal Habitats in the Study Area

Species	Occurrence by Month[a]											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Vultures												
Turkey vulture	-	R	U	F	F	F	F	F	C	F	R	-
Accipiters												
Osprey	-	-	R	F	F	F	F	F	F	U	R	-
Bald eagle	C	C	C	C	C	C	C	F	F	F	C	C
Northern harrier	F	F	F	F	U	U	U	U	F	F	F	F
Buteos												
Rough-legged hawk	F	F	F	U	-	-	-	-	R	U	F	F
Falcons												
Peregrine falcon	U	U	U	U	U	U	U	U	F	F	U	U

[a] Occurrence:
C = Common; F = Fairly Common; U = Uncommon; R = Rare; I = Irregular (Seattle Audubon Society 2008).

Sources: Seattle Audubon Society 2008; Wahl et al. 2005.

4.4.4 Habitat Use by Life History Stages

Shoreline habitats used by raptors in the study area are indicated in Table 9. The six commonly occurring raptors are included because they commonly use marine resources such as fish, marine mammal carcasses, marine waterfowl, and shorebirds using intertidal areas. Raptors occur in coastal dunes and beaches (8 of 10 species), bays and estuary (7 of 10 species), nearshore marine (4 of 10 species), headlands and islets (4 of 10 species), and inland marine habitats (1 of 10 species) (Wahl et al. 2005). Osprey, bald eagle, northern harrier, and peregrine falcon nest in the study area. Osprey nest along shorelines, generally in tall emergent trees, and forage for fish in marine and freshwater habitats. Bald eagles nest near water in large conifers and forage in coastal areas, shifting from marine shorelines to inland rivers when salmon carcasses are abundant (Wahl et al. 2005). Bald eagle forage fishes include rockfish, lingcod, cabezon, arrowtooth flounder, and red Irish lord; forage birds include buffleheads, gulls, scoters, and murres (Verbeck and Butler 1989). Northern harriers nest in marshes and forage in wetlands and tidal flats in the study area (Wahl et al. 2005). The rough-legged hawk forages in estuarine habitats. Peregrine falcons forage and winter on large river deltas, estuaries, and coastal beaches where they feed on shorebirds and waterfowl (Wahl et al. 2005).Turkey vultures forage along shorelines scavenging for dead fish, seals, and other animals (Wahl et al. 2005).

Table 9. Shoreline Habitats and Their Use by Raptors That Commonly Occur in the Study Area

Species	Habitats[a]											
	Eelgrass	Kelp Beds	Rocky Shores	Unconsolidated Shores	Mudflats and Sandflats	Rocky Subtidal	Unconsolidated Subtidal	Estuaries	Salt Marsh	Nearshore Riparian	Backshore Spray	Cherry Point[b]
Vultures												
Turkey vulture	F	-	F	F	F	-	-	F	F	F	-	S
Accipiters												
Osprey	B	F	R	R	B	F	F	B	B	B	B	S
Bald eagle	B	F	B	B	B	F	F	B	B	B	B	R
Northern harrier	F	-	-	B	F	-	-	F	F	F	-	R
Buteos												
Rough-legged hawk	-	-	-	F	-	-	F	-	F	-	-	W
Falcons												
Peregrine falcon	F	-	B	B	F	-	-	F	F	F	-	W

[a] Habitat use: B = Feeds and Reproduces; F = Feeds; R = Reproduces; O = Other (Wahl et al. 2005). For cross reference between the listed specific habitats, those described in the text and those listed in Wahl et al. (2005); eelgrass beds, mudflats and sandflats, estuaries, salt marsh and nearshore riparian are considered primarily bay and estuary habitats (light gray headings); kelp beds, rocky shores, unconsolidated shores, rocky subtidal, unconsolidated subtidal, and backshore spray are considered primarily marine nearshore (dark gray headings) but also occur in coastal dune and beaches habitats or headland and islet habitats.

[b] Cherry Point habitat use: W = winter, R = Resident, S = summer.

Sources: Wahl et al. 2005; Woodcock and Irving 2008.

4.5 Shorebirds

For the purposes of this discussion, shorebirds include plovers, oystercatchers, sandpipers, and phalaropes. Shorebirds are a diverse group of birds associated with shorelines that feed primarily on invertebrates or small aquatic creatures. They generally have longish legs and short to long beaks that they use to probe sand or mud substrates or to pick intertidal invertebrates from rocks. Most species migrate long distances. All but the phalaropes do not generally swim, but walk along shorelines and beaches. Shorebirds are generally long-lived, nest on the ground or on small shrubs, and have precocial young. Fifteen species of shorebirds are common to fairly common in the study area (Table 10). Even though the black oystercatcher is generally considered uncommon throughout its entire range, it is included here because it is considered to be a locally common resident on exposed rocky shorelines of the San Juan Islands and the Strait of Juan de Fuca (Wahl et al. 2005).

4.5.1 Geographic Distribution

Most shorebirds occurring in the study area nest outside of the study area and occur in the study area only during migration between nesting and wintering areas. However, some of the more common shorebird species winter in the study area and the killdeer, black oystercatcher, and spotted sandpiper nest in the study area.

Table 10. Occurrence by Month in the Puget Trough Ecoregion for Shorebirds That Commonly Use Coastal Habitats in the Study Area

	Occurrence by Month[a]											
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Plovers												
Black-bellied plover	F	F	F	F	U	R	R	C	C	F	F	F
Semipalmated plover	-	-	-	U	F	-	F	F	F	R	-	-
Killdeer	C	C	C	C	C	C	C	C	C	C	C	C
Oystercatchers												
Black oystercatcher	U	U	U	U	U	U	U	U	U	U	U	U
Sandpipers												
Spotted sandpiper	R	R	U	U	F	F	F	F	F	U	U	R
Greater yellowlegs	U	U	U	C	F	R	U	C	C	F	F	U
Black turnstone	C	C	C	C	U	-	U	U	F	C	C	C
Surfbird	F	F	F	F	R	-	R	U	U	F	F	F
Sanderling	C	C	C	F	U	-	R	U	C	C	C	C
Western sandpiper	U	U	U	C	C	R	C	C	C	F	U	U
Least sandpiper	U	U	U	C	C	R	C	C	C	U	U	U
Dunlin	C	C	C	C	F	-	R	R	R	C	C	C
Short-billed dowitcher	-	-	-	F	F	R	F	F	U	R	-	-
Long-billed dowitcher	U	U	U	F	F	-	F	F	F	F	F	U
Common snipe	U	U	F	F	U	U	U	U	F	F	F	U
Phalaropes												
Red-necked phalarope	-	-	-	R	F	-	R	C	F	R	-	-

[a] Occurrence: C = Common; F = Fairly Common; U = Uncommon; R = Rare; I = Irregular (Seattle Audubon Society 2008).

Sources: Seattle Audubon Society 2008; Wahl et al. 2005.

4.5.2 Seasonal Distribution in Study Area

The shorebirds present in the study area are common or fairly common during 2 or more months of the year (Table 10). Important shorebird areas in the study area identified in the *Northern Pacific Coast Regional Shorebird Management Plan* (Drut and Buchanan 2000) are listed in Table 11.

Table 11. Important Shorebird Sites in the Study Area That Support at Least 1,000 Shorebirds during Winter, Spring, or Autumn

Site	Estimated Foraging and Roosting Shorebirds Supported
Estuaries	
Baker Bay	~ 1,000
Bellingham Bay	≥ 4,000
Birch Bay	≥ 1,000
Boz Lake	~ 1,000
Chuckanut Bay	≥ 4,000
Crockett Lake	~ 2,000
Cultus Bay	~ 2,000
Deer Lagoon	~ 2,000
Drayton Harbor	≥ 4,000
Dungeness Bay	≥ 4,000
Fidalgo Bay	≥ 4,000
Lummi Bay	≥ 4,000
Padilla Bay	> 20,000
Port Angeles Harbor	~ 2,500
Port Susan	> 20,000
Samish Bay	> 20,000
Sequim Bay	≥ 4,000
Skagit Bay	> 20,000
Rocky Shorelines	
San Juan Islands National Wildlife Refuge	~ 4,000
Strait of Juan de Fuca	~ 4,000
Washington Maritime National Wildlife Refuge	~ 2,000

Source: Drut and Buchanan 2000.

4.5.3 Uses, Status and Trends, and Regulatory Issues

All shorebirds are protected by the MBTA. Except; for the common snipe, shorebirds are not currently harvested in the Pacific Northwest. Historically, shorebirds were harvested, and several species have yet to recover from population declines caused by over exploitation from market hunting. In general, many shorebird populations are in decline due to significant losses and degradation of wetland and estuarine habitats on which these birds rely. Shorebirds commonly occurring in the study area that are considered of high concern due to their regional importance include the black oystercatcher, common snipe, dunlin, greater yellowlegs, and sanderling (Drut and Buchanan 2000). North American population estimates, and population trends for shorebirds that commonly occur in the study area are listed in Table 12.

Table 12. North American Population Estimates, Current Population Trends, and State Natural History Rankings for Shorebirds That Commonly Occur in the Study Area

Species	Population Estimate (Accuracy Rating[a])	Current Population Trend Estimate	State Natural History Rankings[b]
Plovers			
Black-bellied plover	200,000 (Low)	Decline	S4N
Semipalmated plover	150,000 (Low)	Stable	S4N
Killdeer	1,000,000 (Low)	Decline	S4S5B, S4S5N
Oystercatchers			
Black oystercatcher	10,000 (Moderate)	Stable	S4
Sandpipers			
Spotted sandpiper	150,000 (Poor)	Decline	S4B , S3N
Greater yellowlegs	100,000 (Low)	Stable	S4S5N
Black turnstone	95,000 (Good)	Stable	S4S5N
Surfbird	70,000 (Moderate)	Decline	S4N
Sanderling	300,000 (Low)	Decline	S4N
Western sandpiper	3,500,000 (Good)	Decline	S4S5N
Least sandpiper	700,000 (Low)	Decline	S4N
Dunlin	1,525,000 (Low)	Decline	S4S5N
Short-billed dowitcher	153,000 (Low)	Decline	S4N
Long-billed dowitcher	400,000 (Poor)	Unknown	S4S5N
Common snipe	1-3 million (Poor)	Decline	S4B, S5N
Phalaropes			
Red-necked phalarope	2,500,000 (Poor)	Decline	S4N

[a] Accuracy rating: Poor: A population estimate based on an educated guess. Low: A population estimate based on broad-scale surveys where estimated population size is likely to be in the right order of magnitude. Moderate: A population estimate based on a special survey or on broad-scale surveys of a narrowly distributed species whose populations tend to concentrate to a high degree. Good: A calculated estimate based on broad-scale mark-recapture ratios or other systematic estimating effort resulting in estimates on which confidence limits can be placed.

[b] State rankings (S = State); 4 = Apparently Secure; 5 = Secure; B = Breeding; N = Non-breeding.

Sources: Morrison et al. 2006; NatureServe 2013.

4.5.4 Habitat Use by Life History Stages

Shoreline habitats used by the commonly occurring shorebirds in the study area are indicated in Table 13. Shorebirds primarily occur in bays and estuaries (27 of 31 species), coastal dunes and beaches (23 of 31 species), and headlands and islets (8 of 31 species) (Wahl et al. 2005). Phalaropes are the only shorebirds in the study area that use inland marine and marine nearshore waters (Wahl et al. 2005). Sandpipers and plovers forage primarily on benthic invertebrates such as worms, snails, bivalves, crustaceans, and insects. However, one study has shown that western sandpipers also graze and consume large quantities of surficial intertidal biofilm (a thin layer of microbes, detritus, sediment, and polymeric substances secreted by microphytobenthos and benthic bacteria), which can provide up to 50 percent of their daily energy budget (Kuwae et al. 2008). Dunlin have a similar bill and tongue shape as western sandpipers, indicating that they may be capable of consuming biofilm, and previous unexplained observations of large volumes of sediment in the alimentary tract of shorebirds may also indicate consumption of biofilm (Kuwae et al. 2008). Biofilm develops over muddy low-energy intertidal and estuarine areas that do not experience extensive sediment re-suspension (Kuwae et al. 2008).

Table 13. Shoreline Habitats and Their Use by Shorebirds that Commonly Occur in the Study Area

Species	Habitats[a]											
	Eelgrass	Kelp Beds	Rocky Shores	Unconsolidated Shores	Mudflats and Sandflats	Rocky Subtidal	Unconsolidated Subtidal	Estuaries	Salt Marsh	Nearshore Riparian	Backshore Spray	Cherry Point[b]
Plovers												
Black-bellied plover	F	-	F	F	F	-	-	F	F	-	-	-
Semipalmated plover	F	-	F	F	F	-	-	F	F	-	-	-
Killdeer	F	-	B	B	B	-	-	B	B	B	B	R
Oystercatchers												
Black oystercatcher	-	-	B	B	-	B	B	-	-	-	B	-
Sandpipers												
Spotted sandpiper	B	-	-	F	B	-	F	B	B	B	-	S
Greater yellowlegs	F	-	-	F	F	-	F	F	F	F	-	W
Black turnstone	-	-	F	F	F	F	F	-	-	-	F	W
Surfbird	-	-	F	F	F	F	F	-	-	-	F	-
Sanderling	-	-	-	F	F	-	F	F	-	-	F	W
Western sandpiper	-	-	-	F	F	-	F	F	F	-	-	-
Least sandpiper	-	-	-	F	F	-	F	F	F	-	-	-
Dunlin	-	-	-	F	F	-	F	F	F	-	-	W
Short-billed dowitcher	-	-	-	F	F	-	F	F	F	-	-	-
Long-billed dowitcher	-	-	-	-	F	-	-	F	F	-	-	-
Common snipe	-	-	-	-	F	-	-	F	F	F	-	-
Phalaropes												
Red-necked phalarope	-	F	F	F	-	F	F	F	-	-	-	-

[a] Habitat use: B = Feeds and Reproduces; F = Feeds; R = Reproduces; O = Other (Wahl et al. 2005). For cross reference between the listed specific habitats, those described in the text and those listed in Wahl et al. (2005); eelgrass beds, mudflats and sandflats, estuaries, salt marsh and nearshore riparian are considered primarily bay and estuary habitats (light gray headings); kelp beds, rocky shores, unconsolidated shores, rocky subtidal, unconsolidated subtidal, and backshore spray are considered primarily marine nearshore (dark gray headings) but also occur in coastal dune and beaches habitats or headland and islet habitats.

[b] Cherry Point habitat use: W = Winter, R = Resident, S = Summer.

Sources: Wahl et al. 2005; Drut and Buchanan 2000.

4.6 Other Coastal Birds

The “other coastal birds” group is a general grouping for shoreline-associated birds that do not fall within the previous groups. For the purposes of this discussion, “other coastal birds” includes herons, coots, and land birds that use coastal habitats, in addition to dippers, jays, crows, ravens, swallows, and wrens.

4.6.1 Geographic Distribution

Twenty-seven species of other coastal birds occur commonly in the study area during 3 or more months of the year (Table 14). Most other coastal birds are widespread in distribution throughout the Pacific Northwest.

Table 14. Occurrence by Month in the Puget Trough Ecoregion for Other Coastal Birds That Commonly Use Shoreline Habitats in the Study Area

Species	Occurrence by Month[a]											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Herons												
Great blue heron	C	C	C	C	C	C	C	C	C	C	C	C
Coots												
American coot	C	C	C	C	F	F	F	F	C	C	C	C
Land Birds												
Anna's hummingbird	C	C	C	C	C	C	C	C	C	C	C	C
Rufus hummingbird	-	R	U	C	C	C	C	F	F	-	-	-
Northern flicker	C	C	C	C	C	C	C	C	C	C	C	C
Steller's jay	C	C	C	C	C	C	C	C	C	C	C	C
American/northwestern crow	C	C	C	C	C	C	C	C	C	C	C	C
Cliff swallow	-	-	R	U	C	C	C	C	R	-	-	-
Barn swallow	R	R	R	U	C	C	C	C	F	U	R	-
Bushtit	C	C	C	C	C	C	C	C	C	C	C	C
Winter wren	C	C	C	C	C	C	C	C	C	C	C	C
Marsh wren	F	F	F	C	C	C	C	C	C	C	F	F
Ruby-crowned kinglet	C	C	C	C	U	-	-	R	C	C	C	C
American robin	C	C	C	C	C	C	C	C	C	C	C	C
Orange-crowned warbler	R	R	U	F	C	C	C	C	C	U	U	R
Yellow-rumped warbler	U	U	U	C	C	F	F	F	F	C	F	U
Common yellowthroat	R	R	R	F	C	C	C	C	C	R	R	R
Spotted towhee	C	C	C	C	C	C	C	C	C	C	C	C
Savannah sparrow	U	U	U	C	C	C	C	C	C	F	U	U
Fox sparrow	C	C	C	C	F	R	R	R	F	C	C	C
Song sparrow	C	C	C	C	C	C	C	C	C	C	C	C
White-crowned sparrow	F	F	C	C	C	C	C	C	C	C	F	F
Golden-crowned sparrow	C	C	C	C	F	-	-	-	F	C	C	C
Dark-eyed junco	C	C	C	C	C	C	C	C	C	C	C	C
Red-winged blackbird	C	C	C	C	C	C	C	C	C	C	C	C
Brewer's blackbird	C	C	C	C	C	C	C	C	C	C	C	C
Brown-headed cowbird	U	U	U	C	C	C	C	F	F	F	U	U

[a] Occurrence:
C = Common; F = Fairly Common; U = Uncommon; R = Rare; I = Irregular (Seattle Audubon Society 2008).

Sources: Seattle Audubon Society 2008; Wahl et al. 2005.

4.6.2 Seasonal Distribution in the Study Area

Of the 27 common species in the study area, 23 species nest along shoreline habitats, 14 species are year-round residents, and 4 species are winter residents (Table 14).

4.6.3 Uses, Status and Trends, and Regulatory Issues

All "other coastal birds" are protected by the MBTA. Except for the American coot, no other coastal birds are currently harvested in the Pacific Northwest. The relative abundance of breeding land birds in coastal and upland habitats in the study area is summarized in Table 15. Of the 22 common breeding land birds, 6 species have declined significantly in abundance and 2 species have increased significantly in abundance from 1980 to 2006. The remaining species have shown non-significant declining trends (8 species) or increasing trends (6 species) from 1980 to 2006 (Sauer et al. 2007).

Table 15. Other Coastal Bird Abundance during the 2006 Nesting Season in the Study Area and Trends for the Southern Pacific Rainforest Region

Species	Breeding Bird Survey Routes					Average for Routes	Breeding Season Trend[a]
	Ozette	Port Angeles	Warm Beach	Deception	Bay View		
Coots							
American coot	Rare breeder					-	-
Land Birds							
Anna's hummingbird	-	-	-	-	-	-	+ 2.04
Rufus hummingbird	6.88	3.36	4.97	10.14	1.58	5.39	- 0.64
Northern flicker	1.25	0.88	1.03	0.71		0.97	- 0.27
Steller's jay	8.81	2.36	1.00	0.14	2.33	2.93	*+ 1.43*
American/northwest crow	11.68	4.97	26.17	11.71	14.50	13.80	+ 0.91
Cliff swallow	8.03	16.36	100.75	7.86	10.08	28.62	- 1.49
Barn swallow	17.00	39.18	53.92	32.86	47.25	38.04	*- 2.38*
Bushtit	0.31	1.55	1.97	1.57	-	1.35	*- 6.12*
Winter wren	59.22	4.03	3.69	7.14	0.50	14.92	- 0.14
Marsh wren	0.25	0.36	0.92	-	0.33	0.47	+ 1.74
Ruby-crowned kinglet	Non-breeding					-	-
American robin	61.25	84.70	104.78	102.14	90.83	88.74	+ 0.56
Orange-crowned warbler	5.06	11.09	6.78	10.29	1.00	6.84	*- 4.02*
Yellow-rumped warbler	1.56	1.00	0.17	0.43	0.17	0.67	- 0.49
Common yellowthroat	4.50	2.24	4.47	0.14	8.33	3.94	*+ 1.94*
Spotted towhee	1.56	12.03	21.69	30.29	12.92	15.70	+ 0.74
Savannah sparrow	0.38	55.00	14.72	10.00	29.08	21.84	- 0.33
Fox sparrow	Non-breeding						
Song sparrow	31.47	37.45	33.14	26.14	23.08	30.26	*- 0.69*
White-crowned sparrow	1.28	28.06	16.61	31.29	12.25	17.90	*- 1.78*
Golden-crowned sparrow	Non-breeding						
Dark-eyed junco	4.94	3.76	6.94	12.14	0.50	5.66	- 0.56
Red-winged blackbird	2.06	17.88	32.72	8.29	40.92	20.37	+ 1.62
Brewer's blackbird	-	57.64	21.86	14.00	82.58	44.02	- 0.94
Brown-headed cowbird	2.66	19.97	19.56	19.00	12.50	14.74	*- 1.36*

Notes:

Abundance indicates the number of birds per survey route.

Average of routes, including 89001 Ozette, 89002 Port Angeles, 89003 Warm Beach, 89905 Deception, and 89066 Bay View (Sauer et al. 2007). Breeding bird survey routes include both coastal and upland habitats.

[a] Increase (+) or decrease (-) in birds per route within the Southern Pacific Rainforest Region from 1980 to 2006. Bold italics indicated significant trends at *P* < 0.10 (Sauer et al. 2007).

