APPENDIX B

SPECIES BIOLOGY

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Species covered in this Biological Assessment Reference were chosen on the basis of species lists obtained from the National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) (see Appendix C). Because of the inland marine nature of all the Washington State Ferries (WSF) terminals, freshwater fish, oceangoing mammals, and sea turtles (including leatherback sea turtles), terrestrial species, and upland and freshwater plants were excluded from this analysis.

NMFS – Listed Threatened, Endangered, and Proposed Species

Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha*)

Status

Puget Sound Chinook salmon were listed as threatened on August 2, 1999 (Federal Register 1999a.). The evolutionarily significant unit (ESU) includes naturally spawned fish and stocks from 26 artificial propagation programs.

Critical Habitat

Critical habitat was designated for Puget Sound Chinook salmon on February 16, 2000 (Federal Register 2000.). Critical habitat is designated for areas containing the physical and biological habitat features, or primary constituent elements (PCEs) essential for the conservation of the species or which require special management considerations. PCEs include sites that are essential to supporting one or more life stages of the ESU and that contain physical or biological features essential to the conservation of the ESU. Specific sites and features designated for Puget Sound Chinook salmon include the following:

1. Freshwater spawning sites with water quantity and quality conditions and substrate supporting spawning incubation and larval development
2. Freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks
3. Freshwater migration corridors free of obstruction with water quantity and quality conditions and natural cover such as submerged and overhanging large

wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks supporting juvenile and adult mobility and survival

4. Estuarine areas free of obstruction with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh- and saltwater; natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels; and juvenile and adult forage, including aquatic invertebrates and fishes, supporting growth and maturation
5. Nearshore marine areas free of obstruction with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation; and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, and side channels.
6. Offshore marine areas with water quality conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation

The critical habitat proposal for Puget Sound Chinook salmon includes 61 occupied watersheds in 18 associated subbasins as well as 19 nearshore marine zones. In setting this designation, the conservation value of each habitat area was considered in the context of the productivity, spatial distribution, and diversity of habitats across the range of five geographical regions of correlated risk.

In estuarine and marine nearshore areas, the inshore extent is defined by the line of extreme high water. The proposed offshore extent of critical habitat for marine nearshore areas is to the depth of 30 meters (98 feet) relative to mean lower low water (MLLW; average of all the lower low water heights of the two daily tidal levels), and area that "generally coincides with the maximum depth of the photic zone in Puget Sound."

Biology and Distribution

Puget Sound Chinook salmon exhibit two life history types: ocean-type and stream-type. The most common life history in Puget Sound is ocean-type. Ocean-type Chinook can be over 70 millimeters (mm) long when they reach estuaries in late spring. These fish are capable of moving offshore very soon after migrating from the river. However, Chinook longer than 70 mm are captured along estuarine and marine shorelines. Sampling has been conducted for juvenile Chinook in saltwater near the mouths of the major rivers on the east side of Puget Sound (Tyler 1964; Tyler and Bevan 1964; Stober and Salo 1973; Weitkamp and Schadt 1982; Congleton et al. 1982). Ocean-type Chinook were captured near these river mouths from March through June in high numbers, with much smaller catches occurring through the summer.

Puget Sound is a migratory corridor for adult Chinook salmon and provides habitat for out-migrating juvenile Chinook salmon from rivers into Puget Sound before their eventual oceanic phase as adults.

Adults typically spawn in the mainstems and larger tributaries of Puget Sound. Spawning preferences include clean gravel riffles with moderate water velocity and mainstem and lower reaches of tributaries (WDF 1992). Adult spring-run Chinook typically return to freshwater in April and May and spawn in August and September. Adults migrate to the upper portions of their natal streams and hold until they reach maturity. Summer-run Chinook migrate to freshwater in June and July, and spawn in September. Summer/fall run (the most common in Puget Sound) begin freshwater migration in August and spawn from late September through January (Myers et al. 1998).

Recent studies on Chinook salmon use of Puget Sound have found that juveniles begin migrating into estuaries and the nearshore in late January and early February, with peak migration into the Sound occurring in June and July. Juvenile Chinook are found along the nearshore through October and may utilize the nearshore year-round.

Adults could be present in deeper offshore waters year round. The greatest abundance of adults would occur between early summer and early fall as they return from the ocean to natal streams and rivers.