Source: Sauer et al. 2007.

4.6.4 Habitat Use by Life History Stages

Shoreline habitats used by other common coastal birds in the study area include coastal dunes and beaches (38 of 47 species), headlands and islets (25 of 47 species), and bays and estuaries (24 of 47 species) (Wahl et al. 2005). Table 16 shows habitats and their use by shorebirds commonly occurring in coastal habitats in the study area.

Table 16. Specific Habitats and Their Use by Shorebirds That Commonly Occur in Coastal Habitats in the Study Area

Species	Habitats[a]											
	Eelgrass	Kelp Beds	Rocky Shores	Unconsolidated Shores	Mudflats and Sandflats	Rocky Subtidal	Unconsolidated Subtidal	Estuaries	Salt Marsh	Nearshore Riparian	Backshore Spray	Cherry Point[b]
Herons												
Great blue heron	F	-	-	F	F	-	F	F	F	F	-	R
Coots												
American coot	F	-	-	-	F	-	-	F	F	F	-	-
Passerines												
Anna's hummingbird	-	-	F	F	-	-	-	-	-	-	F	-
Rufus hummingbird	-	-	B	B	-	-	-	-	-	-	B	S
Northern flicker	-	-	-	F	-	-	-	-	-	-	F	R
Steller's jay	-	-	-	F	-	-	-	-	-	-	F	R
American/northwestern crow	-	-	F	F	-	-	-	-	-	-	F	R
Cliff swallow	F	-	B	F	F	F	F	F	F	F	F	S
Barn swallow	F	F	B	F	F	F	F	F	F	F	F	S
Bushtit	-	-	-	B	-	-	-	-	-	-	B	R
Winter wren	-	-	-	F	-	-	-	-	-	-	F	R
Marsh wren	F	-	-	F	F	-	-	F	F	F	F	-
Ruby-crowned kinglet	-	-	F	F	-	-	-	-	-	-	F	R
American robin	-	-	-	F	-	-	-	-	-	-	F	R
Orange-crowned warbler	-	-	B	B	-	-	-	-	-	-	B	R
Yellow-rumped warbler	-	-	F	F	-	-	-	-	-	-	F	R
Common yellowthroat	-	-	-	-	-	-	-	B	B	B	-	S
Spotted towhee	-	-	-	B	-	-	-	-	-	-	B	R
Savannah sparrow	-	-	B	B	-	-	-	B	B	B	B	S
Fox sparrow	-	-	B	B	-	-	-	-	-	-	B	W
Song sparrow	-	-	B	B	-	-	-	B	B	B	B	R
White-crowned sparrow	-	-	B	B	-	-	-	B	B	B	B	R
Golden-crowned sparrow	-	-	F	F	-	-	-	-	-	-	F	W
Dark-eyed junco	-	-	-	B	-	-	-	-	-	-	B	W
Red-winged blackbird	-	-	-	-	-	-	-	B	B	B	-	R
Brewer's blackbird	-	-	B	B	-	-	-	B	B	B	B	R
Brown-headed cowbird	-	-	-	B	-	-	-	-	-	-	B	R

[a] Habitat use: B = Feeds and Reproduces; F = Feeds; R = Reproduces; O = Other (Wahl et al. 2005). For cross reference between the listed specific habitats, those described in the text and those listed in Wahl et al. (2005); eelgrass beds, mudflats and sandflats, estuaries, salt marsh and nearshore riparian are considered primarily bay and estuary habitats (light gray headings); kelp beds, rocky shores, unconsolidated shores, rocky subtidal, unconsolidated subtidal, and backshore spray are considered primarily marine nearshore (dark gray headings) but also occur in coastal dune and beaches habitats or headland and islet habitats.

[b] Cherry Point habitat use: W = Winter, R = Resident, S = Summer.

Sources: Wahl et al. 2005; Woodcock and Irving 2008.

Herons generally nest colonially near water in deciduous, coniferous, or mixed stands of mature trees; they feed along shorelines on fish and intertidal invertebrates. American coots nest on freshwater using marine resources such as salt marshes and coastal bays during other portions of the year. They feed primarily on vegetation, fish, and invertebrates. The wide array of coastal land birds in the study area uses a wide variety of foraging habitats. Verbeck and Butler (1989) found that crows (American and Northwest) nesting in coastal areas spend approximately half of their time foraging on beach resources, where they preferred to feed on shore crabs and pricklebacks available at low tide. Hummingbirds feed on nectar and insects; in the Puget Sound area, they nest in huckleberry bushes, alders, blackberries, or conifer branches (Seattle Audubon Society 2008). Steller's jays feed on both vegetation and animal matter, and prey on the young of other birds. Other common land birds feed generally on insects and vegetation.

5. FISH

5.1 Protected Species

Federally and state-listed fish with the potential to occur in the study area are described below. More detailed discussions of life histories and listing status for federally listed species are provided in the draft Biological Evaluation (Appendix G).

5.1.1 Federally Listed Species

5.1.1.1 Bull Trout (Threatened)

The anadromous life history form of bull trout migrates to saltwater during spring. They use the nearshore marine ecosystem during spring and late summer, and the outer coast year-round. Juvenile bull trout rear in the nearshore ecosystem; they prefer unconsolidated habitats that may include eelgrass and kelp beds. The nearshore area provides critical foraging habitat and stable overwintering habitat for bull trout. Adults also feed in this area and then migrate into freshwater rivers and streams to spawn. Temperature is a major factor influencing bull trout distribution because spawning, egg incubation, and juvenile rearing all require specific temperatures. Since the bull trout range includes the Strait of Juan de Fuca, as well as inland marine and fresh waters of Clallam County (USFWS 2005), it is possible that this species would be present in the study area. Coastal marine waters designated as critical habitat for bull trout in the Coastal Puget Sound and Olympic Peninsula areas occur within the study area and extend from the mean higher high water line inland to 10 meters (33 feet) below the mean lower low water elevation line offshore.

Additional information on bull trout is provided in Section 5.2.1 and in the draft Biological Evaluation (Appendix G).

5.1.1.2 Chinook Salmon (Threatened)

The Puget Sound Chinook salmon evolutionary significant unit (ESU) is a composite of many individual populations of naturally spawning Chinook salmon and a number of hatchery stocks. The boundary of the Puget Sound Chinook salmon ESU extends from the Nooksack River in the north to southern Puget Sound, includes Hood Canal, and extends westerly out the Strait of Juan de Fuca to the Elwha River. The Skagit River and its tributaries constitute what was historically the predominate system in Puget Sound containing naturally spawning populations. Two independent populations of Puget Sound Chinook salmon are in the Nooksack basin: North Fork Nooksack River (including Middle Fork) and South Fork Nooksack River. These salmon are distinctive from Chinook salmon in the rest of Puget Sound in their genetic attributes, life history, and habitat characteristics. They are the only populations in the Strait of Georgia region, and they are two of only six Chinook runs left in Puget Sound that return to their rivers in spring (as opposed to fall spawners). For these reasons, the Nooksack populations are considered essential to the recovery of the Puget Sound Chinook ESU (Puget Sound TRT 2006). Adult Chinook migrate through the study area en route to spawning tributaries throughout the Washington north coast, Straits of Georgia and Juan de Fuca, Puget Sound, and Hood Canal. The Puget Sound Chinook salmon ESU includes waters that are part of the study area; therefore, it is possible that this species would be present in the study area. Critical habitat has been designated within the study area for the Strait of Juan de Fuca from the line of extreme high tide to a depth of 30 meters (98 feet).

Additional information on Puget Sound Chinook salmon is provided in Section 5.2.2 and in the draft Biological Evaluation (Appendix G).

5.1.1.3 Chum Salmon (Hood Canal Summer Run) (Threatened)

While the range of chum salmon along the Pacific coast extends from the Bering Sea to the Sacramento River in California, the range of summer chum salmon is highly restricted and extends only to discrete portions of the eastern portion of the Olympic Peninsula and south into Hood Canal. These include spawning adult returning to Snow Creek (Discovery Bay), Chimicum Creek (near Port Townsend), and many drainages in Hood Canal. Adult chum could migrate through the study area en route to spawning tributaries. Therefore, it is possible that this species would be present within the study area. Critical habitat has been designated within the study area for the Strait of Juan de Fuca from the line of extreme high tide to a depth of 30 meters (98 feet).

Additional information on chum salmon is provided in Section 5.2.2 and in the draft Biological Evaluation (Appendix G).

5.1.1.4 Puget Sound Steelhead (Threatened)

The Skagit and Nooksack Rivers, which discharge into the general vicinity of Cherry Point, support populations of native steelhead. Juvenile steelhead move rapidly out of freshwater and into offshore marine areas; recent studies in steelhead migratory behavior suggest that juveniles spend very little time in nearshore areas (NMFS 2013).The nearshore benthic survey conducted by the Lummi Nation found few (n=3) steelhead juveniles in their extensive beach seining sampling during the 2008 to 2009 survey effort, representing a 1.5-percent occurrence in all sets (Dolphin et al. 2010). In addition to the limited occurrence of steelhead documented in the vicinity of the BP Cherry Point dock, this species migrates through the Strait of Juan de Fuca en route to spawning tributaries throughout Washington’s north coast. It is possible that this species would be present within the study area. No proposed critical habitat for Puget Sound steelhead occurs in the study area.

Additional information on Puget Sound steelhead is provided in Section 5.2.3 and in the draft Biological Evaluation (Appendix G).

5.1.1.5 Pacific Eulachon (Threatened)

Eulachon typically spend 3 to 5 years in saltwater before returning to freshwater to spawn from late winter though mid-spring. Most eulachon adults die after spawning. After eggs hatch, eulachon larvae are carried downstream and dispersed in the marine environment (Hay and McCarter 2000). It is not known how long larval eulachon remain in the estuary before entering the ocean (NMFS 2010b). Once juvenile eulachon enter the ocean, they move from shallow nearshore areas to deeper areas over the continental shelf. Larvae and young juveniles become widely distributed in coastal waters, where they are typically found near the ocean bottom in waters from 20 to 150 meters (66 to 292 feet) deep (Hay and McCarter 2000) and sometimes as deep as 182 meters (597 feet) (Barraclough 1964). Little information is currently available about eulachon movements in nearshore marine areas and the open ocean.

A recent WDFW technical report entitled *Marine Forage Fishes in Puget Sound* (Penttila 2007) presents detailed data on the biology and status and trends of surf smelt and longfin smelt in Puget Sound but states that “there is virtually no life history information within the Puget Sound Basin” available for eulachon. Similarly, detailed notes provided by WDFW and the Oregon Department of Fish and Wildlife as part of this review do not provide evidence of spawning stocks of eulachon in Puget Sound rivers.

Monaco et al. (1990) described eulachon as “rare” in Skagit Bay and, in addition to a personal communication, cited Miller and Borton (1980) as a supporting reference. Miller and Borton (1980) report on a total of 20 eulachon specimens collected in the San Juan Islands, southern Strait of Georgia, and Strait of Juan de Fuca and recorded in boat logs and museum collection records; however, samples from Skagit Bay were not included in this list.

The Nooksack River frequently has been listed as supporting a run of eulachon (WDFW and ODFW 2001; Wydoski and Whitney 2003; Willson et al. 2006; Moody 2008); however, there seems to be some confusion as to the exact species encountered. The Nooksack River is known to support a run of longfin smelt [*Spirinchus thaleichthys*], which are sometimes mistaken for eulachon. The run of longfin smelt into the Nooksack River occurs in November, which is outside the normal spawning time for eulachon. Additionally, mid-water trawl surveys thought the Strait of Juan de Fuca routinely collected longfin smelt juveniles, while eulachon were rarely encountered (Anchor Environmental 2003). Pacific eulachon critical habitat does not occur within the study area.

Additional information on eulachon is provided in the draft Biological Evaluation (Appendix G).

5.1.1.6 Green Sturgeon (Threatened)

Southern DPS green sturgeon were first determined to occur in Oregon and Washington waters in the late 1950s when tagged San Pablo Bay green sturgeon were recovered in the Columbia River estuary (CDFG 2002). A few green sturgeon have been recovered in Puget Sound as incidental harvest from trawl fishers. The reason for their occurrence in the study area is unknown as they are not known to spawn, rear, or feed in coastal Washington or Puget Sound (Adams et al. 2002). The presence of green sturgeon in Puget Sound is rare (Lindley et al. 2011), but the species could occur in the study area. Critical habitat for Southern DPS green sturgeon has been designated in the study area and includes waters in the Strait of Juan de Fuca and a portion of Rosario Strait (see Figure 3.3-6 in Appendix G) (74 FR 52300). Puget Sound has been excluded from designation because the economic benefits of exclusion outweigh the benefits of inclusion and exclusion will not result in extinction of the species.

Additional information on green sturgeon is provided in the draft Biological Evaluation (Appendix G).

5.1.1.7 Rockfish (Bocaccio [Endangered], Canary [Threatened], and Yelloweye [Threatened])

The WDFW considers the north Puget Sound area to be one of the most productive areas for groundfish. This area extends from the Canadian border to Deception Pass out to the center of the Strait of Juan de Fuca, including all of the San Juan Islands. Within this area, production data in the vicinity of Cherry Point are not kept distinct. For conservation purposes, bocaccio, yelloweye, and canary rockfish populations are managed as two distinct stocks, one stock occupying areas west of Port Angeles and a separate stock unit east of Port Angeles.

Information on the actual distribution of these three listed rockfish species in the vicinity of the Cherry Point facility is vague. Rockfish adults tend to prefer rocky, deeper water habitats that are not common in the vicinity of the BP Cherry Point dock. Bocaccio has been found to occur in Central Puget Sound, Tacoma Narrows, Ports Gardner and Susan, and along the Strait of Juan de Fuca, with the most common occurrences recorded south of the Tacoma Narrows (NMFS 2010c). Detection of adult yelloweye and canary rockfish indicate that they do occur in the broader vicinity of the San Juan Islands near suitable habitat but do not occur near Cherry Point (see Figures 3.3-7 and 3.3-8 in Appendix G). Yelloweye rockfish have been reported by anglers to occur off Middle Bank in Haro Strait, Waldron Island, Hood Canal, Foulweather Bluff, Jefferson Head, Mukilteo, and Bainbridge Island (Washington 1977; Palsson et al. 2009). Canary rockfish have been documented as part of the assemblage of fishes in Puget Sound region for as long as there have been formal fisheries surveys, dating back to at least the 1930s (NMFS 2010c). It is likely that bocaccio, canary, and yelloweye rockfish could be present in the study area.

Critical habitat for rockfish has been proposed in the study area and includes waters east of Port Angeles north to the BP Cherry Point dock (78 FR 47635).

Additional information on bocaccio and yelloweye rockfish is provided in Section 4.3.2 and in the draft Biological Evaluation (Appendix G). Additional information on canary rockfish is provided in Section 5.3.1 and in the draft Biological Evaluation (Appendix G).

5.1.2 State-Listed Species

5.1.2.1 Rockfish (Candidate)

Brown rockfish belong to the nearshore complex, which is characterized by larval and/or juvenile stages that are strongly associated with the non-canopy nearshore area with a wide substrate type range. A review of the status and trends, habitat use, and distribution within the study area for this complex is provided in Section 5.3.1.

Black, China, copper, quillback, giger, and widow rockfish belong to the nearshore surface vegetation complex, which is characterized by larval and/or juvenile stages that are strongly associated with the nearshore, kelp canopy, nearshore demersal (bottom), or shelf-surface with drifting algal mats. Section 5.3.2 provides a review of the status and trends, habitat use, and distribution within the study area for this complex.

Greenstriped and redstripe rockfish belong to the offshore subsurface vegetation complex, which is characterized by larval and/or juvenile stages being strongly associated with continental slope, deep shelf, epipelagic, and demersal habitats. A review of the status and trends, habitat use, and distribution within the study area for this complex is provided in Section 5.3.3.

Brown, black, China, copper, quillback, tiger, widow, greenstriped, and redstripe rockfish are expected to occur in the study area.

5.1.2.2 Pacific Herring (Candidate)

The Pacific herring is the most widely studied forage fish in the study area, primarily because of its economic value in commercial and recreational fisheries. A review of the status and trends, habitat use, and distribution within the study area for this species is provided in Section 5.6.1. Pacific herring are expected to occur in the study area.

5.1.2.3 Pacific Cod, Pacific Hake, Walleye Pollock (Candidate)

Pacific cod, Pacific hake, and walleye pollock are roundfish; their life history stages are associated with surface waters and unconsolidated subtidal and shelf habitat. A review of the status and trends, habitat use, and distribution within the study area for these species is provided in Section 5.5.1. Pacific cod, Pacific hake, and walleye pollock are expected to occur in the study area.

5.1.2.4 Pacific Lamprey (Candidate)

Lampreys are a primitive group of fishes that are eel-like in form but lack jaws and paired fins. Shortly after hatching in freshwater streams, lamprey larvae drift downstream into areas of low velocity where they burrow and live as filter feeders for up to 7 years. After this period, they metamorphosize into their juvenile phase; this process occurs over a period of months from July to November. Once the metamorphosis is complete, they migrate to the ocean. Adult Pacific lampreys are parasitic and feed on a variety of fish, including Pacific salmon, flatfish, rockfish, and pollock. They have been caught in depths ranging from approximately 91 to 792 meters (300 to 2,600 feet). After lampreys spend 1 to 3 years in the marine environment, they migrate back to freshwater between February and June, where they overwinter until they spawn the following year between March and July. After spawning, lamprey die.

The current distribution of Pacific lamprey in western Washington includes most large rivers and streams along the coast and the Strait of Juan de Fuca, and throughout Puget Sound including the Nisqually Reach and Hood Canal streams. Information on the abundance of Pacific lamprey in western Washington is limited and largely anecdotal; much of the data references only natal streams. Collection records show that Pacific lampreys are widely distributed on the Olympic Peninsula and streams flowing into the Strait of Juan de Fuca; however, no population status and trend data are available (USFWS n. d.). Adult Pacific lamprey are likely to be present in the study area.

5.2 Salmonids

Salmonids include salmon, trout, and char; they are the most ubiquitous, commercially significant, and ecologically and culturally prominent group of fishes in the Pacific Northwest (Groot and Margolis 1991). Salmon use an extensive network of waterbodies that include small headwater streams; rivers; lakes; wetlands and floodplain habitats; estuaries; and nearshore, off-shore, and open ocean environments.

Most of the salmonids have both freshwater and anadromous forms; however, only the anadromous forms are specifically addressed in this EIS because of the location of the study area. All juvenile salmon move along the shallows of estuaries and nearshore areas during their seaward outmigration, but some species have more extensive associations. The salmonids have been categorized into three subgroups for discussion based on similarities in utilization of surface water and nearshore habitats in the study area by life history stages. The groupings are based on early migrant distribution patterns and include the following:

- **Nearshore resident:** bull trout, Dolly Varden, coastal cutthroat
- **Nearshore outmigrant:** chum salmon and Chinook salmon
- **Neritic:**[1] pink salmon, steelhead, coho salmon, and sockeye salmon

These patterns are important determinants of the population's productivity rates because the early life history stages are generally the most sensitive to natural and anthropogenic changes to surface water and nearshore habitat condition. These three groupings are discussed in more detail below.

5.2.1 Nearshore Residents

The nearshore residents salmonid group consists of three species: bull trout, Dolly Varden (outer coast), and coastal cutthroat trout. Bull trout and Dolly Varden are two closely related native char species that co-exist; therefore, these two species were evaluated together. This group is considered *iteroparous*, which means that they are capable of spawning more than once. They exhibit resident, fluvial, adfluvial, and anadromous life history forms. Anadromous life history forms use small streams for spawning and rearing, and then migrate to the more productive nearshore marine and estuarine wetland ecosystems for growth and maturation. Fluvial forms migrate within rivers and tributaries for spawning, and adfluvial forms rear in lakes and migrate to tributaries for spawning. The life history strategies exhibited by this

[1] The neritic zone occurs between low tide and the edge of the continental shelf.

group are very flexible. Individual fish may adopt more than one strategy during the course of a lifetime and may even alternate strategies from year to year.

5.2.1.1 Geographic Distribution

Bull trout and Dolly Varden occur from the headwaters of the Yukon in Alaska to the Klamath basin (Dunham et al. 2003). The southern range of bull trout was much broader during the last major ice age and extended as far south as the McCloud River until recent times (Cavender 1978). Bull trout are widely distributed in the state of Washington (Figure 4), and the overall range is likely similar to the historical range (WDFW 2000). The USFWS recognizes five DPSs within the co-terminous United States: (1) Coastal-Puget Sound; (2) St. Mary-Belly River; (3) Klamath River; (4) Columbia River; and (5) Jarbridge River.

Coastal cutthroat trout are distributed along the western coast of North America from the Kenai Peninsula in Alaska to the Eel River in California; their inland distribution typically is limited to less than 150 km (93 mi) from the coast (Behnke 1992). NOAA Fisheries (Johnson et al. 1999) recognized six ESUs in the contiguous United States: (1) Puget Sound; (2) Olympic Peninsula; (3) Southwestern Washington; (4) Upper Willamette River; (5) Oregon Coast; and (6) Southern Oregon/California. The distribution of coastal cutthroat trout within the state of Washington includes large rivers and small tributaries of the Columbia River up to the Bonneville Dam and drainage basins on the west side of the Cascade Mountains, including the Olympic Peninsula.

5.2.1.2 Uses, Status and Trends, and Regulatory Issues

Limited information about the historical abundance of bull trout and Dolly Varden indicates that population segments are geographically isolated from each other due to natural and anthropogenic barriers. The WDFW evaluated 80 bull trout/Dolly Varden stocks within the state of Washington and found that 18 percent were healthy, 3 percent were depressed, 8 percent were critical, and the status of 72 percent of the stock was unknown (WDFW 2000). Native fish occurring throughout Washington State have been reduced from historical levels, particularly in eastern Washington (WDFW 2000). See Figure 4 for the distribution of bull trout in Washington.

Due to the similar morphology, life history requirements, and habitat utilization of bull trout and Dolly Varden, the State of Washington has developed a single management plan for both species (WDFW 2000). In addition to a reduction from historical numbers, several stocks in both eastern and western Washington have become fragmented where lower rivers are no longer utilized or free movement has been restricted. Relatively few native fish are now observed in the mainstem Columbia and Snake Rivers; and they have apparently been extirpated from the Chelan, lower Yakima, and Okanogan basins. A number of stocks have been isolated above dams in river systems where they once roamed freely. With only a few exceptions, however, the overall geographic range in Washington of both continuous and disjunct stocks is believed similar to the historical range. Only one introduction of hatchery-released native fish has been verified in Washington.

Cutthroat trout are managed as a freshwater and saltwater recreational fishery. A 2002 ruling by the USFWS determined that the coastal cutthroat trout did not require ESA protection. Coastal cutthroat trout stocks in Washington, Oregon, and California appear to be declining (Johnson et al. 1999) whereas stocks in Alaska and British Columbia are apparently stable (Wydoski and Whitney 2003). As part of the 2000 coastal cutthroat trout salmonid stock inventory, the WDFW determined that 2 percent of the stock within the state were healthy, 18 percent were depressed, and the status of 80 percent of the stock was unknown (WDFW 2000).

Figure 4. Distribution of Bull Trout in the State of Washington (2005)

5.2.1.3 Seasonal Distribution in Study Area

The anadromous life history form of bull trout and Dolly Varden migrate to saltwater during spring and use the nearshore ecosystem during spring and late summer. Their use of the outer coast can occur year-round. In the study area, this group is distributed throughout the marine and estuarine waters of Puget Sound, Hood Canal, the San Juan Islands, the Strait of Juan de Fuca, the Strait of Georgia, and the outer coast. Bull trout use the nearshore marine waters of Puget Sound seasonally for foraging and migration.

Adfluvial coastal cutthroat trout may use both littoral (nearshore) and limnetic (open water) habitats, and feed openly in the water column in the absence of predatory and competitive pressures (Wydoski and Whitney 2003). Fluvial and adfluvial coastal cutthroat trout typically migrate out of their natal streams between 1 and 4 years of age, with most migrating to saltwater during the spring at 2 to 4 years of age. In Washington, 97 to100 percent of outmigrants were ages 2 and 3 (Wydoski and Whitney 2003).

5.2.1.4 Utilization of Study Area Habitats by Life History Stages

Juvenile bull trout and Dolly Varden rear in the nearshore ecosystem, with preference for unconsolidated habitats that may include eelgrass and kelp beds. The nearshore area is important foraging habitat for this species group. Adults also feed in this area and then migrate into freshwater rivers and streams to spawn. Temperature is a major factor influencing bull trout distribution because spawning, egg incubation, and juvenile rearing all require specific temperatures. Bull trout and Dolly Varden prefer streams with abundant cover and clean gravel. They spawn from October to November in western Washington (WDFW 2013). Because their range includes the Strait of Juan de Fuca, as well as inland marine and fresh waters of Clallam County (USFWS 2005), this species may be present in the study area.

Anadromous juvenile cutthroat remain in their spawning streams for 1 or more years before migrating to saltwater. Their diet primarily consists of aquatic and terrestrial insects, planktonic crustaceans, crayfish, salmon eggs, and small fish. Coastal cutthroat trout that enter nearshore waters reportedly move moderate distances along the shoreline but typically do not cross large bodies of open water (Saiget et al. 2007). Coastal cutthroat trout forage in estuarine wetlands, as well as in nearshore coastal and inland waters, and typically occur in water less than 3 meters (10 feet) in depth (Pauley et al. 1989). Available information indicates that this species occurs at river deltas, in distributary channels, and along shallow shorelines (Pauley et al. 1989; Johnson et al. 1999), thus demonstrating some preference for unconsolidated habitats. Although this review did not find evidence of the use of consolidated and neritic habitat use in the marine environment, evidence from freshwater lakes indicates that this behavior cannot be ruled out. While evidence suggests that coastal cutthroat trout rarely occur in waters greater than 3 meters (10 feet) deep (Pauley et al. 1989), the species has been captured by fishing vessels up to 80 kilometers (55 mi) off the Oregon/Washington coast (Wydoski and Whitney 2003). Little is currently known about habitat utilization in the offshore ecosystem. Although it is widely believed that the species does not overwinter at sea, the possibility cannot currently be ruled out. This species may occur in the study area.

5.2.2 Nearshore Outmigrants

This salmonid group consists of chum and Chinook salmon. This group is anadromous (maturing in saltwater and spawning in freshwater) and semelparous (they perish after spawning). Chinook salmon are the largest of the Pacific salmon. Chinook juveniles rear in freshwater for a period of time before migrating to saltwater to mature. Chum salmon are best known for the enormous canine-like fangs and the striking body color of spawning males. Chum juveniles migrate almost immediately to saltwater after emerging from the gravel. Chinook are generally divided into three categories based on when they return to freshwater: (1) spring run (March to May); (2) summer run (June and July); and (3) fall run (August and September) (Wydoski and Whitney 2003). All Chinook spawn in fall, with the spring runs spawning first in headwater streams, followed by summer Chinook in tributary mouths, and fall types in mainstem tributaries (Wydoski and Whitney 2003). This species also exhibits one of two life history types, or races: the stream-type and the ocean-type (Myers et al. 1998). Stream-type Chinook tend to spend one or more years in freshwater environments as juveniles prior to migrating to saltwater as smolts. Ocean-type Chinook spend between 3 months and 1 year in freshwater before smolting and migrating to estuarine or nearshore areas in saltwater. Ocean-type Chinook are more dependent on estuarine habitats to complete their life history than any other species of salmon (Healey 1991).

Chinook are the largest of the Pacific salmon, with an average length of approximately 1 meter (3 feet) and weights ranging from 1 to 56 kilograms (2 to 123 pounds) (Wydoski and Whitney 2003). They tend to spawn in large river systems (Healey 1991). The species spends between 2 and 6 years at sea prior to returning to freshwater to spawn, but this time varies between stocks and depends somewhat on ocean conditions (Wydoski and Whitney 2003). Similar to other salmonids, Chinook spawn in cold, highly oxygenated water (Healey 1991). Spring Chinook are especially dependent on high water quality and good access to spawning areas, as they move upstream during periods of lower flow and hold in rivers for extended periods of time before spawning. Adult spring Chinook salmon tend to prefer deep, cool “holding pools” with woody debris, over-hanging vegetation, and undercut banks to protect them from predators (Healey 1991).

5.2.2.1 Geographic Distribution

The historical range of Chinook salmon included most of the North Pacific Ocean from California to Alaska, through the Aleutian Islands and into Siberia. They are found in the rivers and streams of Puget Sound, including Hood Canal and the Strait of Juan de Fuca, the Pacific Coast, and the Columbia River and its tributaries (Wydoski and Whitney 2003). Ocean migrations extend well into the North Pacific Ocean.

The range of chum salmon along the Pacific coast extends from the Bering Sea to the Sacramento River in California. Chum and Chinook fully utilize Puget Sound and the study area. Chum salmon have the widest natural geographic and spawning distribution of any Pacific salmonid. Chum salmon usually spawn in coastal areas and generally spawn in the lower reaches of alluvial rivers.

5.2.2.2 Uses, Status and Trends, and Regulatory Issues

Chinook salmon are one of the predominant sport and commercial fisheries in the region. Puget Sound Chinook salmon are federally listed as threatened under the ESA. Generally, interior populations of Chinook (Columbia River and Puget Sound) have been drastically reduced from historical abundance. Chum salmon are the least commercially valuable species. Hood Canal summer-run chum, which migrate through the study area, are listed as federally threatened under the ESA. The chum salmon’s minimal dependence on freshwater for rearing could be a main reason why the impacts on their runs are not as widespread as other salmon species.

Freshwater, estuarine, and marine habitat loss or degradation is thought to be the primary reason for declining populations. Instream flow abundance during summer and a rapidly rising hydrograph in urbanizing areas are impacts associated with watershed management issues that can influence population abundance. Degradation and loss of habitat in the headwaters of many Washington rivers now limit their spawning range (Wydoski and Whitney 2003).

5.2.2.3 Seasonal Distribution in Study Area

The ocean migrations of Chinook salmon extend well into the North Pacific Ocean (Myers et al. 1998). Adult Chinook and chum salmon migrate through the study area, en route to spawning tributaries throughout the Washington north coast, Straits of Georgia and Juan de Fuca, Puget Sound, and Hood Canal. Chinook salmon have different life history strategies and therefore use marine habitat (estuary, coastal, and ocean) to different extents. Chinook adult migrants are present most of the year although stock composition shifts from southern to northern basins as the year progresses. They enter Washington streams from June to November to spawn. Fry arrive in estuaries with a peak in approximately mid-May. These species are expected to occur in the study area.

5.2.2.4 Utilization of Study Area Habitats by Life History Stages

Juvenile chum and Chinook reside in estuaries longer than most other anadromous salmon species. The diet of outmigrating ocean-type Chinook salmon varies geographically and seasonally. Feeding appears to be opportunistic, with aquatic insect larvae and adults making up a large portion of the prey items.

Fry and juveniles (smolts) depend on estuaries for rearing; however, the Chinook and chum move offshore relatively quickly to increase their prey base as they increase in size. Smolts are more dependent on estuarine habitats to complete their life history than other species of salmon. Smolts migrate into estuarine or nearshore areas and make extensive use of estuarine and nearshore habitats for rearing in shallow eelgrass beds and nearshore kelp beds. Chinook generally feed on invertebrates but eat more fish with age (Healey 1991); they feed on sand lance, sticklebacks, crab larvae, and small herring while at sea (Healey 1991). Chum juveniles outmigrate to marine water almost immediately after emerging from the gravel. This ocean-type migratory behavior contrasts with the stream-type behavior of some other species in the genus *Oncorhynchus*, which usually migrate to sea at a larger size, after months or years of freshwater rearing (Johnson et al. 1997).

Adult Chinook migrate through the study area en route to spawning tributaries throughout the Washington north coast, Straits of Georgia and Juan de Fuca, Puget Sound, and Hood Canal. The Puget Sound Chinook salmon ESU includes waters that are part of the study area; therefore, this species may be present in the study area. Critical habitat has been designated in the study area for the Strait of Juan de Fuca, from the line of extreme high tide to a depth of 30 meters (98 feet). Adult chum could migrate through the study area en route to spawning tributaries. Therefore, this species may be present in the study area.

5.2.3 Neritics

This salmonid group consists of coho, pink, sockeye, and steelhead salmon. Coho, pink, and sockeye salmon are anadromous and semelparous (spawn once); steelhead are anadromous and iteroparous (capable of spawning more than once in their lifetime).

5.2.3.1 Geographic Distribution

Coho salmon were historically distributed throughout the North Pacific Ocean from central California to Alaska, through the Aleutian Islands, and from Russia south to Japan. This species probably inhabited most of the coastal streams in Washington, Oregon, and central and northern California. There are believed to be 90 distinct stocks in Washington (Wydoski and Whitney 2003), with populations occurring throughout Puget Sound, Hood Canal, the Strait of Juan de Fuca, the Olympic Peninsula, and the Columbia River Basin.

Pink salmon are the most abundant species of salmon and are found throughout the North Pacific, including northern Asia. The North American range is from the Sacramento River in northern California, north to the Bering Strait, and east to the MacKenzie River in northern British Columbia, although spawning is rare south of the Columbia River. They are common from central Alaska south to the Fraser River in British Columbia (Hard et al. 1996). Thirteen stocks of pink salmon have been identified in Washington, with actively spawning populations occurring in the Nooksack, Skagit, Stillaguamish, Snohomish, Skykomish, Snoqualmie, Puyallup, Nisqually, Hamma Hamma, Duckabush, Dosewallops, Dungeness, and Elwha Rivers (Hard et al. 1996). Pink salmon have been reported in other systems (e.g., Bogachiel River, Lake Washington), but these are considered strays, not spawning populations (Hard et al. 1996).

Sockeye naturally occur from Alaska through British Columbia and into Washington and Idaho, as far south as the Columbia River system. The historical range of this species is thought to be close to their current range (Burgner 1991; Gustafson et al. 1997). Sockeye also occur in an anadromous and a land-locked form, which is referred to as *kokanee*. The WDFW recognizes nine sockeye salmon stocks in the state, with the two largest runs occurring in Lake Washington (three stocks) and in the Columbia River (two stocks).

Currently, steelhead trout occur naturally from Alaska through British Columbia, Washington, Oregon, California, and Idaho. The historical range is thought to be from northern Mexico to Alaska in most rivers with access to the Pacific Ocean (Busby et al. 1996). Steelhead trout have also been introduced worldwide, becoming naturalized in many areas with rainbow trout, the non-anadromous form of steelhead. Steelhead populations in Washington occur in the Upper, Lower, and Middle Columbia River; in Puget Sound; on the Olympic Peninsula; in southwest Washington; and in the Snake River basin.

5.2.3.2 Uses, Status and Trends and Regulatory Issues

Neritic species are an important major component of regional, coastal, and high seas commercial, tribal, and recreational fisheries. Catch records for coho have fluctuated cyclically in the past 30 years but reached record low levels during the early 1990s (Johnson et al. 1997). In general, coho populations throughout the region are considered depressed from historical levels. In 1995, NOAA Fisheries named six ESUs for coho in the Pacific Northwest (Weitkamp et al. 1995). Three of the six ESUs are located in California and Oregon—the California Coast ESU is federally listed as endangered, and the Southern Oregon/Northern California and Coastal Oregon ESUs are federally listed as threatened. In Washington, the Lower Columbia ESU is listed as threatened. Although the Olympic Peninsula and Puget Sound ESUs are not listed, NMFS has designated the Puget Sound ESU as a species of concern.

According to Hard et al. (1996), pink salmon populations are relatively healthy in the state of Washington, except in the rivers along the Strait of Juan de Fuca. The Elwha River population is thought to be extinct, and the Dungeness River stocks are considered depressed as a result of heavy flooding in 1979 and 1980 (Hard et al. 1996). Both anthropogenic and natural disturbances have profound impacts on this species because of their strict 2-year life cycle (Bonar et al. 1989).

Catch records for sockeye have fluctuated cyclically during the last 30 years but reached record low levels during the last decade (Stouder et al. 1997). In general, sockeye populations throughout the region are considered depressed from historical levels. NOAA Fisheries identified seven individual ESUs for sockeye in Washington (Gustafson et al. 1997); two of these ESUs are considered to be in danger of or threatened with extinction (Snake River and Ozette Lake).

In general, steelhead populations throughout the region are considered depressed from historical levels; 5 of the 15 ESUs in the Pacific Northwest are federally listed as endangered, and 4 ESUs are listed as threatened (West Coast Salmon Biological Review Team 2003). Puget Sound steelhead are federally listed as threatened under the ESA.

5.2.3.3 Seasonal Distribution in the Study Area

Pink, sockeye, and steelhead salmon migrate through the study area en route to spawning tributaries throughout the Washington north coast, Straits of Georgia and Juan de Fuca, Hood Canal, and Puget Sound. Outmigration begins in spring, with the young moving rapidly through estuaries and out to sea. As smolts begin the ocean phase of their life, they usually travel through most, if not all, of the marine environments, including estuaries, nearshore habitat, and open ocean.

Pink and sockeye salmon enter Washington streams from June to November to spawn. Fry arrive in estuaries, with a peak approximately in mid-May. Juveniles reside in estuaries longer than most other anadromous salmon species. Juvenile sockeye typically rear for 1 to 3 years in lake habitats (NOAA Fishwatch 2013a). The offspring of riverine spawners generally rear for 1 to 2 years in lower slow-velocity sections of rivers (river-type), although some populations migrate to estuarine environments after a few months in their natal stream (sea-type) (Burgner 1991). Outmigrating lake-type sockeye typically migrate to the estuary between 1 and 3 years of age (Burgner 1991).

5.2.3.4 Utilization of Study Area Habitats by Life History Stages

These species spend little time in estuarine environments, and their association with estuarine environments is limited to seaward migration and a period of osmoregulatory[2] adjustment through their smolt phase, where they experience rapid growth and move to marine nearshore habitats. Juveniles may form schools in estuaries for several months during summer before moving offshore by late summer or early fall. Coho, pink, and sockeye juveniles entering the ocean, swim north along the coast of British Columbia and Alaska, and then move offshore into the Gulf of Alaska, where they spend 2 years. Some Puget Sound populations spend their entire marine life in marine nearshore habitats.

Coho outmigration begins in spring, with the young moving rapidly through estuaries and out to sea. As smolts begin the ocean phase of their life, they usually travel through most, if not all, of the marine environments, including estuaries, nearshore habitat, and open ocean. During this time, coho tend to utilize the coastal waters, moving as far north as the Gulf of Alaska (Johnson et al. 1997).

Juvenile sockeye salmon spend the first part of their marine lives in estuarine and nearshore areas adjacent to their natal streams, although their residence time in these areas may be the shortest for any of the salmon species. Smolt migration begins in late April, with southern stocks migrating earliest. Northward migration of juveniles to the Gulf of Alaska occurs in a band relatively close to shore, and offshore movement of juveniles occurs in late autumn or winter. Sockeye salmon prefer cooler ocean conditions than do other Pacific salmon (Burgner 1991).

Pink salmon migrate downstream almost immediately after emergence; if the distance to saltwater is short, the migration may occur in 1 night. The species spends very little time in estuarine environments, moving quickly to marine nearshore habitats where they grow rapidly, feeding on small crustaceans such as euphausiids, amphipods, and cladocerans (Bonar et al. 1989). Prey may be benthic or pelagic, although foraging usually occurs in the water column in nearshore areas, along beaches, or along shorelines with complexity. Juveniles form schools in estuaries for several months during summer before moving

2 *Osmoregulation* refers to maintaining the mineral and salt content in the blood while transitioning from a freshwater to saltwater environment.

offshore by late summer or early fall (Hard et al. 1996). Some Puget Sound populations spend their entire marine life in marine nearshore habitats (Hard et al. 1996).

Outmigrating steelhead smolts typically leave their natal streams between 2 and 4 years of age (Groot and Margolis 1991), traveling through most, if not all, of the marine environments including estuaries, nearshore habitat, and the open ocean.

All neritic species migrate through the Strait of Juan de Fuca en route to spawning tributaries throughout Washington's north coast or spend their entire marine life in marine nearshore habitats. In addition to the general occurrence of neritic species in the study area, limited occurrences of steelhead have been documented in the vicinity of the BP Cherry Point dock. Therefore, these species may be present in the study area.

5.3 Rockfish

Rockfish are any species of fish in Puget Sound east of Cape Flattery belonging to the family Scorpaenidae and members of the *Sebastes* or *Sebastologus* genra. Species can be grouped into several assemblages, or complexes, based on their life histories and habitat associations. Rockfish complexes within the study area include:

- **Nearshore complex:** fish with strong larval or juvenile association with nearshore habitats.
- **Nearshore surface vegetation complex:** fish with pelagic larvae or juveniles and strong association with algal mats or canopy.
- **Offshore subsurface complex:** fish with larval or juvenile association with offshore and subsurface.

These three complexes are described in more detail below.

5.3.1 Nearshore Complex

The nearshore complex contains the following four species and is characterized by the larval and/or juvenile stages strongly associated with the non-canopy nearshore area, with a wide substrate type range:

- Brown rockfish (*Sebastes auriculatus*)
- Canary rockfish (*Sebastes pinniger*)
- Puget Sound rockfish (*Sebastes emphaeus*)
- Stripetail rockfish (*Sebastes saxicola*)

One representative species is used to describe the group in general. The following information is provided for the brown rockfish.

5.3.1.1 Geographic Distribution

Brown rockfish range from the northern Gulf of Alaska to southern Baja California (Stout et al. 2001; Love et al. 2002). In Washington, brown rockfish appear to be limited to central and south Puget Sound; most reports of the species occur near Seattle and Bainbridge Island (Miller and Borton 1980; Stout et al. 2001). The NOAA Fisheries status review (Stout et al. 2001) described two distinct population segments consisting of Puget Sound proper (the area south of Admiralty Inlet and east of Deception Pass) and the coastal waters west of Cape Flattery. The few brown rockfish reports outside of Puget Sound proper and inland of Cape Flattery were considered to represent vagrant brown rockfish from the Puget Sound proper population segment.

5.3.1.2 Uses, Status and Trends, and Regulatory Issues

The importance of brown rockfish to the fresh fish commercial fishery has diminished through the years. Past recreational fishing for brown rockfish in Puget Sound accounted for up to 31 percent of the recreation harvest in Puget Sound proper (Matthews and Barker 1983). Currently, there is no recreational rockfish fishery in Puget Sound; however, they continue to be at risk from bycatch for lingcod and salmon fisheries. In Puget Sound proper, scuba surveys showed brown rockfish populations increasing by a factor of approximately 6 between 1987 and 1995 (Matthews 1990a; Stout et al. 2001).