Prey

The harvest of salmonid prey species (e.g., forage fishes such as herring, anchovy, and sardines) may present another potential habitat-related management activity. Chinook salmon feed primarily on forage fishes.

Juvenile Chinook salmon in Pacific Northwest estuaries primarily feed on chironomids (order: *Diptera*, family: *Chironomidae*), yet also consume additional larvae, pupae, and adult forms of other Insecta. Annelids, crustaceans, arachnids, playhelminthes, gastropoda, rotifera, and osteicthyes are also part of the juvenile Chinook diet (Levy et al. 1979; Levings et al. 1991). Chinook fry also feed on forage fish eggs in large aggregations along protected shorelines, thus generating a base of prey for the migrating salmon fry.

Puget Sound Steelhead (*Oncorhynchus mykiss*)

Status

Puget Sound steelhead were listed as threatened on May 11, 2007 (Federal Register 2007).

Critical Habitat

Critical habitat for steelhead was designated in 2016; no WSF facilities are within proposed steelhead critical habitat (Federal Register 2016.) 78 FR2725.

Biology and Distribution

The present spawning distribution of steelhead extends from the Kamchatka Peninsula in Asia, east through Alaska, and south to southern California. The historical range of steelhead extended at least as far south as the Mexico border (Busby et al. 1996). Anadromous forms of *O. mykiss* are called steelhead, and non-anadromous forms (fresh water resident forms) are called rainbow trout.

Steelhead exhibits perhaps the greatest diversity of life history patterns of any Pacific salmonid species (Barnhart 1986). Individuals rear in freshwater between 1 and 4 years and remain at sea between 1 and 4 years (Meehan and Bjornn 1991). Other sources indicate that steelhead can spend up to 7 years in fresh water prior to smoltification and then spend up to 3 years in salt water prior to first spawning (Busby et al. 1996). In the Pacific Northwest, steelhead that enter freshwater systems between May and October are considered summer steelhead (stream-maturing type) and steelhead that enter fresh water between November and April are considered winter steelhead (ocean-maturing type). Summer steelhead enter fresh water in a sexually immature condition and require several months to mature and spawn; whereas, winter steelhead enter fresh water with well-developed gonads and spawn shortly thereafter. Some river basins have both summer and winter runs, but some rivers only have one type. In rivers where the two types co-occur, they are often separated by a seasonal hydraulic barrier, such as a waterfall.

Unlike the five Pacific salmon species, steelhead are iteroparous; they do not invariably die after spawning. Some significant post-spawning mortality occurs; however, a small number of steelhead adults migrate out of the river after spawning and return to spawn in subsequent years (Busby et al. 1996). The frequency of multiple spawnings is variable both within and among populations of steelhead. For North American steelhead populations north of Oregon, repeat spawning is relatively uncommon, and more than two spawning migrations are rare. In Oregon and California, the frequency of two spawning migrations is higher, but more than two spawning migrations are still unusual. Iteroparous steelhead are predominately female.

Generally, juvenile steelhead out-migrate from freshwater between mid-March and early June. Juvenile steelhead enter marine waters at a much larger size and have a higher rate of survival than other salmonid species. The majority of steelhead smolts appear to migrate directly to the open ocean and do not rear extensively in the estuarine or coastal environments (Burgner et al. 1992).

Recent sampling in the Puget Sound nearshore supports the general life history model that juvenile steelhead use of the nearshore is very limited. Available data from townet sampling (deeper nearshore) and beach seine sampling (shallow nearshore) efforts around Puget Sound have reported the capture of few steelhead. In townet sampling in North and South Puget Sound, NMFS captured a total of 18 steelhead (Rice unpublished data). The total sampling effort was not available, but the mean steelhead catch ranged from 0 to 0.2 per net in North Puget Sound and 0.1 to 0.8 per net in South Puget Sound. Beach seine sampling in Bellingham Bay (North Puget Sound) also captured few steelhead (Lummi Nation unpublished data). The Bellingham Bay research reported the capture of two juvenile steelhead salmon in 336 sets between February 14 and December 1, 2003. The steelhead were captured in the eastern portion of Bellingham Bay near the Taylor Avenue Dock on June 12 and June 25.