Brown rockfish are rare in coastal ecosystems, and no data were available for analysis by the NOAA Fisheries status review (Stout et al. 2001). The risks to the survival of brown rockfish were listed by West (1997) as “anthropogenic stressors and natural limiting factors” and include “over-harvesting, loss or degradation of habitat, predation by pinnipeds and fish, and pollution-related adverse effects.” Loss of eelgrass or kelp through dredging or filling also may negatively affect juvenile and adult habitat (Palsson et al. 1998).

5.3.1.3 Seasonal Distribution in the Study Area

Brown rockfish mate in March and April (Stein and Hassler 1989) in demersal habitats, have internal fertilization, and retain embryos until larval release (Boehlert and Yoklavich 1984). In Puget Sound, ova develop during winter; females in Washington probably give birth annually from May through July (Stout et al. 2001).

5.3.1.4 Utilization of Study Area Habitats by Life History Stages

Brown rockfish are 5 to 6 millimeters (mm) (less than 0. 2 inch) in length at birth and are free floating, preying on zooplankton (Stout et al. 2001). Larvae and juveniles use the open water habitat in the nearshore ecosystem of inland and coastal waters in addition to estuaries for nursery grounds (Stein and Hassler 1989; Stout et al. 2001). After settling, juveniles feed on amphipods, copepods, polychaete worms, shrimp, and small fish (NMFS 2013; Stein and Hassler 1989). Juveniles and subadults commonly live at depths between approximately 122 and 137 meters (400 and 450 feet). Pelagic juvenile brown rockfish settle into shallow, vegetated habitats such as low-relief natural and artificial reefs and beds of kelp or eelgrass (West et al. 1994), in depths of approximately 37 meters (120 feet).

5.3.2 Nearshore Surface Vegetation Complex

The nearshore surface vegetation complex contains the following 11 species and is characterized by the larval and/or juvenile stages strongly associated with the nearshore, kelp canopy, nearshore demersal, or shelf-surface with drifting algal mats.

- Black rockfish (*Sebastes melanops*)
- Blue rockfish (*Sebastes mystinus*)
- Bocaccio rockfish (*Sebastes paucispinis*)
- China rockfish (*Sebastes nubulosus*)
- Copper rockfish (*Sebastes caurinus*)
- Quillback rockfish (*Sebastes maliger*)

- Splitnose rockfish (*Sebastes diploproa*)
- Tiger rockfish (*Sebastes nigrocintus*)
- Vermilion rockfish (*Sebastes miniatus*)
- Widow rockfish (*Sebastes entomelas*)
- Yellowtail rockfish (*Sebastes flavidus*)

Three species of Puget Sound rockfish are listed under the ESA: the bocaccio rockfish is listed as endangered, and the canary and yelloweye rockfish are listed as threatened (75 FR 22276). To describe the group in general, information is provided for the copper rockfish.

5.3.2.1 Geographic Distribution

Copper rockfish range from the Gulf of Alaska to central Baja California (AFSC n.d.). This species is widely distributed in Puget Sound and Washington's coastal waters, except for the southeast Georgia Strait area (Miller and Borton 1980). The NOAA Fisheries status review delineated three DPSs within Washington's waters: (1) Northern Puget Sound (San Juan Islands and Straits of Juan de Fuca), (2) Puget Sound Proper; and (3) Outer Coast (Cape Flattery west) (Stout et al. 2001). The Northern Puget Sound DPS includes not only Washington waters but also the Canadian Gulf Islands and the Strait of Georgia (Stout et al. 2001). The boundaries of the Outer Coast DPS are also broad and ill defined, including areas south into California and north into Alaska. Only the Puget Sound DPS was clearly defined as that area labeled "Puget Sound proper," defined as the marine waters south of Admiralty Inlet and east of Deception Pass.

5.3.2.2 Uses, Status and Trends, and Regulatory Issues

Copper rockfish is a recreationally harvested species with recorded catches of between 800 and 2,000 individuals from 2000 to 2007. As with many of the rockfishes, they have been subject to fisheries bycatch through the years. The copper rockfish is a candidate species in Washington State and does not hold a federal listing. Copper rockfish are vulnerable to overharvest by recreational fisheries in all population segments. West's (1997) presentation of risk factors for copper rockfish in greater Puget Sound points to overharvest as the probable major factor contributing to the decline of these fish. This conclusion was further supported by the findings of the NOAA Fisheries status review (Stout et al. 2001). Late-maturing, long-lived species such as rockfish are slow to rebuild depleted populations, making them particularly sensitive to overfishing.

The risks to the survival of the copper rockfish were listed by West (1997) as "anthropogenic stressors and natural limiting factors" and include "overharvesting, loss or degradation of habitat, predation by pinnipeds and fish, and pollution-related adverse effects." Habitat for juvenile rockfish could be affected through shoreline development. Adult habitat does not appear to be limiting at this time because unoccupied habitat is apparently present in Puget Sound (Stout et al. 2001). The WDFW management strategy is to eliminate targeted harvest of rockfishes in Puget Sound. These rules became effective in 2004 and will help reduce fishing effort on rockfishes.

5.3.2.3 Seasonal Distribution in the Study Area

Adult copper rockfish prefer consolidated habitats of nearshore and upper offshore ecosystems in coastal and inland waters. Their depth range is between 1 and 23 meters (3 and 75 feet) in high-relief rocky reefs and low-relief areas when kelp cover is present (Matthews 1990a). Adults are solitary or occur in small aggregations, with a small home range of 30 to 13,106 square meters (100 to 43,000 square feet)

(Mathews and Barker 1983; Matthews 1990b). During winter, this species may migrate to deeper water or retreat into crevasses (Richards 1987).

5.3.2.4 Utilization of Study Area Habitats by Life History Stages

Larval fish are extruded into the nearshore inland and coastal neritic zones, and associate with shallow-water habitats including algae attached to overwater structures, shallow consolidated reefs, and eelgrass meadows (Shaffer et al. 1995). They remain off the bottom in these habitats until they reach 20 to 45 mm (0.8 to 1.8 inches) total length (Buckley 1997; Love et al. 2002); they prey on zooplankton, polychaetes, and larval fish (Murie 1995; Hueckel and Stayton 1982).

At 50 to 90 mm (2 to 3.5 inches) total length, juveniles settle into benthic habitats on consolidated high-relief rocky reefs and/or in kelp or eelgrass beds at the unconsolidated and consolidated rock interface in water no deeper than 18 meters (59 feet) (Matthews 1990a; West et al. 1994; Shaffer et al. 1995; Buckley 1997). Movement from off bottom to benthic habitats occurs from July to October. The juveniles are crepuscular (twilight) feeders, concentrating feeding activity at dawn and dusk on small fish and crustaceans (Patten 1973; Hueckel and Stayton 1982; Hueckel and Buckley 1987).

5.3.3 Offshore Subsurface Vegetation Complex

The offshore-subsurface vegetation complex contains the following 13 species and is characterized by the larval and/or juvenile stages being strongly associated with continental slope, deep shelf, epipelagic, and demersal habitats.

- Darkblotched rockfish (*Sebastes crameri*)
- Greenstriped rockfish (*Sebastes elongatus*)
- Longspine thornyhead rockfish (*Sebastolobus altivelis*)
- Pacific Ocean perch rockfish (*Sebastes alutus*)
- Rebanded rockfish (*Sebastes babcocki*)
- Redstripe rockfish (*Sebastes proriger*)
- Rosethorn rockfish (*Sebastes helvomaculatus*)
- Rosy rockfish (*Sebastes rosaceus*)
- Rougheye rockfish (*Sebastes aleutianus*)
- Sharpchin rockfish (*Sebastes zacentrus*)
- Shortspine thornyhead rockfish (*Sebastolobus alascanus*)
- Silvergray rockfish (*Sebastes brevispinis*)
- Yelloweye rockfish (*Sebastes ruberrimus*)

To describe the group in general, information for the greenstriped and redstripe rockfish are provided.

5.3.3.1 Geographic Distribution

These species range from Alaska, the Gulf of Alaska, or the Aleutian Islands to southern California (Love et al. 2002). Distribution of greenstriped rockfish in Washington includes coastal waters, the Strait of Juan de Fuca, central and south Puget Sound, and Hood Canal (Palsson et al. 2009). Distribution of redstripe rockfish in Washington includes the San Juan Islands, north Puget Sound (eastern San Juan Islands, Bellingham), Possession Sound (Everett), central Puget Sound, and Hood Canal (Palsson et al. 2009).

5.3.3.2 Uses, Status and Trends, and Regulatory Issues

This complex of rockfish is managed under the Pacific Coast Groundfish Fishery Management Plan (PFMC 2011), and the WDFW has strict limits for recreational take (Palsson et al. 1997). There are little data on population trends for this complex of rockfish, although population trends for many other species of rockfish show evidence of declining abundance due to overharvest as either the target species or bycatch of other fisheries (Wright 1999; Love et al. 2002).

5.3.3.3 Seasonal Distribution in the Study Area

Similar to other rockfish, this complex has internal fertilization and is ovoviviparous, producing live young. Eggs develop internally and hatch several days before they are extruded (parturition) (Love et al. 2002). Some species are multiple brooders, releasing young two or more times per year.

Greenstriped rockfish release larvae that are approximately 5 mm (less than 0.2 inch) long during late spring and early summer off Oregon, Washington, and British Columbia (Hart 1973). Redstripe rockfish release their larvae in Puget Sound during July; the larvae are 3 to 7 mm (0.1 to 0.3 inch) upon release (Kendall and Lenarz 1986). Adults of this complex primarily distribute year-round in deep shelf-demersal habitats.

5.3.3.4 Utilization of Study Area Habitats by Life History Stages

Greenstriped rockfish larvae undergo a planktonic period lasting 1 to 2 months. While drifting, these fish mostly feed on smaller plankton such as copepods and are likely preyed on by siphonophores and chaetognaths (Drake et al. 2010). In Monterey Bay, greenstriped rockfish larvae settle at 3 cm in length, in water deeper than 40 meters (131 feet) over soft bottoms. Newly settled fish have a growth rate of 0.17 mm per day, with the juveniles moving to deeper water as they mature. Juvenile prey items include krill, fishes, shrimp, calanoid copepods, squid, and gammarid amphipods (Love et al. 2002).

Redstripe rockfish larvae feed on all stages of copepods and euphausiids (Kendall and Lenarz 1986) and are likely a food source for planktonic predators such as siphonophores and chaetognaths (Drake et al. 2010). Juvenile redstripe rockfish exhibit a pelagic to semi-demersal movement pattern (Drake et al. 2010) and utilize both marine and estuarine habitat while feeding on all stages of copepods and euphausiids (Kendall and Lenarz 1986).

5.4 Flatfish

The flatfish are a group of species characterized by a demersal adult life history stage compressed form that orient themselves parallel to the substrate; both eyes are positioned on the same side, facing upward. Flatfishes in the study area are separated into two subsections (complexes) for discussion:

- **English sole complex:** fish with larval and juvenile life history stages that are strongly associated with the water surface and estuarine nursery areas.
- **Arrowtooth flounder complex:** fish with epipelagic or pelagic eggs, larvae, and juveniles and distributions of those life history stages farther offshore–in the shallow and deep shelf ecological regions.

5.4.1 English Sole Complex

The English sole complex is comprised of flatfish with similar egg stage characteristics—eggs float at the surface in the nearshore to deep shelf ecological regions—and larvae and juveniles are strongly associated with estuarine habitats. The following species are in the English sole complex:

- Butter sole (*Pleuronectes isolepis*)
- English sole (*Pleuronectes vetulus*)
- Dover sole (*Microstomus pacificus*)
- Flathead sole (*Hippoglossoides elassodon*)
- Sand sole (*Psettichthys melanostictus*)
- Starry flounder (*Platichthys stellatus*)
- Rock sole (*Lepidosetta bilineata*)
- Pacific halibut (*Hippoglossus stenolepis*)
- Pacific sanddab (*Citharichthys stigmaeus*)

English sole is discussed as an example to represent the species in this complex. The species description below, unless otherwise referenced, is a summary and adaptation of information as presented and cited in *Life History, Geographical Distribution, and Habitat Associations of 82 West Coast Groundfish Species: a Literature Review* (McCain et al. 2005).

5.4.1.1 Geographic Distribution

English sole are found from Nunivak Island in the southeast Bering Sea and Agattu Island in the Aleutian Islands, to San Cristobal Bay, Baja California Sur.

5.4.1.2 Seasonal Distribution in Study Area

Adult English sole make limited migrations. Those off Washington show a northward post-spawning migration in spring to summer feeding grounds, and a southerly movement in fall. Tidal currents appear to be the mechanism by which English sole move into estuaries; these currents also transport larvae into nearshore nursery areas (i.e., shallow coastal waters and estuaries). Although many post-larvae settle outside of estuaries, most will enter estuaries during some part of their first year of life. Larvae metamorphose into juveniles in spring and early summer, and rear until fall/winter at which time most emigrate to deeper waters. There is a general movement to deeper waters as fish grow.

5.4.1.3 Uses, Status and Trends, and Regulatory Issues

English sole is an important commercial fish, captured primarily by bottom trawls. Most of the harvest is taken in the coastal waters off the coasts of Washington, Oregon, and California. English sole are usually caught in relatively shallow water, less than 100 meters (328 feet) deep. Females dominate the catch because males seldom grow to marketable size. Along with starry flounder, sand sole, and Pacific sanddab, English sole forms a nearshore, mixed-species flatfish assemblage and fishery. It is not an important recreational species, although it is caught on hook and line by boat, shore, and pier anglers.

5.4.1.4 Utilization of Study Area Habitats by Life History Stages

In the North Pacific, English sole is an inner-shelf mesobenthal species, occurring to 55 meters (180 feet) deep. They are a member of the outer continental shelf community in southern California, the shallow sublittoral community in Puget Sound, and the intermediate depth Nestucca assemblage off Oregon. Eggs and larvae are pelagic; juveniles and adults are demersal. Larvae are found primarily in waters less than 200 meters (656 feet) deep. Larvae undergo diel vertical migrations. Juveniles reside primarily in shallow-water coastal, bay, and estuarine areas and, as they grow, they move to deeper water. Large juveniles commonly occur out to depths of 150 meters (492 feet). Spawning occurs over soft-bottom mud substrata at depths of 50 to70 meters (164 to 230 feet). Spawning occurs in Puget Sound stocks from January to April, peaking in February or March. Adults, spawning adults, and eggs have been found in Puget Sound, Hood Canal, Skagit Bay, and Grays Harbor. Larvae and juveniles occur in most estuaries between Puget Sound and San Pedro Bay, California. English sole is a very important flatfish in shallow-water, soft-bottom marine, and estuarine environments along the Pacific coast.

Adults and juveniles prefer soft bottoms composed of fine sands and mud but also are reported to occur in eelgrass habitats. Associations with sandy sediment at depths less than 110 meters (361 feet) have been reported off the coasts of Oregon and Washington. In Puget Sound, juveniles and adults prefer shallow (<12 meters [40 feet] deep) muddy substrata. Eggs are neritic and buoyant but sink just before hatching. Eggs are mostly found in polyhaline[3] waters at temperatures of 4 to 12ºC (39–54 ºF), optimally at salinities of 25 to 28 part per thousand (ppt) and 8 to 9ºC (46–48 ºF). Adults are found primarily in euhaline waters, while juveniles and larvae occur in polyhaline and euhaline waters. English sole are expected to occur in the study area (Table 17).

5.4.1.5 Trophic Interactions

English sole larvae are planktivorous. Larvae probably eat different life stages of copepods and other small planktonic organisms. Larvae appear to have a strong preference for appendicularians (shaped somewhat like a tadpole). Juveniles and adults are carnivorous, apparently feeding primarily during daylight hours, using sight and smell, and sometimes they dig for prey. Juveniles feed on harpacticoid copepods, gammarid amphipods cumaceans, mysids, polychaetes, small bivalves, clam siphons, and other benthic invertebrates. Small juvenile English sole concentrate their feeding on harpacticoid copepods and other epibenthic crustaceans until they reach approximately 50 to 65 mm (2 to 2.6 inches) in length, then they switch to feeding primarily on polychaetes. (Kravitz et al. 1976).

English sole larvae are probably eaten by larger fishes. The main predators of juvenile English sole are probably piscivorous birds (such as great blue heron), larger fishes, and marine mammals. Adults may be eaten by marine mammals, sharks, and other large fishes. English sole compete for resources with slim sculpin, blackbelly eelpout, Pacific tomcod, spotted ratfish, Dover sole, and white croaker.

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3 *Polyhaline* and *euhaline* refer to the salt content in the seawater**.**

Table 17. Vertical Distribution and Ecological Zone Categories for English Sole Complex Species

Common Name	Scientific Name	Eggs	Larvae	Juvenile[a]	Subadult and Adult[a]
Butter sole	*Pleuronectes isolepis*	Nearshore Float	Offshore Surface	Nearshore to continental slope	Nearshore to continental slope
English sole	*Pleuronectes vetulus*	Nearshore Float	Nearshore Surface	Nearshore to deep shelf	Estuary to continental slope
Dover sole	*Microstomus pacificus*	Epipelagic	Epi-mesopelagic	Nearshore to continental slope	Estuary to continental slope
Flathead sole	*Hippoglossoides elassodon*	Float	Estuaries Surface to epipelagic	Nearshore	Nearshore to continental slope
Pacific halibut	*Hippoglossus stenolepis*	Float	Epipelagic	Nearshore to deep shelf	Shallow shelf to continental slope
Pacific sanddab	*Citharichthys sordidus*	Nearshore and shelf	Estuaries Epipelagic	Estuary to shallow shelf	Estuary to continental slope
Sand sole	*Psettichthys melanostictus*	Nearshore to shallow shelf Float	Estuaries to shelf Subsurface	Estuary to shallow slope	Estuary to continental slope
Starry flounder	*Platichthys stellatus*	Nearshore to shallow shelf Float	Nearshore	Estuary to shallow slope	Estuary to deep shelf
Rock sole	*Lepidosetta bilineata*	Nearshore to continental slope[a]	Subsurface Estuaries	Nearshore to continental slope	Estuary to continental slope

Notes:

Vertical distribution categories are surface, subsurface, epipelagic, and mesopelagic.

Coastal ecological zones are nearshore, shallow shelf, deep shelf, and continental slope.

A *complex* is a subgroup of species with similar distribution and life history patterns.

[a] Demersal.

Sources: McCain et al. 2005; NOAA 2008.

5.4.2 Arrowtooth Flounder Complex

The arrowtooth flounder complex consists of fish with epipelagic or pelagic eggs, larvae, and juveniles and distributions of those life stages farther offshore in the shallow and deep shelf ecological regions. The following species are in this complex:

- Curlfin sole (*Pleuronichthys decurrens*)
- Slender sole (*Lyopsetta exilis*)
- Petrale sole (*Eopsetta jordani*)
- Rex sole (*Glyptocephalus zachirus*)
- Arrowtooth flounder (*Atheresthes stomias*)
- C-O sole (*Pleuronichthys coenosus*)
- Speckled sanddab (*Citharichthys stigmaeus*)

The arrowtooth flounder is discussed as an example to represent the species in this complex. The species description below, unless otherwise referenced, is a summary and adaptation of information as presented and cited in *Life History, Geographical Distribution, and Habitat Associations of 82 West Coast Groundfish Species: a Literature Review* (McCain et al. 2005).

5.4.2.1 Geographic Distribution

Arrowtooth flounder range from the southern coast of Kamchatka to the northwest Bering Sea and Aleutian Islands, to Santa Barbara, California. Densities are low south of Cape Blanco, Oregon.

5.4.2.2 Seasonal Distribution in Study Area

Arrowtooth flounder exhibit a strong migration from shallow-water summer feeding grounds on the continental shelf to deep-water spawning grounds over the continental slope. Depth distribution may vary from as little as 50 meters (164 feet) in summer to more than 500 meters (1,640 feet) in winter.

5.4.2.3 Uses, Status and Trends, and Regulatory Issues

Aarrowtooth flounder is the third most common commercially caught flatfish species off the Washington coast, exceeded only by Dover sole and petrale sole. The catch is made almost exclusively by deepwater trawl. Arrowtooth flounder are not a recreationally important species, but they are caught incidentally.

5.4.2.4 Utilization of Study Area Habitats by Life History Stages

Arrowtooth flounder is the dominant flounder species on the outer continental shelf from the western Gulf of Alaska to Oregon. Eggs and larvae are pelagic; juveniles and adults are demersal in depths of 9 to 900 meters (30 to 3,000 feet). Larvae are neritic, generally in 200 meters (656 feet) of water or less, with larger fish tending to be found deeper. Young juveniles are typically found in waters shallower than 200 meters (656 feet), while older juveniles and adults may be found from 50 to 500 meters (164 to 1,640 feet). However, arrowtooth flounder have been reported to exhibit only weak depth-distribution patterns. Juveniles and adults are most commonly found on sand or sandy gravel substrata but occasionally occur over low-relief rock-sponge bottoms. A strong association with mud, pebble, and mud-pebble substrate has been reported off the coasts of Oregon and Washington. All life stages of the arrowtooth flounder occur almost exclusively in euhaline waters.

The arrowtooth flounder is a batch spawner, and spawning may occur deeper than 500 meters (1,640 feet) off the Washington coast. Spawning occurs off the coast of Washington between fall and winter, and in Puget Sound during winter. This species is unlikely to occur in the study area (Table 18).

5.4.2.5 Trophic Interactions

Larvae eat copepods, their eggs, and copepod nauplii (a larval form). Juveniles and adults feed on crustaceans (mainly ocean pink shrimp and krill) and fish (mainly gadids, herring, and pollock). Arrowtooth flounder exhibit two feeding peaks, at noon and at midnight. The main predators reported for arrowtooth flounder include the Pacific halibut and killer whales.

5.5 Roundfish

Roundfish tend to have elongate body forms, and all of the species are oviparous with external fertilization. Roundfish in the study area are separated into two complexes for discussion:

- **Pacific hake-walleye pollock-Pacific cod-sablefish complex (Complex 1):** species with life history stage associations with surface waters and unconsolidated subtidal and shelf habitats.
- **Lingcod-cabezon-greenling complex (Complex 2):** species that are strongly associated with rocky intertidal and subtidal habitats and sensitive early life history stage associations with surface water and nearshore habitats.

5.5.1 Pacific Hake – Walleye Pollock – Pacific Cod – Sablefish Complex

Pacific hake, Pacific cod, and walleye pollock have sensitive early life stage associations with shallow water or nearshore habitats in the study area and other management issues that warrant more detailed discussion. Sablefish are considered here as part of the hake-pollack-cod complex because of similarities in distribution patterns of larvae and juveniles at and near the ocean surface, as well as in commercial importance. However, sablefish larvae and juvenile distribution are associated only with the western margin of the study area; therefore, sablefish are addressed in less detail.

Table 18. Vertical Distribution and Ecological Zone Categories for Arrowtooth Flounder Complex Species

Common Name	Scientific Name	Eggs	Larvae	Juvenile[a]	Subadult and Adult[a]
Curlfin sole	*Pleuronichthys decurrens*	Nearshore to continental slope	N/A	N/A	Shallow shelf to continental slope
Slender sole	*Lyopsetta exilis*	N/A	N/A	Shallow shelf to deep shelf	Shallow shelf to continental slope
Petrale sole	*Eopsetta jordani*	Shallow shelf to continental slope	Shallow shelf to continental slope	Nearshore to continental slope	Nearshore to continental slope
Rex sole	*Glyptocephalus zachirus*	Nearshore to continental slope	Shallow shelf to continental slope	Deep shelf to continental slope	Estuary to continental slope
Arrowtooth flounder	*Atheresthes stomias*	Shallow shelf to continental slope	Shallow shelf to continental slope	Shallow shelf to continental slope	Shallow shelf to continental slope
C-O sole	*Pleuronichthys coenosus*	N/A	Nearshore	Nearshore to continental slope	Nearshore to continental slope
Speckled sanddab	*Citharichthys stigmaeus*	Pelagic	Nearshore Pelagic	Nearshore to continental slope	Nearshore to continental slope

Notes:

N/A = Not applicable.

Vertical distribution categories are surface, subsurface, epipelagic, and mesopelagic.

Coastal ecological zones are nearshore, shallow shelf, deep shelf, and continental slope.

A *complex* is a subgroup of species with similar distribution and life history patterns.

[a] Demersal.

Source: McCain et al. 2005.

Other deepwater offshore species of roundfish, such as Pacific grenadier, Pacific flatnose, and Pacific midshipman were considered in association with this complex. Because these and similar species are found at the outer margins and beyond the study area, and at depths that isolate them from the events at issue, they are not further addressed here.

The following species are included in the hake-pollack-cod complex:

- Pacific hake (Pacific whiting) (*Merluccius productus*)
- Pacific cod (*Gadus macrocephalus*)
- Walleye pollock (*Theragra chalcogramma*)
- Sablefish (*Anoplopoma fimbria*)
- Pacific grenadier (*Coryphaenoides acrolepis*)

The species descriptions below, unless otherwise referenced, are largely a summary and adaptation of information as presented and cited in *Life History, Geographical Distribution, and Habitat Associations of 82 West Coast Groundfish Species: a Literature Review* (McCain et al. 2005).

5.5.1.1 Geographic Distribution

Coastal stock Pacific hake range from Attu Island in the western Gulf of Alaska to Magdalena Bay, southern Baja California. They are most abundant in the California Current System. A smaller stock unit (designated as a Georgia Basin Pacific hake DPS) occupies the study area, and other stocks may exist within the above range outside the study area that are not considered further here (Bailey et al. 1982; Hart 1973). Smith (1995) recognized three habitats utilized by the offshore stock of Pacific hake: (1) a narrow 30,000-km^2 (18,640-mi^2) feeding habitat near the shelf break of British Columbia, Washington, Oregon, and California, populated 6–8 months per year; (2) a broad 300,000-km^2 (186,400-mi^2) open sea area of California and Baja California populated by spawning adults in winter and embryos and larvae for 4-6 months; and (3) a continental shelf juvenile rearing area of unknown size off the coast of California and Baja California.

Walleye pollock are found in the waters of the northeastern Pacific Ocean from the Sea of Japan, north to the Sea of Okhotsk, east in the Bering Sea and Gulf of Alaska, and south in the northwestern Pacific Ocean along the Canadian and U.S. West Coast to Carmel, California. Currents, eddies, and meso-scale physical structures along a coast influence the distribution of early life history stages. The distributions of later life history stages of walleye pollock appear to be influenced by temperature, light, and prey abundance—variables that may change in an area from year to year (Bailey et al. 1996; Bailey 1989; Swartzman et al. 1994; Olla et al. 1996; Sogard and Olla 1996a, 1996b; Brodeur et al. 1995; Ciannelli et al. 2002). Adult walleye pollock are generally a semi-demersal species that inhabit the continental shelf and slope. Moreover, various life history stages are capable of inhabiting nearshore areas, large estuaries such as Puget Sound, coastal embayments, and open ocean basins. The primary densities of numerous populations are in the North Pacific Ocean, including the northern Gulf of Alaska, Bering Sea, and the Sea of Okhotsk, suggesting that walleye pollock populations in Puget Sound are relatively isolated. Adults occur as deep as 366 meters (1,200 feet), but the vast majority occur between 100 and 300 meters (330 and 985 feet) deep. Spawning takes place at depths of from 50 to 300 meters (165 to 985 feet). Eggs are pelagic and are found throughout the water column. Larvae and small juveniles are pelagic and are generally found in the upper water column to depths of 60 meters (200 feet). Post-larvae and small juveniles occupy a wider depth range, generally with diel movements that involve rising to the surface at night to feed and sinking down in schools during the day. Juvenile pollock have been found in a variety of habitat types, including eelgrass (over sand and mud), gravel, and cobble. Because of their pelagic mode, however, they are not thought to consistently associate with many types of substrates (Hart 1973; Merati and Brodeur 1996; Bailey et al. 1996; Miller et al. 1977).

Pacific cod are found in the waters of the northeast Pacific from the Sea of Japan, east to the Bering Sea in Alaska, and south along the West Coast to Santa Monica, California. Pacific cod in Puget Sound are generally categorized into three components: (1) the North Sound component (located in U.S. waters north of Deception Pass, including the San Juan Islands, Strait of Georgia, and Bellingham Bay); (2) the West Sound component (located west of Admiralty Inlet and Whidbey Island, and in the U.S. section of the Strait of Juan De Fuca, including Port Townsend); and (3) the South Sound component (located south of Admiralty Inlet). The primary densities of numerous populations historically have been in the North Pacific, including the Bering Sea and the waters near northern Japan, suggesting that cod populations in Puget Sound are relatively isolated (Allen and Smith 1988; Fredin 1985; Shimada and Kimura 1994; Westrheim 1996; Stout et al. 2001).

Sablefish range from Baja California to the western Bering Sea and the northeastern Pacific Ocean to Japan. Three stocks of sablefish appear to exist along the west coast of North America. Two of those stocks appear to overlap off the coasts of southwest Vancouver Island and northwest Washington and in the study area: a northern population inhabits Alaska and northern British Columbia waters; and a southern population inhabits southern British Columbia and Washington, Oregon, and California waters as summarized by Schirripa (2007).

5.5.1.2 Seasonal Distribution in Study Area

The Pacific hake is unorthodox among the roundfishes because it is highly migratory, moving into many areas of the West Coast, including nearshore shelf, shelf break, and slope (McCain et al. 2005). The offshore Pacific hake stock spawns off the California coast in winter and then mature adults begin moving northward and inshore, following the food supply and Davidson currents, and reaching the study area and into British Columbia by fall. By late fall, they are migrating back to the southern spawning grounds (Bailey et al. 1982; Dorn 1995; Smith 1995; Stauffer 1985). Pacific hake stocks in the Strait of Georgia and Puget Sound undergo similar migration patterns but on a greatly reduced scale. In both areas, spawning occurs in locations proximate to major sources of freshwater inflow: near the Frazer River in the Strait of Georgia and near the Skagit and Snohomish Rivers in Port Susan. The Puget Sound and Strait of Georgia stocks spend their entire lives in these estuaries (McFarlane and Beamish 1985; Pedersen 1985; King and McFarlane 2006).

Walleye pollock are not considered to be a migratory species, but pre-spawning adults do make relatively short migrations to regional spawning grounds. These grounds are generally in sea valleys, canyons, indentations in the outer margin of the continental shelf, or in fjords such as Puget Sound (Schumacher and Kendall 1995). A seasonal bathymetric movement occurs from deep spawning areas of the outer shelf and upper slope in fall and winter to shallow middle-upper shelf feeding grounds in spring. Larvae may be transported by tidal current to nursery areas. Some evidence suggests that the fish move into deeper water with growth, but they are not found exclusively in deeper water (Dunn and Matarese 1987; Hart 1973; Shimada and Kimura 1994; Brodeur et al. 1995; Palsson et al. 1998).

5.5.1.3 Uses, Status and Trends, and Regulatory Issues

Pacific hake support one of the most important commercial fisheries off the West Coast. Coastal stocks are fished with midwater trawls off the northern California coast starting in April and moving northward to British Columbia by late July. Fishing ceases in October. The interior stocks of Pacific hake in Puget Sound and the Strait of Georgia are fished from January through May (Gustafson et al. 2000). Historically, commercial fisheries for Pacific hake in Puget Sound centered on the Port Susan, Saratoga Passage, Port Gardner, and southern Carr Inlet areas. Pacific hake is not a recreationally sought after species; almost all recreational catch is incidental to salmon fishing (Gustafson et al. 2000).

Pacific cod also support commercial fisheries along the West Coast. Primary fishing methods are bottom trawling and longlining. Pacific cod also are fished recreationally from boats and piers. The fisheries in Puget Sound have been restricted in recent years to address concerns for the depressed status of the stock (Gustafson et al. 2000). In a recent status review, a Biological Review Team (BRT)—a scientific panel convened by NOAA Fisheries—concluded that inshore resident Pacific hake within the marine waters of the Strait of Georgia, Puget Sound, and eastern Strait of Juan de Fuca constitute a discrete segment of the species that warrants separate consideration relative to offshore Pacific hake. The unit has been designated as the Georgia Basin Pacific hake DPS and is considered a species under the ESA. The BRT further concluded that the Georgia Basin Pacific hake DPS was not presently in danger of extinction, but it continues to be under ongoing review as a species of concern. In the same review, the BRT further concluded that the Lower Boreal Eastern Pacific walleye pollock DPS extends from Puget Sound northward to encompass all of southeast Alaska. The BRT also concluded there is good reason to believe that Pacific cod from Puget Sound are part of a DPS that extends beyond the boundaries of the Puget Sound ecosystem, to at least as far north as Dixon Entrance. Quantitative information on the abundance of Pacific cod stocks and on potential factors affecting their abundances is limited, and members of the BRT expressed considerable uncertainty in assessing extinction risks. Members of the BRT identified several concerns, especially about the status of Puget Sound stocks. Given the general synchronicity of the changes in apparent Pacific cod abundance from Puget Sound to southeast Alaska, some BRT members are concerned that factors affecting the decline of the Puget Sound stocks will similarly affect the stocks in British Columbia and southeast Alaska in the future. Overall, it is uncertain which factors, either singly or in combination, may be significantly contributing to the current low stock sizes of Pacific cod. (Gustafson et al. 2000.)

5.5.1.4 Utilization of Study Area Habitats by Life History Stages

Pacific hake adults are epi-mesopelagic; they most frequently occur between 100 and 150 meters (328 to 492 feet), with nearly all taken at depths of 50 to 400 meters (164 to 1,312 feet). All life stages of Pacific hake feed near the surface late at night and early in the morning (Bailey et al. 1982; Sumida and Moser 1980; Allen and Smith 1988). Pacific hake larvae tend to aggregate near the base of the thermocline or mixed layer (Stauffer 1985). This association with the thermocline or mixed layer may partially explain why Pacific hake in the Strait of Georgia and Puget Sound spawn near major sources of freshwater, which would cause a stratified layer of low-salinity water on top of the well mixed marine waters common during winter. Larvae would likely be found in the study area in the southern Strait of Georgia, San Juan archipelago, Skagit Bay, and Port Susan during late winter through spring (Gustafson et al. 2000). Juveniles reside in shallow coastal waters, bays, and estuaries and move to deeper water as they get older. Older juveniles and adults therefore would be found throughout those same areas in the southern Strait of Georgia, San Juan archipelago, and the rest of the eastern region of the study area throughout the year (Bailey et al. 1982; Dark 1975; Dark and Wilkins 1994; Dorn 1995; Sakuma and Ralston 1995; Smith 1995).

The distribution of juvenile and adult walleye pollock is determined by a variety of biological and environmental factors, including hydrographic fronts, temperature, light intensity, prey availability, and depth. Larvae tend to aggregate in patches under the influence of currents, geographical formations, and availability of prey. Puget Sound information on the relationship between the bathymetric distribution and size suggests that the tendency for juvenile walleye pollock to move into deeper waters with age, as has been reported in coastal walleye pollock populations, also occurs in Puget Sound. Both adult and juvenile walleye pollock exhibit diel vertical migrations in order to forage on prey practicing that behavior (Sogard and Olla 1996a; Bailey et al. 1999).

Pacific cod are historically an important groundfish of shallow, soft-bottom habitats in marine and estuarine environments along the West Coast (Gustafson et al. 2000). All life stages of Pacific cod occur in various bays in Puget Sound and in the Strait of Juan de Fuca near Vancouver Island. Adults and large juveniles prefer mud, sand, and clay, although adults have been found associated with coarse sand and gravel substrata (Gustafson et al. 2000). Adult Pacific cod are a member of the inner shelf-mesobenthal community. Adults are found in marine waters, whereas juveniles are found in polyhaline to euhaline waters. Adults occur as deep as 875 meters (2,870 feet), but the vast majority occurs between 50 and 300 meters (164 and 984 feet) (Allen and Smith 1988; Hart 1973). Spawning occurs from 40 to 265 meters (131 to 1,526 feet) deep; eggs are demersal adhesive and are found sublittorally in polyhaline to euhaline waters. Larvae and small juveniles are pelagic; large juveniles and adults are parademersal. Larvae are found in the upper 45 meters (148 feet) of the water column, with the highest abundances between 15 and 30 meters (49 and 98 feet). Eggs and larvae are found over the continental shelf between Washington and central California from winter through summer. Small juveniles usually settle between

60 and 150 meters (197 and 492 feet) deep, gradually moving into deeper water with increased age (Alderdice and Forrester 1971; Dunn and Matarese 1987; Hart 1973; Matarese et al. 1981). Pacific cod juveniles and adults are carnivorous and feed at night. Juveniles have been reported to eat a variety of size-dependent suitable prey such as shrimp, mysids, amphipods, crabs, sand lance, and walleye pollock (Allen and Smith 1988). Adult Pacific cod have been described as euryphages (able to subsist on a wide variety of foods) because the main part of their diet is whatever prey species is most abundant (Klovach et al. 1995).

In the North Pacific, sablefish is considered an inner shelf-bathybenthal species. Adults are found as deep as 3,000 meters (9,843 feet) but are most abundant between 200 and 1,000 meters (656 and 3,281 feet). Spawning takes place at depths greater than 300 meters (983 feet). Sablefish eggs, larvae, and young juveniles are pelagic, whereas older juveniles and adults are benthopelagic on soft bottoms. Eggs are usually found deeper than 300 meters (983 feet). Eggs and newly hatched larvae are found in these deep waters from January through March. Newly hatched larvae are demersal until the yolk sac is absorbed, at which time larvae become pelagic and rise to the neuston layer at the surface. Larvae and young juveniles are found up to 370 km (230 mi) offshore, often near drifting kelp. Young juveniles inhabit the upper 100 meters (328 feet) of the water column. Larvae and small juveniles move inshore after spawning and may rear there for up to 4 years. McFarlane et al. (1997) reported that larval sablefish collected off the west coast of Vancouver Island tended to be most abundant in waters where mean currents were weakest. They suggest that the distribution of the larvae in the water column at the time of the spring transition (i.e., the onset of upwelling conditions) strongly influences the abundance and distribution of sablefish larvae. Older juveniles and adults inhabit progressively deeper waters, although juveniles are rarely found at depths greater than 200 meters (656 feet) (Hart 1973; Kendall and Matarese 1987; Boehlert and Yoklavich 1985; Beamish and McFarlane 1988; Grover and Olla 1990).

5.5.1.5 Reproduction

The coastal stock of Pacific hake spawns from December through March, peaking in late January. In the Strait of Georgia, spawning occurs from March through May and peaks in late April. Spawning occurs primarily during February through April, peaking in March. Spawning aggregations begin to form up to a month before actual spawning (Smith 1995; Beamish and McFarlane 1985). Within Puget Sound (including Hood Canal), Pacific hake are known to spawn in Port Susan and in Dabob Bay, and there may be other spawning aggregations of Pacific hake in Puget Sound (Bailey and Yen 1983; Pedersen 1985). The main Pacific hake stock in the Strait of Georgia aggregates to spawn in the deep basins of the southcentral Strait of Georgia, with peak spawning occurring from March to May. This area is bound by Halibut Bank and Gabriola Island to the east and west, and Texada Island and Galiano Island to the north and south. Spawning aggregations of Pacific hake in the southcentral Strait of Georgia occur in two depth strata: between 50 and 120 meters (164 and 394 feet) and between 150 and 330 meters (492 and 1,083 feet). A second discrete stock of Pacific hake in the Strait of Georgia has been found spawning northwest of Texada Island near Montgomery Bank, and reports of other spawning and fish in spawning condition throughout the year suggest further diversity within the stock (Goñi 1988; Kieser et al. 1999).

Walleye pollock are oviparous with external fertilization; eggs are pelagic. During spawning, walleye pollock apparently pair and spawn after a complex courtship. Females spawn several batches of eggs over a short period of time (multiple-batch spawning). Eggs are usually spawned in deep water and remain at 100 to 400 meters (328 to 1,312 feet) deep at most spawning localities but also can be spawned in shallower waters in coastal bays such as those in the eastern region of the study area (Baird and Olla 1991; Hinckley 1987).

Pacific cod spawning occurs from late fall to early spring in Puget Sound (Gustafson et al. 2000); stocks farther north in the Gulf of Alaska and the Bering Sea spawn in winter through spring (Klovach et al.

1995). Eggs are demersal, adhesive, and found in polyhaline (dense saltwater) to euhaline waters between 1EC and 10EC (Alderdice and Forrester 1971; Dunn and Matarese 1987; Hart 1973). Cod eggs have been found associated with coarse sand and cobble bottoms (Phillips and Mason 1986). Because most winter concentration areas have bottom sediments consisting of coarse sand and cobble, it is inferred that cod preferentially spawn near these bottom types (Phillips and Mason 1986).

Sablefish spawning takes place largely or totally out of the study area.

5.5.2 Lingcod – Cabezon – Greenling Complex

This subsection of the roundfish group describes the lingcod-cabezon-greenling complex. Lingcod, cabezon, and kelp greenling are important commercial and recreational fishery resources. They have sensitive early life stage associations with surface water and nearshore habitats in the study area and therefore warrant discussion here.

The following species are included in the lingcod-cabezon-greenling complex:

- Lingcod (*Ophiodon elongatus*)
- Cabezon (*Scorpaenichthys marmoratus*)
- Kelp greenling (*Hexagrammos decagrammus*)

The species descriptions below, unless otherwise referenced, are largely a summary and adaptation of information as presented and cited in *Life History, Geographical Distribution, and Habitat Associations of 82 West Coast Groundfish Species: a Literature Review* (McCain et al. 2005).

5.5.2.1 Geographic Distribution

Lingcod occur from Shumagin Island in the Gulf of Alaska to Punta San Carlos, Baja California. Highest densities are found from Cape Spencer, Alaska to Point Conception, California. Cabezon are found in southeast Alaska to as far south as Punta Abreojos in central Baja California. Kelp greenling are relatively common all along the west coast of North America, from the Aleutian Islands to southern California off La Jolla.

5.5.2.2 Seasonal Distribution in Study Area

Adult lingcod are considered a relatively sedentary species. Mature males may live their whole lives associated with a single rock reef. However, migrations greater than 100 km (62 mi) have been reported, typically undertaken by sexually immature fish. Adult cabezon and kelp greenling appear to be more sedentary and are not known to make any significant migrations. Pacunski and Palsson (2001) reported no changes in kelp greenling density between 1993 and 1998 in northern Puget Sound, indicating that no individuals were leaving or entering the study area.

In late winter, newly hatched lingcod larvae are carried by tidal currents into rearing areas within estuaries. Larvae metamorphose in late spring to early summer into juveniles that settle from surface waters and migrate to bottom habitats, frequently around kelp and eelgrass beds, and rear until winter before moving to deeper waters. Both cabezon and kelp greenling larvae have been reported to be carried great distances by offshore oceanic currents, and kelp greenling may take up to a year for larvae to return and settle into nearshore habitats.

5.5.2.3 Uses, Status and Trends, and Regulatory Issues

Lingcod support an important commercial and recreational fishery throughout their range. Lingcod are caught commercially through five main gear types: bottom trolling, handline jigging, otter trawls, set nets, and set lines. Catches are generally highest in depths of 70 to 150 meters (230 to 492 feet), and catches on the West Coast have been highest from Vancouver Island to the Columbia River estuary. Lingcod, cabezon, and kelp greenling are all taken throughout their range by recreational fishers from boats, docks, and shore, and by spear-fishing divers.

5.5.2.4 Utilization of Study Area Habitats by Life History Stages

In the North Pacific, lingcod occupy the estuarine-mesobenthal zone, occurring from intertidal areas to 475 meters (1,558 feet) deep. Older larvae and very young juveniles are epipelagic, primarily found in the upper 3 meters (10 feet) of the water column in waters less than 150 meters (492 feet) deep. Eggs, young larvae, older juveniles, and adults are demersal. Spawning generally occurs in waters from 3 to 10 meters (10 to 33 feet) below mean lower low water over rocky reefs in areas of swift current. Adults, spawning adults, and eggs are common in Puget Sound, Hood Canal, and Skagit Bay in Washington.

Eggs masses are found in association with rocky reefs. Egg masses usually are found wedged in rock crevices or under overhanging boulders in areas with currents 3.5 km/hour (2.2 mi/hour) or greater to maintain interstitial oxygen levels in the center of the mass. Juveniles and larval lingcod are common in most Washington estuaries. Eggs and larvae occur in nearshore areas from winter through late spring. Small juveniles settle in estuaries and shallow waters all along the coast but are more common in northerly extents of the range. Juveniles move to deeper waters as they grow but are still most common in waters less than 150 meters (492 feet) deep. Juvenile lingcod prefer sandy and rocky substrata in subtidal zones and estuaries. All life history stages occur in polyhaline to euhaline waters (18 to 30+ ppt) that are between 5 and 15 ^{o}C, although juveniles may also be found in mesohaline waters (5 to 18 ppt). Adult and large juvenile lingcod have been reported to prefer rocky subtidal and other associated habitats, including slopes of submerged banks, ridges, and boulders. In some cases, they are found on soft bottoms and channels with swift currents that flow around rocky reefs, concentrating plankton and plankton-feeding fish.

Cabezon are found on hard bottoms in shallow water from intertidal pools to depths of 76 meters (250 feet). Cabezon are found intertidally or in shallow, subtidal areas on a variety of habitats, often in the vicinity of kelp beds, jetties, isolated rocky reefs, or pinnacles and in shallow tide pools. Rocky bottoms and cobble substrata are utilized most frequently. Eelgrass beds and occasionally sandy bottoms are used. Cabezon are abundant all year in estuarine and subtidal areas, as well as to mid-depths along the continental shelf. Eggs, large juveniles, and adults are demersal; larvae and small juveniles are pelagic and planktivorous. Juveniles and adults reside primarily in shallow water bays and estuarine areas. Pelagic juveniles are silvery when small, spending their first 3 to 4 months in the open ocean feeding on tiny crustaceans and other zooplankton. Off the Washington coast, adults are found as deep as 80 meters (262 feet) but are most common intertidally to 25 meters (82 feet). Cabezon are most abundant in estuaries of the West Coast, where all life stages can be found. Eggs and larvae are found there from winter through spring. Eggs, juveniles, and adults are not reported to occur far offshore. However, neustonic planktivorous larvae have been reported as far from shore as 322 km (200 mi).

Kelp greenling adults, spawning adults, and large juveniles are abundant in coastal waters and in inland seas, such as Puget Sound. Adults are demersal, inhabiting rocky reefs of shallow nearshore areas. Kelp greenlings show a high affinity to rocky banks near dense algae or kelp beds, or in kelp beds. Eggs are demersal and found subtidally. Larvae and small juveniles are pelagic whereas large juveniles are demersal. In Puget Sound, adults are most abundant between 7 and 12 meters (23 and 39 feet) and are not commonly found below 20 meters (66 feet). Larvae and small juveniles are found in the upper 45 meters (148 feet) of the water column in spring and summer, and may be found up to 965 km (600 mi) offshore. Juveniles are commonly associated with rocky reefs and macroalgae, and occasionally are found in tide pools.

5.5.2.5 Reproduction

Lingcod are iteroparous and gonochoristic (individuals are either male or female and maintain the same sex throughout their lifespan). Spawning takes place in Washington waters (Puget Sound, Hood Canal, and Skagit Bay) and peaks from February to March. Embryonic development is indirect and external. Egg masses are adherent and usually are laid in rock crevices or on rocky reefs. Males guard the nest until hatching.

The spawning season for cabezon in Puget Sound is from November to early May, peaking in March. Cabezon may spawn more than once per year. Cabezon males build and guard nests, and more than one female may deposit egg masses in the same male’s nest. Fertilized eggs are adherent to rocks and macroalgae.

Kelp greenling spawning in Puget Sound occurs in fall and peaks in October and November. Fertilized eggs are laid on or between rocks, or in algae beds and are guarded by the males. Upon hatching, larvae immediately move to open seas for approximately 1 year and return as demersal juveniles.

5.6 Forage Fish

Small, schooling fish species known as forage fish play an important ecological role as the link between lower trophic levels (primary and secondary planktonic production) and higher trophic level species (such as salmon, marine mammals, and marine birds). Several forage fish species occur in Puget Sound and in the nearshore waters of Washington State and British Columbia. The three primary species found in the study area include Pacific herring, surf smelt, and Pacific sand lance. These species are described in more detail below.

5.6.1 Pacific Herring

In the past, Pacific herring in Puget Sound commonly were encountered up to 10 years of age. In more recent years, herring rarely live over 6 years. This curtailed age structure may be due to fishing pressure or disease (Hershberger et al. 2002). Pacific herring are iteroparous, spawning once per year after they reach sexual maturity at approximately age 2 to 4.

Pacific herring are zooplanktivores, feeding on pelagic plankton. Larvae feed on copepods, invertebrate eggs, and diatoms (Stout et al. 2001; Hart 1973; Lasker 1985). Juveniles eat copepods, decapod larvae in sublittoral habitats, and copepods and euphausiids in pelagic habitats (Stout et al. 2001; Fresh et al. 1981). Adults eat planktonic crustaceans and smaller fishes (Stout et al. 2001; Hart 1973). Herring in turn are eaten by many species throughout their life cycle. Eggs and larvae are eaten by other fish, invertebrates, and birds. Adult herring form large pelagic schools and are preyed upon by many species of fish, including salmon, hake, sablefish, and dogfish, as well as pinnipeds, orcas, and birds (Stout et al. 2001; Hourston and Haegele 1980).

Spawning occurs in the intertidal and shallow subtidal zone (0 to 3 meters [0 to 10 feet]) of sheltered inlets, sounds, bays, and estuaries. Prior to spawning, herring congregate in holding areas near the spawning site for several weeks, where they are most susceptible to fishing pressure and predation. Eggs are deposited over, and adhere to, various types of substrate—the most common being kelp or eelgrass, but in some instances, gravel or bare rock. Incubation ranges from 10 to 14 days, depending on temperature, with much longer incubation in colder waters. Once the eggs hatch, larvae drift with the currents for several months until they metamorphose into juveniles. The timing and location of spawning in relation to the local oceanography are important factors that determine whether larvae will be retained in food-rich waters close to shore or will be transported to less hospitable areas offshore. Juveniles form large schools in protected nearshore areas during their first summer and then either migrate offshore to feed or remain inshore until maturity. The former life history is the most common, especially for north Puget Sound and Strait of Georgia stocks, whereas the latter life history is relatively more common in herring from southcentral Puget Sound (Gao et al. 2001).

5.6.1.1 Geographic Distribution

Pacific herring are distributed widely across the temperate coastal waters of the North Pacific Ocean. Along North America, Pacific herring range from the Bering Sea to Baja California. In the northwest Pacific, this species ranges from Arctic waters of the Aleutian chain and Kamchatka Peninsula south to the Sea of Japan.

In the study area, Pacific herring are distributed throughout the marine and estuarine waters of Puget Sound, Hood Canal, the San Juan Islands, the Strait of Juan de Fuca, the Strait of Georgia, and the outer coast. There is some dichotomy in the life history because some individuals from each stock are migratory, leaving the inland waters to feed in the nutrient-rich coastal upwelling zone, and some remain resident to their respective areas. It is generally known that herring exhibit some level of fidelity to spawning sites although stray rates could be as much as 20 percent (Hourston 1982). The study area includes the migration corridor for south and central Puget Sound stocks as well as the spawning locations and residence areas of north Puget Sound and Strait of Juan de Fuca stocks.

5.6.1.2 Uses, Status, Trends, and Regulatory Issues

Many different types of herring fisheries have existed historically to meet demand for either eggs or adults. Currently, commercial harvest of herring is limited to a sport bait fishery, which targets 1.5-year-old herring with small seines in southcentral Puget Sound. From 1995 to 2004, the average annual landing by the herring sport bait fishery was 414 tons (Stick 2005). Until the late 1990s, a spawn-on-kelp fishery took place mostly in north Puget Sound. Gravid fish were captured prior to spawning, retained in net pens strung with pieces of kelp until eggs were released, and then released back into the wild. A significant drop in abundance of the primary stock used for this fishery, the Cherry Point stock, led to more stringent regulations and the effective end of the spawn-on-kelp fishery. A spawning biomass of 3,200 tons for the Cherry Point herring stock is required before the fishery will be reconsidered. The recreational fishery is believed to be relatively insignificant in terms of landings. Anglers either jig or dip herring for use as bait for other fisheries such as salmon and groundfish.

The WDFW manages Pacific herring as 22 distinct stocks, with 19 in Puget Sound (Table 19). Each stock’s status is reviewed biannually based on biomass estimates achieved by spawning deposition surveys and acoustic/trawl surveys. The status of these stocks is variable but generally has declined in recent years, especially in the north Puget Sound and Strait of Juan de Fuca regions (Stick 2005).

Other than the direct mortality incurred from fishing pressure, which is managed in a precautionary way by the WDFW, the most significant threat to the health and abundance of herring populations is the trend in stabilizing beaches with bulkhead structures to facilitate commercial and residential construction. Shoreline armoring alters beach formation processes and wave action, which leads to erosion and loss of intertidal and subtidal vegetation (Thom and Hallum 1990). Non-point source pollution and stormwater issues stemming from increased human activities also can lead to a loss of eelgrass beds that are critical for herring spawning success. Pacific herring are considered a Washington State Priority Species, and all known spawning beds are considered Saltwater Habitat Areas of Special Concern (WAC 220-110-250), which means that disturbance may be prohibited or conditional.

The conservation status of Pacific herring in Washington State also has drawn the attention of the National Oceanic and Atmospheric Administration (NOAA) because of several petitions submitted to the agency to list certain herring stocks under the ESA. In response to the multiple petitions, NOAA reviewed the status of Pacific herring with a focus on determining whether the population (defined by the petitioners) met the requisite criteria to be considered a DPS (USFWS and NMFS 1996). Namely, evidence was needed to show that the Cherry Point stock is both distinct from other nearby herring stocks and significant to the long-term persistence of the species throughout its range. Based on the best scientific evidence available at the time, the initial status review determined that Cherry Point herring were part of the Georgia Basin DPS and not at risk of extinction (Stout et al. 2001). In the updated status review, NOAA determined that, although the Cherry Point herring stock is discrete, it does not warrant consideration as a DPS because it does not constitute a significant part of the species range (Gustafson et al. 2006). As part of a metapopulation, the local decline of the Cherry Point herring stock does not threaten the persistence of the species.

5.6.1.3 Seasonal Distribution in Study Area

Pacific herring are present year-round in the study area. Herring that undergo seasonal migrations to offshore feeding areas primarily utilize the nearshore habitats of north Puget Sound and the Strait of Juan de Fuca only in late winter as spawning grounds (or in the case of the Cherry Point stock, in late spring). Migratory herring from throughout Puget Sound utilize the study area as a feeding and migration corridor prior to and after winter spawning. Any adult herring that remain resident, along with young-of-the-year, may be present in the study area during summer.

5.6.1.4 Use of Study Area Habitats by Life History Stages

Pacific herring spawning locations throughout the greater Puget Sound area, including the study area, are illustrated in Figure 5. Spawn timing in Puget Sound generally occurs in late winter and early spring, with a peak during the last week of February through the first week of March (Stout et al. 2001). The Cherry Point herring stock is an exception, with peak spawning occurring on approximately May 10 (O'Toole et al. 2000). Intertidal and subtidal vegetation are important features of the habitat to ensure egg survival. Larvae use the entire water column, with depth distribution linked to temperature preferences (Batty 1994). Juvenile herring settle into protected nearshore areas. Because of their dichotomous life history, adults (migratory or resident) can be found within all estuarine, shallow nearshore, and pelagic habitats. The western Strait of Juan de Fuca and outer coast areas are used primarily for feeding by adults in summer.

5.6.2 Pacific Sand Lance

Pacific sand lance are a narrow, elongated forage fish common to marine and estuarine waters throughout Puget Sound, the Strait of Georgia, the Strait of Juan de Fuca, and the protected bays and inlets of coastal Washington State and Vancouver Island. Sand lance are perciformes, in the class Actinopterygii (related to sand eels, commonly known to burrow in sandy substrates). They can attain a maximum length of 30 centimeters (cm) (1 foot) and an age of 11 years. Also referred to as *candlefish*, post-larval Pacific sand lance school in nearshore waters and serve as an important prey item for piscivorous fish, birds, and marine mammals.

Table 19. Pacific Herring Stocks in Washington State Waters

Spawning Ground	Spawning and Holding Sites Present in Study Area[a]	Region[b]	Months of Peak Spawning	Pre-Spawning Holding Area	1977–1996 Average Run Size (tons)	Current Stock Status	Recent Trend	Federal/ State Status
Squaxin Pass	N	South/Central PS	Jan-Apr	Nisqually Reach	439	Moderately healthy	Stable	N/A
Wollochet Bay	N	South/Central PS	Jan- Feb	Hale Passage on NE side of Fox Island	117[c]	Unknown	Stable	N/A
Quartermaster Harbor	N	South/Central PS	Jan-Apr	S Maury Island	1,224	Healthy	Stable	N/A
Port Orchard/ Port Madison	N	South/Central PS	Jan-Apr	(1) Near Fletcher Bay to Port Orchard (2) Between Indianola, Agate Pass, and Port Madison	1,281	Depressed	Stable	N/A
South Hood Canal	N	South/Central PS	Jan-Mar	SW Hood Canal	272	Unknown	Stable	N/A
Quilcene Bay	N	South/Central PS	Jan-Apr	Not listed	251	Healthy	Stable	N/A
Port Gamble	N	South/Central PS	Jan-Apr	NE Hood Canal	2,214	Healthy	Decreasing	N/A
Kilisut Harbor	Y	South/Central PS	Feb-Mar	NW Indian Island, SE Port Townsend	405	Unknown	Stable	N/A
Port Susan	Y	South/Central PS	Jan-Apr	E off Southern Camano Island	823	Depressed	Stable	N/A
Holmes Harbor	Y	South/Central PS	Feb-Apr	Not listed	373	Unknown	Increasing	N/A
Skagit Bay	Y	South/Central PS	Feb-Apr	Between SE Whidbey and NE Camano	867	Healthy	Stable	N/A
Fidalgo Bay	Y	North PS	Jan-Apr	E Guemes Island	775	Healthy	Stable	N/A
Samish-Portage Bay	Y	North PS	Feb-Apr	(1) SE Lummi Island (2) NE Samish Island	283	Healthy	Stable	N/A
Interior San Juan Islands	Y	North PS	Jan-Apr	Between Blakely, Lopez, and Orcas	254	Unknown	Insufficient	N/A

Table 19. Pacific Herring Stocks within Washington State Waters (Continued)

Spawning Ground	Spawning and Holding Sites Present in Study Area[a]	Region[b]	Months of Peak Spawning	Pre-Spawning Holding Area	1977–1996 Average Run Size (tons)	Current Stock Status	Recent Trend	Federal/ State Status
NW San Juan Islands	Y	North PS	Jan-Apr	Not listed	200	Unknown	Insufficient	N/A
Semiahmoo Bay	Y	North PS	Feb-Apr	W off Birch Bay S to Cherry Point	1,461	Healthy	Stable	N/A
Cherry Point	Y	North PS	Mar-Jun	W off Birch Bay S to Neptune Beach	6,095	Depressed	Increasing	FC/SC[d]
Discovery Bay	Y	SJF	Feb-Apr	Northern Discovery Bay and mouth	1,468	Critical	Increasing	FC/SC[d]
Dungeness Bay	Y	SJF	Jan-Mar	N off mouths of Sequim and Discovery Bays	188	Healthy	Decreasing	N/A
Willapa Bay	N	Outer Coast	Feb-Mar	Not listed	256[c]	Unknown	Insufficient	N/A
Grays Harbor	N	Outer Coast	Feb-Mar	Not listed	133[c]	Unknown	Insufficient	N/A

[a] Y = Yes; N = No.

[b] PS = Puget Sound; SJF = Strait of Juan de Fuca; N/A = Not applicable

[c] Initial sampling occurred annually from 2000 to 2004, and data quality are considered poor by the Washington Department of Fish and Wildlife. The amount represents the mean 5-year biomass (in tons).

[d] Federal and State Candidate (FC, SC) species have been, or are being, reviewed for possible federal and state listing as sensitive, threatened, or endangered species.

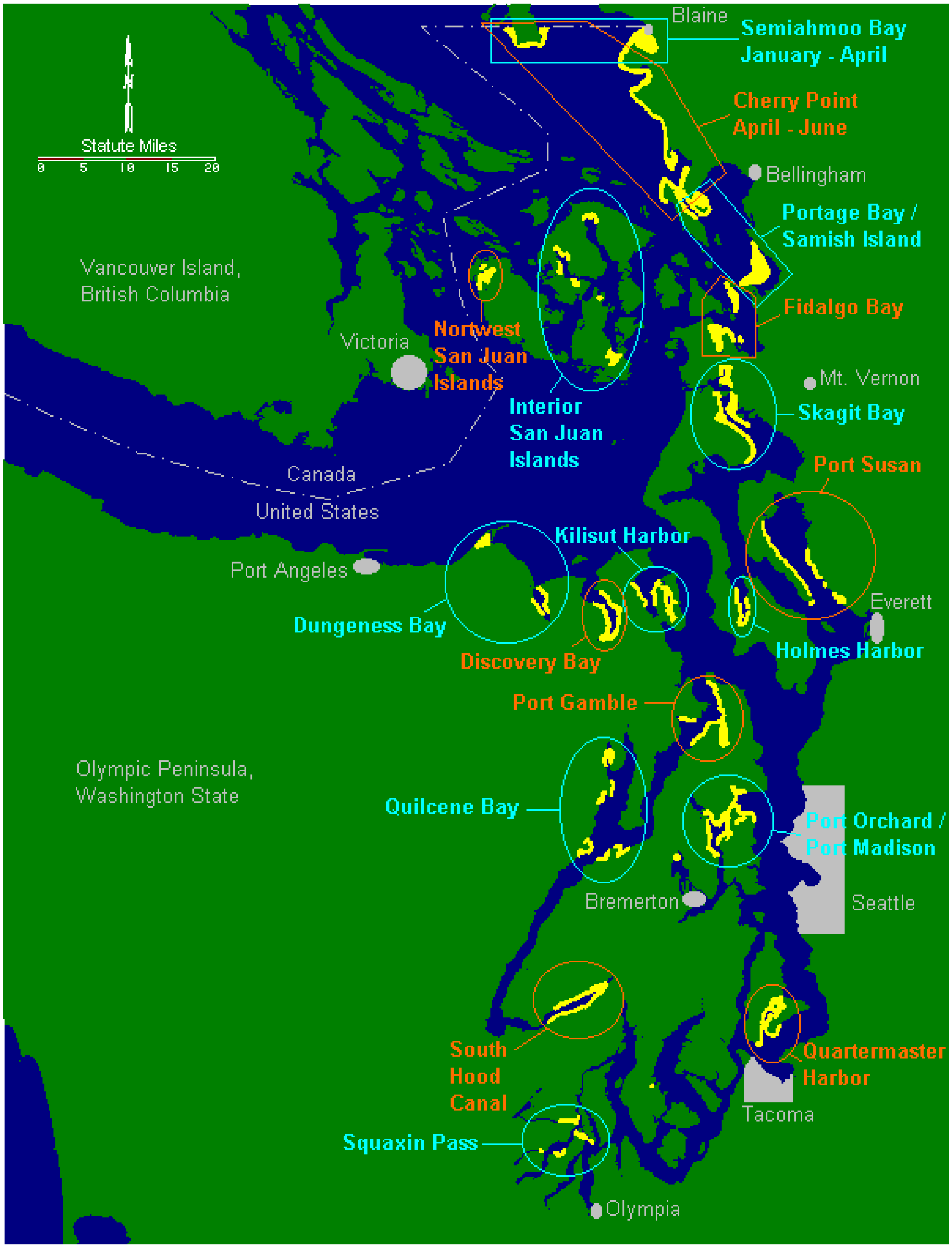

Figure 5. Herring Spawning Locations in Greater Puget Sound

Source: WDFW 1997b.

5.6.2.1 Geographic Distribution

Pacific sand lance occur throughout the temperate waters of the northeast and northwest Pacific Ocean, from Alaska to southern California and to the Sea of Japan (Eschmeyer and Herald 1983). They are common in shallow nearshore areas, in depths ranging from intertidal to almost 50 meters (164 feet) and can be distributed throughout the water column and buried up to 6 cm (2.4 inches) below the surface in sandy substrates (Pinto et al. 1984). Sand lance also occur over deeper waters and offshore but remain in the epipelagic portion of the water column (Eschmeyer and Herald 1983).

Shoreline spawning habitat has been documented by identifying sand lance egg deposition on beaches in Puget Sound, the San Juan Islands and the Strait of Juan de Fuca. WDFW beach surveys in the 1990s found sand lance eggs in 208 km (129 mi) of shoreline in Puget Sound (Penttila 1995, 2007) and found that few bays and inlets in Puget Sound do not support sand lance spawning.

5.6.2.2 Uses, Status, Trends, and Regulatory Issues

Within the study area, Pacific sand lance are common and serve an important role in the marine food web, but they are not commonly fished. No commercial fishery targets sand lance, and they rarely occur as bycatch in other fisheries because their body shape makes them unsusceptible to being caught in most types of net gear. Only occasionally do recreational fishermen target them for use as bait, using dip nets on balls of tightly packed schools.

The status of Pacific sand lance is difficult to assess; no efforts have been made to estimate biomass, and historical catch records do not exist. Pacific sand lance are one of five forage fish considered a Washington State Priority Species, and their spawning beds are considered Saltwater Habitats of Special Concern (Bargmann 1998).

Pacific sand lance are obligate upper intertidal spawners, making them vulnerable to shoreline armoring and other modifications to nearshore habitat that can directly bury sand-gravel portions of beaches or disrupt the natural supply and movement of beach sediments.

5.6.2.3 Seasonal Distribution in Study Area

Pacific sand lance are present in the study area year-round and spawn in winter, from early November to mid-February.

5.6.2.4 Use of Study Area Habitats by Life History Stages

Figure 6 shows documented Pacific sand lance spawning locations in the greater Puget Sound area. Pacific sand lance spawn on sand/gravel beaches in the upper intertidal zone (between +1.5 meters [5 feet] and mean higher high water) during high tide. Eggs adhere to grains of sand and disperse along the beach with tide and wave action. After incubating for approximately 4 weeks, the eggs hatch and the larvae become part of the epipelagic plankton community. Pacific sand lance spawn on beaches with a wide range of substrate types and sizes, between fine sand and 3-mm (0.1-inch) gravel. Adult sand lance exhibit diel behavior, feeding in open water during the day and burrowing in the sand at night, to conserve energy and avoid predation. Pinto et al. (1984) found that sand lance chose burrowing locations primarily based on sediment grain size and contamination; they avoid burrowing in sediments contaminated with crude oil.

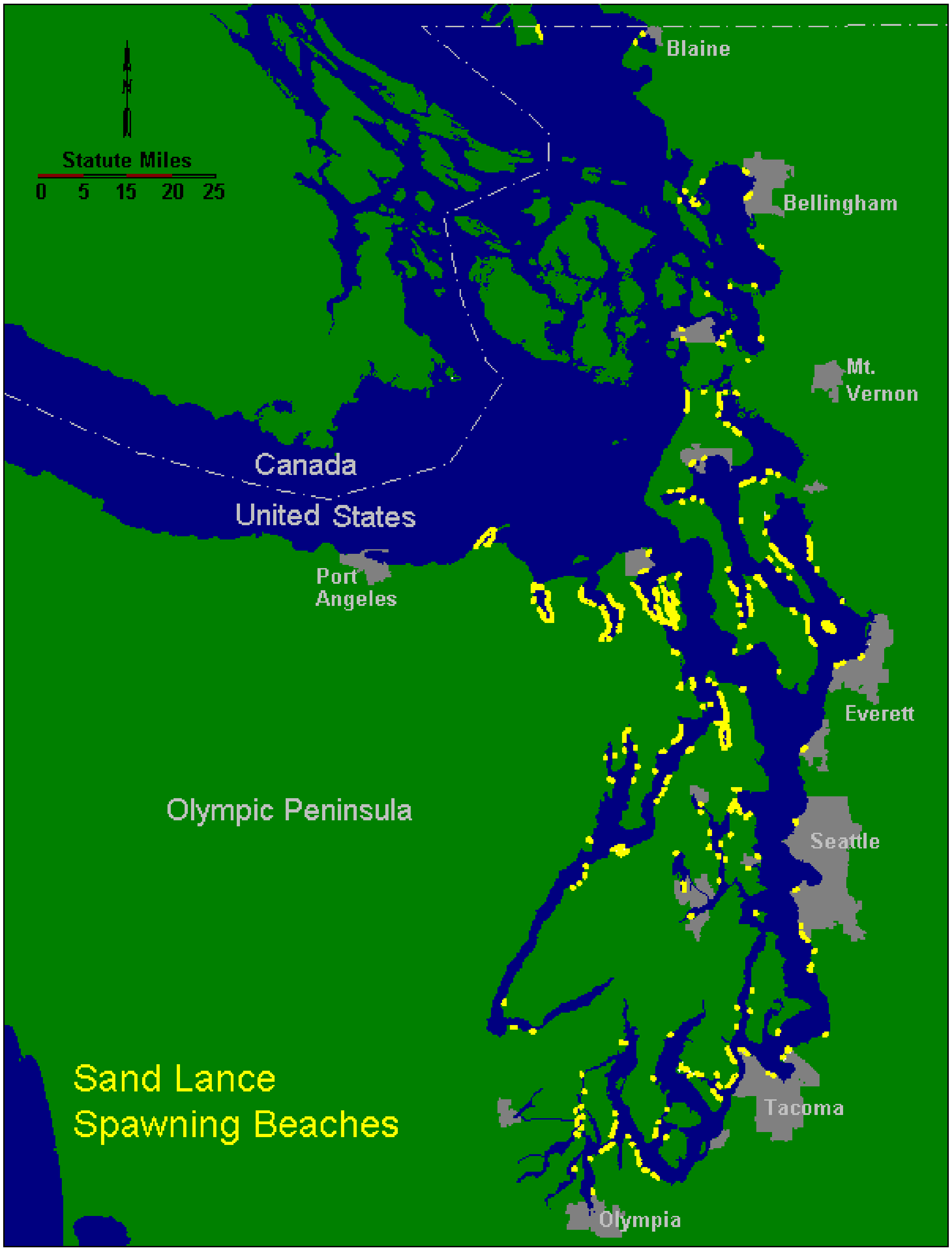

Figure 6. Documented Sand Lance Spawning Locations in Greater Puget Sound

Note: Spawning surveys covered approximately 75 percent of the shoreline. The occurrence of sand lance eggs on the remaining 25 percent of shoreline is unknown. Therefore, this figure likely underrepresents the total distribution of sand lance spawning activity.

Source: WDFW 1997c.

5.6.3 Surf Smelt

Surf smelt are in the family Osmeridae and are closely related to two other forage fish species in the region: eulachon (*Thaleichthys pacificus*) and longfin smelt (*Spirinchus thaleichthys*). Unlike these other two species, surf smelt spend their entire life cycle in marine/estuarine waters. The maximum reported size of surf smelt is 30.5 cm (12 inches). They can live to 5 years of age and become sexually mature after 1 year. The majority of surf smelt in spawning aggregations range from 1 to 2 years old. Similar to sand lance, surf smelt spawn and deposit eggs at high tide in the upper intertidal portions of coarse sand and gravel beaches, often near freshwater seeps. Eggs adhere to grains of sand and substrate, and are distributed across the beach with tide and wave action. Surf smelt eggs incubate for 2 to 5 weeks depending on temperature; once hatched, the larvae become part of the epipelagic plankton community. Adult surf smelt are dissimilar from herring in that they rarely form schools in the open water and do not migrate to offshore feeding areas. They are believed to distribute close to the bottom in nearshore shallow areas and establish long-term residency (Bargmann 1998).

5.6.3.1 Geographic Distribution

Surf smelt are distributed widely across the coast of the eastern Pacific Ocean from Prince William Sound in the Gulf of Alaska to Southern California. In Washington, surf smelt are common in the outer coast estuaries of Willapa Bay and Grays Harbor, along the Olympic Peninsula, and throughout greater Puget Sound. Spawning beach surveys conducted by WDFW identified 201 lineal km (195 mi) of beach used by surf smelt for spawning and egg incubation (Figure 7). This is likely an underestimate of the total available spawning habitat because the survey was unable to be completed (only 75 percent of the shoreline was surveyed) (Bargmann 1998).

5.6.3.2 Uses, Status, Trends, and Regulatory Issues

Surf smelt play an important role in the marine food web, serving as a prey item for a wide range of piscivorous fish, sea birds, and marine mammals. They are also the focus of small-scale commercial and recreational fisheries that occur throughout Puget Sound, Hood Canal, the Strait of Juan de Fuca, and the outer coast. The highest annual statewide commercial catch recorded between 1980 and 1996 was 123 tons in 1994, but the average has been approximately 57 tons per year (Bargmann 1998). Drag seines are the most common gear used to commercially harvest surf smelt and are used to target spawning aggregations. In recent years, much of the spawning stock has been protected from harvest through time and area restrictions on the fishery and through limited access to beach spawning grounds. The recreational fishery in Washington State is not as well monitored but is believed to land more surf smelt than the commercial fishery in some years. Jigging is commonly used to catch non-spawning fish, and dip nets are commonly used to catch fish schooled in spawning aggregations.

The current status and recent population trends of surf smelt abundance are not well known. However, there is little concern that this species is overfished because of its widespread spawning distribution, its non-schooling behavior, and limits to fishing on spawning grounds. Surf smelt are one of five forage fish species considered a Priority Species in Washington State, and all surf smelt spawning beds are considered Saltwater Habitats of Special Concern (WAC 220-110-250), meaning that they are protected from disturbance.

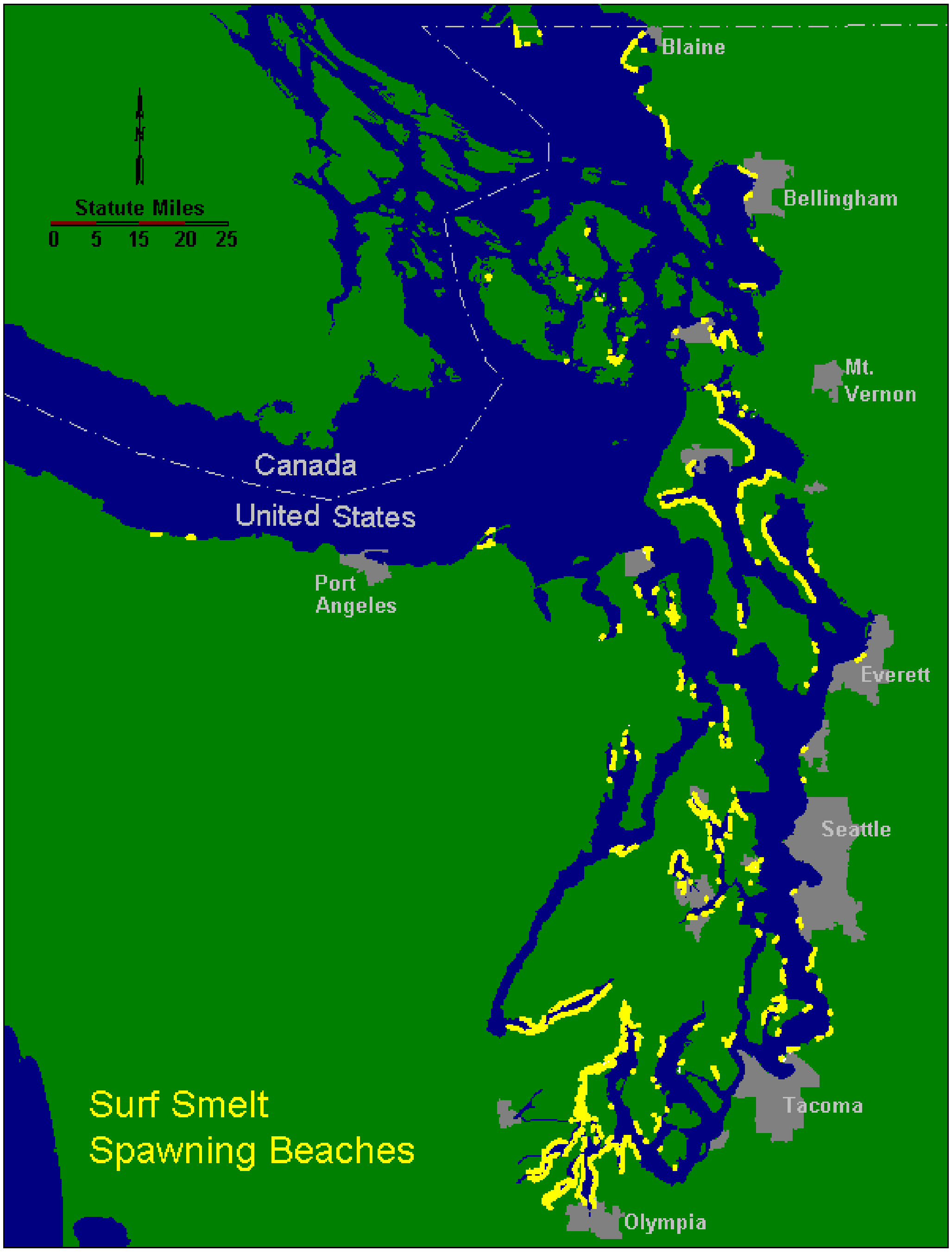

Figure 7. Documented Surf Smelt Spawning Locations in Greater Puget Sound

Note: Spawning surveys covered approximately 75 percent of the shoreline. The occurrence of surf smelt eggs on the remaining 25 percent of shoreline is unknown. Therefore, this figure likely underrepresents the total distribution of surf smelt spawning activity.

Source: WDFW 1997a.

Similar to Pacific sand lance, the most significant threat to surf smelt in Puget Sound is the loss of spawning habitat as a result of shoreline armoring practices. Coastal development often requires stabilizing beaches, banks, and bluffs, which can alter erosional processes and natural beach function.

Shoreline modifications affect longshore currents and redirect wave energy, which can lead to loss of finer-grained substrates needed for spawning (Thom and Hallum 1990). Structures such as bulkheads and docks that directly cover upper intertidal beaches also reduce the amount of available spawning habitat.

5.6.3.3 Seasonal Distribution in Study Area

Surf smelt are present in the study area year-round and are not believed to migrate. Spawning occurs over an extensive spawning season, with peaks during summer and fall/winter. At some locations, spawning has been documented throughout the year.

5.6.3.4 Utilization of Study Area Habitats by Life History Stages

Surf smelt eggs utilize the upper intertidal portion of beach habitat and incubate in coarse sand and gravel substrates. Spawning activity, and consequently incubating eggs, may occur on beaches throughout the year. Larvae drift from these beaches with prevailing oceanographic currents and can be found in the water column throughout Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca. Juveniles settle in shallow nearshore areas with sandy substrates and prefer coverage of aquatic vegetation such as algae and seagrass (Shaffer 2004). Adults use nearshore marine, estuarine, and pelagic habitat and are believed to associate closely with the bottom.

5.7 Coastal Pelagic Species

Coastal pelagic species (CPS) include the following species:

- Northern anchovy (*Engraulis mordax*)
- Jack mackerel (*Trachurus declivis*)
- Pacific sardine (*Sardinops sagax*)
- Pacific mackerel (*Scomber Japonicus*)
- Market squid (*Loligo opalescens*)

These species groups are discussed briefly because the members have limited associations with habitats or locations with a high probability of oil exposure, with the exception of anchovy. CPS can occur in shallow embayments or brackish water, but not to a significant degree. These water-column dwellers can generally be found anywhere from the surface to 1,006 meters (3,300 feet) deep and at significant distances offshore.

Jack mackerel and northern anchovy are part of the CPS Fisheries Management Plan (FMP) and, along with market squid, are considered monitored species (they do not need management by harvest guidelines or quotas according to the provisions of the FMP). Jack mackerel and northern anchovy are actively monitored by the California Department of Fish and Game.

The species descriptions below, unless otherwise referenced, are a summary and adaptation of information as presented and cited in the *Coastal Pelagic Species Fishery Management Plan (Amendment 8 to the Northern Anchovy Fishery Management Plan)* (PFMC 1998).

5.7.1 Geographic Distribution

Northern anchovy are distributed from the Queen Charlotte Islands, British Columbia, to Magdalena Bay, Baja California and have recently colonized the Gulf of California. Northern anchovy in the central subpopulation are typically found in waters that range from 12 to 21.5^{o} C. Jack mackerel range widely throughout the northeastern Pacific from Cabo San Lucas in Baja California, with much of the range beyond 322 km (200 mi) from the coast. Pacific sardine are distributed from the tip of Baja California to southeastern Alaska and throughout the Gulf of Mexico. Pacific (chub) mackerel in the northeastern Pacific range from Banderas Bay, Mexico to southeastern Alaska, including the Gulf of California. They usually occur within 32 km (20 mi) of shore but have been observed up to 402 km (250 mi) offshore. Adult and juvenile market squid are distributed throughout the California and Alaska current systems from the southern tip of Baja California, Mexico to southeastern Alaska (Vojkovich 1998).

The geographic range of all CPS finfish varies widely over time in response to the temperature of the upper mixed layer of the ocean. Sea surface temperatures and habitat boundaries for CPS finfish are dynamic both seasonally and from year to year. Year-to-year variation in temperature and habitat boundaries is most pronounced during summer. In addition, variations in the boundaries of preferred habitat are more pronounced than variation in the boundaries of thermal tolerance. These relationships mean that highly mobile mackerels and sardine are seasonally much more abundant in the Oregon to Alaska region during summer and warm water years (e.g., El Niño) than during winter and cold water years due to increased habitat availability.

5.7.2 Uses, Status, and Trends

Northern anchovy supports a small bait fishery off the coasts of Oregon and Washington. In Washington, anchovies are not consistently available in numbers necessary for commercial use. They are, however, important along the Columbia River estuary as live bait for salmon and sturgeon fisheries. No anchovy stock condition or habitat assessment activities are presently conducted for Washington coastal anchovies.

Pacific sardines supported extensive historical fisheries from British Columbia to Mexico. Modern fisheries focused in southern and central California are mostly for overseas markets and bait. From peak populations levels in 1940 to extremely low levels in 1970, the sardine has experienced a modest increase in abundance. NOAA (Lo et al. 2006) stock assessment modeling indicates a general decline in stock productivity (recruits per spawning biomass) that began in the mid-1990s. In Washington, Pacific sardine is managed under the Emerging Commercial Fishery provisions as an experimental commercial fishery. Sardines landed in Washington are typically caught from 16 to 56 km (10 to 35 mi) offshore.

Pacific (chub) mackerel in the northeastern Pacific are harvested by commercial fisheries in California and Mexico (outside the study area); some recreational harvest also occurs.

Minor amounts of market squid are landed in Washington during their spawning season (winter), primarily in central and southern California. Catch records were at their highest from 1994 to 1996, primarily in support for bait and the export market.

5.7.3 Seasonal Distribution in the Study Area

Anchovy spawning occurs year-round, with increases in late winter and early spring. Anchovy eggs and larvae are found near the surface, generally at depths of less than 50 meters (164 feet) and in the same areas as spawning adults. Their eggs and larvae fall prey to an assortment of invertebrate and vertebrate planktivores. Northern anchovy eat phytoplankton and zooplankton by either filter feeding or biting, depending on the size of the food. Anchovies are thought to move inshore in spring and summer and offshore in fall and winter. They are a pelagic species and are particularly susceptible to changes in water temperature. Nearshore habitats can support ten times higher juvenile anchovy densities than other habitat areas and at least 70 percent of the juvenile anchovy population (Methot 1981; Smith 1985).

Pacific sardines are pelagic at all life history stages. They can occur in estuaries but are most common in nearshore and offshore coastal habitats. Spatial and seasonal distribution of spawning is influenced by temperature. Spawning in the upper 50 meters (165 feet) of the water column (their northern distribution for spawning) increases during periods of warmer sea surface temperatures—sometimes as far as Oregon. Juveniles have been found in British Columbia coastal waters coincident with northern spawning periods.

5.7.4 Utilization of Study Area Habitats by Life History Stages

Puget Sound and nearshore coastal areas, bays, estuaries, and river mouths of Washington and British Columbia generally do not experience extensive use by these pelagic species, except for the northern anchovy. Northern anchovy of all life stages are found in these areas and can be abundant, particularly during warmer water periods in summer and fall. Increasing sea surface temperatures related to climate change may shift the northern distribution of the spawning areas for the CPS, resulting in increasing frequency and abundances in juvenile use of Puget Sound and nearshore coastal areas of Washington, or increased abundance in the offshore areas. Recent nearshore surveys have documented increased abundances of larval and juvenile anchovies in the study area and other areas within Puget Sound (USGS Western Fisheries Research Center 2013).

Young Pacific jack mackerel frequently school near kelp and under piers, but more typically in the northern regions; the adults are foraging offshore. Market squid spawning areas are nearshore areas adjacent to submarine canyons.

CPS are most common in the upper mixed layer of the ocean (above the thermocline) in a broad band (up to hundreds of miles wide) along the coast. CPS may occur in shallow embayments and brackish water but do not depend on these habitats to any significant degree. In general, older and larger individuals occur farther north and offshore. The northern extent of the distribution and essential fish habitat for CPS depends on temperature and biomass. Northern areas tend to be used most extensively when water temperatures are warm and abundance is high. Adult CPS prefer water temperatures in the range from 10 to 26 °C (50 to 79 °F). Spawning and successful reproduction occurs at approximately 14 to 16 °C (57 to 61 °F).

5.8 Sharks, Skates, and Chimaeras

Sharks and skates are members of the subclass Elasmobranchi, and chimaeras are of the subclass Holocephali. All species within these subclasses are cartilaginous fishes and consist of the following.

- Soupfin shark (*Galeorhinus zyopterus*)
- Spiny dogfish (*Squalus acanthias*)
- Big skate (*Raja binoculata*)
- California skate (*Raja inornata*)
- Longnose skate (*Raja rhina*)
- Spotted ratfish (*Hydrolagus colliei*)

The soupfin shark is iteroparous and viviparous, with fertilization occurring internally and embryogenesis occurring within the female. The spiny dogfish is also viviparous. The three species of skates, big skate, California skate, and longnose skate, are in the family Rajidae, known as hardnose skates. They are all oviparous; eggs are fertilized internally and deposited on the bottom to develop and hatch. When the eggs hatch, the young are fully developed although they do have a yolk sac that is gradually absorbed. The spotted ratfish is a chimaera. They are generally found in deep waters along the continental slope and are oviparous (Branstetter 1993; Talley 1983).

This species group is discussed briefly, as the members have limited associations with habitats with a high probability of being exposed to oil in the event of a spill. The species descriptions below, unless otherwise referenced, are a summary and adaptation of information as presented and cited in *Life History, Geographical Distribution, and Habitat Associations of 82 West Coast Groundfish Species: a Literature Review* (McCain et al. 2005).

5.8.1 Geographic Distribution

Soupfin sharks are found from northern British Columbia to Abreojos Point, Baja California and the Gulf of California. Spiny dogfish are found in temperate and subarctic latitudes in both the northern and southern hemispheres and occur from the Bering Sea to Baja California.

Big skates are found from the eastern Bering Sea to Cabo Falsa, southern Baja California. California skates range from the Strait of Juan de Fuca, Canada, southward to Cedros Island, central Baja California, and in the Gulf of California. Longnose skates are found from the Bering Sea and Aleutian Islands to Cedros Island, Baja California, and the Gulf of California. Spotted ratfish are found from the western Gulf of Alaska to Sebastian Vizcaino Bay, Baja California, and in the northern part of the Gulf of California (Compagno 1984; Hart 1973; Allen and Smith 1988).

5.8.2 Seasonal Distribution in Study Area

Soupfin sharks form dense shoals and have a coast-wide movement that is not completely understood. The soupfin migrates north in summer and south in winter. Their movements are extensive without recognizable patterns. They travel up to 56 km (35 mi) per day, with sustained speeds of 16 km/hour (10 mi/hour) for 1,600 km (994 mi) (Johnson and Horton 1972).

Dogfish often migrate in large schools and feed avidly on their journeys. Dogfish undertake seasonal migrations to stay in their preferred temperature range. Schooling behavior occurs with inshore populations and with migratory offshore populations. The schools, numbering in the hundreds, exhibit north-south coastal movements and onshore-offshore movements that are not completely understood. Spiny dogfish can travel long distances. In one instance, a dogfish tagged from Queen Charlotte Sound in 1980 was recovered off the northeast coast of Japan in 1982. They also make diel migrations from near bottom during the day to near surface at night (McFarlane and Beamish 1986). Big skates can be found in waters from the intertidal range to depths of 120 meters (394 feet); they inhabit the coast in estuaries, in bays, and over the continental shelf. Big skates are commonly found on sandy and muddy bottoms where they hide with only eyes protruding, although they are also sometimes observed in low stands of kelp.

The spotted ratfish makes significant seasonal and diel migrations. In winter, spotted ratfish move into shallow nearshore waters and estuaries, probably for feeding and pre-spawn mate selection. In Puget Sound and other estuaries, spotted ratfish move from deep water, where they reside during the day, to much shallower water at night (Love 1996; Quinn et al. 1980; Johnson and Horton 1972).

5.8.3 Uses, Status and Trends, and Regulatory Issues

During the late 1930s and 1940s, the soupfin shark was one of the most economically important of the sharks on the West Coast. Currently, most catches are made as bycatch in other commercial fisheries or by recreational fishers.

Spiny dogfish are currently the most abundant and economically important shark off North American coasts. In recent years, large numbers have been taken in commercial trawl, set net, and longline fisheries, especially in Puget Sound, to supply foreign markets and for biology class dissections and research. They can be readily caught by rod and reel, longline, trawl, or set net. Spiny dogfish often are regarded as a menace to fisheries because they cause damage to nets and lines, and they rob hooks (Northeast Consortium 2010).

Big skates are generally taken as bycatch in other fisheries. The coastal trawl fleets account for the majority of the catch off the West Coast. Only the pectoral fins, or *wings*, are bought commercially. Big skates also occasionally are taken by recreational fishers. California and longnose skate have little commercial value. The majority of catch is in the form of bycatch by the coastal trawl fleets.

There is no directed fishery for spotted ratfish in the northeast Pacific, but they are taken quite often as bycatch in bottom trawls. Spotted ratfish are not sought by recreational fishers but are caught occasionally while fishing for other demersal species (NOAA Fishwatch 2013b).

5.8.4 Utilization of Study Area Habitats by Life History Stages

Soupfin sharks are an abundant coastal-pelagic species of temperate continental and insular waters. They are often associated with the bottom, inhabiting bays and muddy shallows. Although soupfin sharks often occur as shallow as 2 meters (7 feet), they also can occur in submarine canyons up to 471 meters (1,545 feet). The population of soupfin sharks along the western Pacific Coast is considered to be homogeneous (Compagno 1984).

The spiny dogfish is reported to be an inner shelf-mesobenthal species with a depth range of 0 to 1,236 meters (0 to 4,055 feet) in the North Pacific and Bering Sea. They occur from the surface and intertidal areas to greater depths and are common in inland seas, such as Puget Sound and in shallow bays from Alaska to central California. Adult females move inshore to shallow waters during spring to release their young. Small juveniles (<10 years old) are pelagic, while subadults and adults are mostly sublittoral-bathyal. Subadults can also be found on muddy bottoms (Allen and Smith 1988; Saunders and McFarlane 1993).

The big skate occupies inner and outer shelf areas, particularly on soft bottom. Records show big skates inhabiting water as shallow as 3 meters (10 feet), but they are found most frequently on the outer shelf in waters 50 to 200 meters (164 to 6,562 feet) deep and rarely deeper than 350 meters (1,148 feet). Juveniles are associated with soft bottom sediments. Egg cases of big skates are deposited on the bottom. Off Oregon, egg cases were taken at depths up to 120 meters (394 feet) but were by far most abundant at 64 meters (210 feet). The longnose skate is one of the more common skates and occurs on the bottom in inner and outer shelf areas from 0 to 1,069 meters (3,507 feet) (Allen and Smith 1988).

In the North Pacific, spotted ratfish are considered a middle-shelf-mesobenthal species and have been reported at depths of 0 to 971 meters (0 to 3,186 feet). Spotted ratfish are a common demersal fish in larger estuaries throughout their range, especially from early winter to late spring. In Puget Sound, spotted ratfish often occur in less than 10 meters (32 feet) of water, depending on the time of day and season. Generally, spotted ratfish are a deepwater species that prefers low-relief rocky bottoms with exposed gravel and cobble; they are not common on sand or over boulders. Eggs are attached by the mother to rocks, or placed upright in the sand in polyhaline to euhaline waters. In summer and fall, spotted ratfish move offshore into deep waters, where egg cases are most often deposited (Allen and Smith 1988; Quinn et al. 1980; Hart 1973; Johnson and Horton 1972).

5.8.5 Reproduction

Soupfin shark mating occurs during spring. After a gestation period of approximately 1 year, females move into bays to bear live young. The number of young (from 6 to 52) depends on the size of the mother; larger females produce more young. Spiny dogfish mating and fertilization occurs on the ocean bottom between September and January. Females release their young in the midwater zone over depths of 165 to 350 meters (541 to 1,148 feet) during spring, in shallow waters. Reproduction and egg laying in skates are not well understood. Spotted ratfish spawning occurs at all times throughout the year but seems to peak from late summer to early fall (Andrews and Quinn 2012).

5.8.6 Trophic Interactions

Soupfin sharks are opportunistic, carnivorous feeders. They feed at the bottom, mid-depths, and the surface. Soupfin feed primarily on moderate-sized bony fishes but also readily feed on invertebrates, including squid.

Spiny dogfish are opportunistic carnivorous scavengers that prey on many commercial fishes and invertebrates. Their diet consists primarily of fish (especially sand lance, herring, smelts, cods, capelin, hake, and ratfish) and of invertebrates (particularly shrimp, crabs, worms, krill, squid, octopus, jellyfish, and sea cucumbers).

Big skate adults feed on crustaceans, small benthic fishes, polychaete worms, and mollusks. Juveniles consume primarily polychaete worms and mollusks. Big skate are preyed on by sevengill shark and northern elephant seals. The California skate feeds on shrimp and other invertebrates, such as polychaete worms.

Spotted ratfish at all life history stages are opportunistic feeders; no one single food item usually makes up more than 25 percent of their diet. Spotted ratfish are, in turn, preyed on by Pacific halibut, soupfin shark, and spiny dogfish. (Allen and Smith 1988; Quinn et al. 1980).

6. INVERTEBRATES

Marine invertebrates are organisms without backbones, such as shrimps, crabs, sponges, corals, worms, jellyfishes, snails, and squids. Crustaceans, of which nearly all are marine invertebrates, make up the greatest biomass of any marine animal group. These include economically valuable species such as crabs and shrimps. Marine invertebrates that are present in the study area provide important commercial, recreational, and tribal fisheries.

6.1 Protected Species

No federally listed invertebrates occur in the study area. Two state listed species have the potential to occur: Pinto abalone and Newcomb's littorine snail. These species are described below.

6.1.1 State-Listed Species

Pinto Abalone (Candidate)

Pinto abalone are medium-sized abalone (marine snails) that are distributed from Point Conception, California to southeast Alaska. They are generally found on hard, rocky substrates in exposed coastal areas, including Puget Sound, the Strait of Juan de Fuca, and the San Juan Archipelago (Puget Sound Restoration Fund 2014). The pinto abalone is considered functionally extinct in Washington waters; natural populations have plummeted and there are too few left in the wild to reproduce successfully (Puget Sound Restoration Fund 2014). The species could be present in the study area; however, their occurrence would be rare.

Newcomb's Littorine Snail (Candidate)

Newcomb's littorine snail is a medium-small marine snail whose biology and ecology is incompletely understood (Larsen et al. 1995). The snail inhabits a narrow strip of land on glasswort salt marshes at the edges of bays and estuaries where fresh and ocean water mix. Within the study area, Newcomb's littorine snail has been reported in Neah Bay (Larsen et al. 1995). The snail may be present in the pickleweed zone of the high intertidal marshes in the study area, but a literature review did not reveal any documented sightings.

6.2 Mollusks

Mollusks have soft bodies with a mantel, head, foot for locomotion, radula for feeding (except bivalves), and a fully developed digestive tract. The study area provides habitat for a wide variety of mollusks; species expected to occur in the study area are described in more detail below.

6.2.1 Geoduck Clam

Geoduck are the largest of the burrowing clams, commonly reaching weights of more than 1.4 kilograms (3 pounds), with some weighing more than 4.5 kilograms (10 pounds). Geoducks are also among the longest-lived animals in the ocean, some living 140 years or more. They bury themselves up to 1 meter (3 feet) deep in mud, silt, and gravel bottoms. Goeduck larvae drift with the currents for 2 to 7 weeks, after which they settle to the bottom and metamorphose into non-swimming juvenile clams. Because of the long planktonic larval period, the young may be carried by water currents many miles from their parents before settling (WSDNR 2001).

6.2.2 Native Littleneck

Adult and juvenile native littleneck clams are found in coarse, sandy-rock muds of the upper intertidal beaches of estuaries and on the open coast where there is appropriate substrate, detritus (decaying plant material), and protection from predators. They are found in quiet waters in the mid to upper low intertidal (to a depth of 37 meters [121 feet]) but also may be found under boulders in gravel substrates along the outer coast. Native littlenecks burrow to a depth of approximately 80 mm (1.3 inch) due to their relatively short siphons (WSU 2007; Kegel 1998). Their siphons allow this species to gather food by filtering water for phytoplankton and diatoms. Rock crabs, fish, birds, sea otters, and others feed on these clams, depending on the region. They spend 2 to 3 weeks in the larval form (Shaw 1986).

6.2.3 Manila Clam

Manila clams are found in the intertidal zone under cobbles in rocky crevices, in gravel, roots, and other protected holdfasts. Manila clam is the second-most important commercial clam species on the Pacific Coast. It also is one of the most important recreationally dug clams. The species is found from the intertidal zone to depths of approximately 10 meters (32 feet) but is primarily found at 0.9 to 2.4 meters (3 to 8 feet) above the mean lower low water. An ideal substrate appears to consist of gravel (much of which is <25 mm [0.9 inch] in diameter), sand, some mud (4 to 5 percent), and shell. Beaches with this type of substrate are often relatively stable and occur in many protected areas of Pacific Northwest inlets and bays. However, Manila clams can inhabit a wide range of substrates. The Manila clam often occurs with Pacific littleneck clam, butter clam, softshell clam, *Macoma* spp. clams, and other estuarine infauna (Emmett et al. 1991).

6.2.4 Giant Pacific Oyster

The giant Pacific oyster is an intertidal and subtidal species that attaches to rocks and debris. They prefer firm surfaces in sheltered waters, but they also live in muddy or muddy and sandy substrates. Fertilization occurs externally and larvae are planktonic, spending approximately 3 weeks in this free-swimming stage. When settling, the larvae group together and crawl around the sea floor, searching for a suitable hard substratum to which they can cement their lower shell valves (NIMPIS 2002).

6.2.5 Butter Clam

The butter clam (*Saxidomus giganteus)* inhabits the low intertidal and subtidal zones, in quiet protected beaches. They bury themselves from 25 to 35 cm (10 to 14 inches) into mud, sand, or gravel substrate. They spawn throughout the year.

6.2.6 Spiny Scallop

The spiny scallop is very common in waters near Rosario Strait. They often attach to the bottom by a few byssal threads in the low intertidal zone of muddy and sandy substrate and on rocky reefs. The species filter feeds approximately 4 liters of water per gram per hour (Kozloff 1993).

6.2.6.1 Pink Scallop

Pink scallops may live on rocky or soft bottoms, although they are most common on gravel/mud bottoms in the low intertidal to subtidal zones (Kozloff 1993).

6.2.7 Pacific Razor Clam

Pacific razor clams *(Siliqua patula)* inhabit the low intertidal and subtidal zones on flat, sandy exposed beaches, burrowing rapidly into the sand. Spawning of razor clams occurs simultaneously (on the same day) along several kilometers of beach, triggered by a sudden rise in water temperature in late May or June. The larvae persist in a pelagic form for approximately 8 weeks. Predators include flatfish such as the starry flounder and the Dungeness crab. Razor clams may have a commensal nemertean worm (*Malacobdella grossa*) or the pea crab (*Pinnixia faba*) in its mantle cavity.

6.3 Echinoderms

Echinoderms include sea stars, starfish, brittle stars, sea urchins, sand dollars, sea cucumbers, and others. Echinoderms present in the study area and noted for their value to commercial and recreational fisheries include California sea cucumber, green sea urchin, and red sea urchin. These species are described in more detail below.

6.3.1 California Sea Cucumber

California sea cucumbers are found under rocks and in mussel beds, in the intertidal and subtidal areas of beaches with a fair amount of wave energy—particularly in the Strait of Juan de Fuca and western portions of Haro Strait and the San Juan Islands. Commercial harvesting of this species is limited to 3 weeks during fall or winter. The giant California sea cucumber is a scavenger that feeds on plankton and other organic matter. They feed by sifting through sediments with their tentacles or by positioning themselves so they can use their tentacles to catch food passing by in the current. Spawning usually takes place in November, and each female can produce thousands of eggs. After fertilization, a larva is formed that metamorphoses into a juvenile life stage after a few weeks (Soltani et al. 2010).

6.3.2 Green Sea Urchin

Green sea urchin are found in the low intertidal to subtidal zone on seaweed, surfgrass, eelgrass, and rocks. There is a small commercial fishery for this species. Sea urchins feed mainly on algae but also can feed on a wide range of invertebrates such as mussels, sponges, brittle stars, and crinoids. Sea urchins provide a substantial food source for sea otters and are also the main source of nutrition for wolf eels. Sea urchins reproduce annually, with spawning occurring in spring—generally between February and May, but sometimes as late as June. They spawn externally, releasing gametes into the water column, resulting in a larval stage that develops planktonically for 1 to several months before settling.

6.3.3 Red Sea Urchin

Red sea urchins are found in similar habitat, with similar foraging and reproductive characteristics, as green sea urchins. While the commercial fishery for the red sea urchin is small, it is larger than that of the green sea urchin and the species is noted as a WDFW Priority Species of commercial, tribal, and recreational importance.

6.4 Crustaceans

Crabs, shrimp, and barnacles are crustaceans. Crustaceans are harvested recreationally and commercially, and are an important source of food to other marine species. Crustaceans present in the study area include Dungeness crab, Alaska prawn, red rock crab, and goose barnacle. These species are described in more detail below.

6.4.1 Dungeness Crab

Dungeness crabs are fished from Alaska to California and are thought to be the oldest known shellfish fishery in the Pacific Northwest (WDFW 2002). According to the WDFW (2002), Dungeness crabs are the only commercially important crab within Washington's territorial waters, making this species important for fisheries commercially and economically. The female Dungeness crab lays up to 2.5 million eggs and lives up to at least 6 years. Females can store sperm received during one mating season and use it during the next season. Dungeness crab spawn in spring, and the larvae from the Puget Sound region may disperse as far as Alaska (Park et al. 2007). This species is a carnivore that feeds on more than 40 different species including small clams, oysters, fish, shrimp, and worms.

6.4.2 Alaska Prawn

The Alaska prawns, or spot prawns, inhabit the deep sandy bottoms in the Rosario Strait area. Spot prawns feed on crustaceans, polychaetes, limpets, and carcasses. The breeding season for spot prawns ends in late October, after which females carry their eggs on the abdomen for 4 to 5 months, while remaining in deep water. The eggs hatch in March or April, and the larvae settle a few months later in May and June. Juveniles feed in shallow water during summer, especially among *Agarum fimbriatum* and *A. clathratum* kelp. During their second fall (carapace length 2.8 cm [1 inch]), they become males. They remain males until they grow to 3.3 cm (1.3 inch) carapace length, at which time they become females. Females may mate only once, and they may not live longer than 4 years. (O'Clair and O'Clair 1998.)

6.4.3 Red Rock Crab

Red rock crabs inhabit rocky and soft bottoms, and are most common around rocks. They may be found partially buried in sand or under rocks during the day, while they are more active at night. Red rock crabs forage on barnacles and smaller crabs, amphipods, sea cucumbers, polychaetes, many other intertidal invertebrates, and dead fish and other carcasses. Males often will guard a female who is preparing to molt by holding her under his abdomen. This may last for several weeks until she molts. He then guards her until her exoskeleton hardens again. Mating occurs in summer after a female has molted. Gravid females may be found from October to June. Females may carry from 172,000 to 597,000 eggs on the pleopods of the abdomen. Males overwinter in shallow areas, while females seem to overwinter in deeper water (Kozloff 1993). While not recognized as a state Priority Species, the red rock crab is part of a commercial and recreational fishery.

6.4.4 Goose Barnacle

Goose barnacles, also called *gooseneck barnacles*, inhabit open, surf-swept coastlines (Kozloff 1993). In Puget Sound, gooseneck barnacles breed from April to October, peaking in July. Individuals are hermaphroditic, meaning they possess both male and female reproductive organs, but will always cross-fertilize. Each sexually mature individual may produce up to four broods per year, with up to 20,000 developed young per brood. The young temporarily aggregate at the base of the adults, where their survival rate increases. Within 1 month, young disperse to locations separate from adults. Many areas prohibited the commercial harvesting of goose barnacle until enough information about the species is available to determine sustainable harvest rates with biologically based management.

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