Steelhead were also infrequently captured in a beach seine study around Bainbridge Island (City of Bainbridge Island, Suquamish Tribe, and WDFW 2005). The study consisted of 271 beach seine sets conducted between April and September 2002 and between April 2003 and December 2004. Three steelhead were captured in the study; one was captured in May and two were captured in September. The steelhead were 179, 280, and 300 mm in total length. One of the three steelhead had been fin clipped, indicating it was of hatchery origin.

Prey

Juvenile steelhead eat invertebrates: crustaceans and insects, such as mayflies, caddis flies, and black flies. Steelhead will also eat salmon eggs when available. Adults at sea feed primarily on fish, squid, and amphipods.

Hood Canal Summer Chum Salmon (*Oncorhynchus keta*)

Status

Hood Canal summer-run chum salmon were listed as threatened on August 2, 1999 (64 Fed Reg 41835-41839).

Critical Habitat

Critical habitat was designated for Hood Canal chum salmon on February 2, 2000 (Federal Register 2000).

Biology and Distribution

A total of 11 streams that are tributaries to the Hood Canal have been identified as recently having indigenous summer chum populations (WDFW 2006a).

Summer chum salmon are the earliest returning chum salmon stock in the Hood Canal and Strait of Juan de Fuca region. Spawning occurs from late August to late October, generally within the lowest 1 to 2 miles of the streams. Eggs and alevins develop in the redds for approximately 18 to 20 weeks before emerging as fry between February and the last week of May (WDFW 2006a).

In Puget Sound, chum fry have been observed through annual estuarine area fry surveys to reside for their first few weeks in the top 2 to 3 centimeters of surface waters and extremely close to the shoreline. Chum fry maintain a nearshore distribution until they reach a size of about 45 to 50 mm, at which time they move to deeper offshore areas (NMFS 1999).

Summer chum entering the estuary are thought to immediately commence migration seaward. After 2 to 4 years of rearing in the northeast Pacific Ocean, maturing Puget Sound-origin chum salmon follow a southerly migration path parallel to the coastlines of southeast Alaska and British Columbia. Summer chum mature primarily at 3 and 4 years of age with low numbers returning at age 5. They enter the Strait of Juan de Fuca from the first week of July through September and the Hood Canal terminal marine area from early August through the end of September. Summer chum adults may mill in front of their stream of origin for up to 12 days before entering freshwater to spawn (WDFW 2006a).

Prey

Chum salmon feed on insects as they migrate downriver and on insects and marine invertebrates in estuaries and nearshore marine habitats. As adults in the ocean, they eat copepods, fishes, mollusks, squid, and tunicates.

Humpback Whale (*Megaptera novaeangliae*)

Status

Humpback whales were listed as endangered on June 2, 1970 (Federal 1970). In 2016, NMFS revised the ESA listing for the humpback whale to identify 14 Distinct Population Segments, and listed one as threatened, four as endangered, and nine others as not warranted for listing (Federal Register 2016b). When a humpback whale is sighted in Washington inland waters (Puget Sound, Strait of Juan de Fuca, San Juan Islands) it is 43% likely to be from the unlisted Hawaii Distinct Population Segment (DPS), 42% likely to be from the threatened Mexico DPS, and 15% likely to be from the endangered Central American DPS (NMFS 2016).

Critical Habitat

Critical habitat has not been designated for humpback whales.

Biology and Distribution

Major humpback whale breeding and calving areas are in Mexican and Hawaiian waters. Humpback whales migrate to Alaska during the summer to feed. The Washington coast is a corridor for their annual migration north to feeding grounds and south to breeding grounds. Feeding groups of up to five whales have been documented on Juan de Fuca Bank and La Perouse Bank in summer (Osborne et al. 1998). Sightings of humpbacks in Puget Sound are infrequent; however, reported sightings have been increasing since the late 1990s. Until the late 1990s, sighting of humpback whales in Puget Sound occurred approximately once every 2 years (Calambokidis 1998). However, since 2001 there have been several Puget Sound humpback whale sightings reported through the Orca Network annually. The increase in sightings is likely due to increased local awareness and the establishment of sighting networks such as the Orca Network where residents can easily report whale sightings.

Humpbacks in Puget Sound are typically sighted as single individuals. An exception occurred in 1988 when two juvenile whales were reported in south Puget Sound (Calambokidis and Steiger 1990).

Cascadia Research Collective has been studying humpback whales along the US West Coast since 1986. In the early 2000s, increasing numbers of humpback whales were sighted in Washington inland waters (Figure B-1) (CRC 2017).

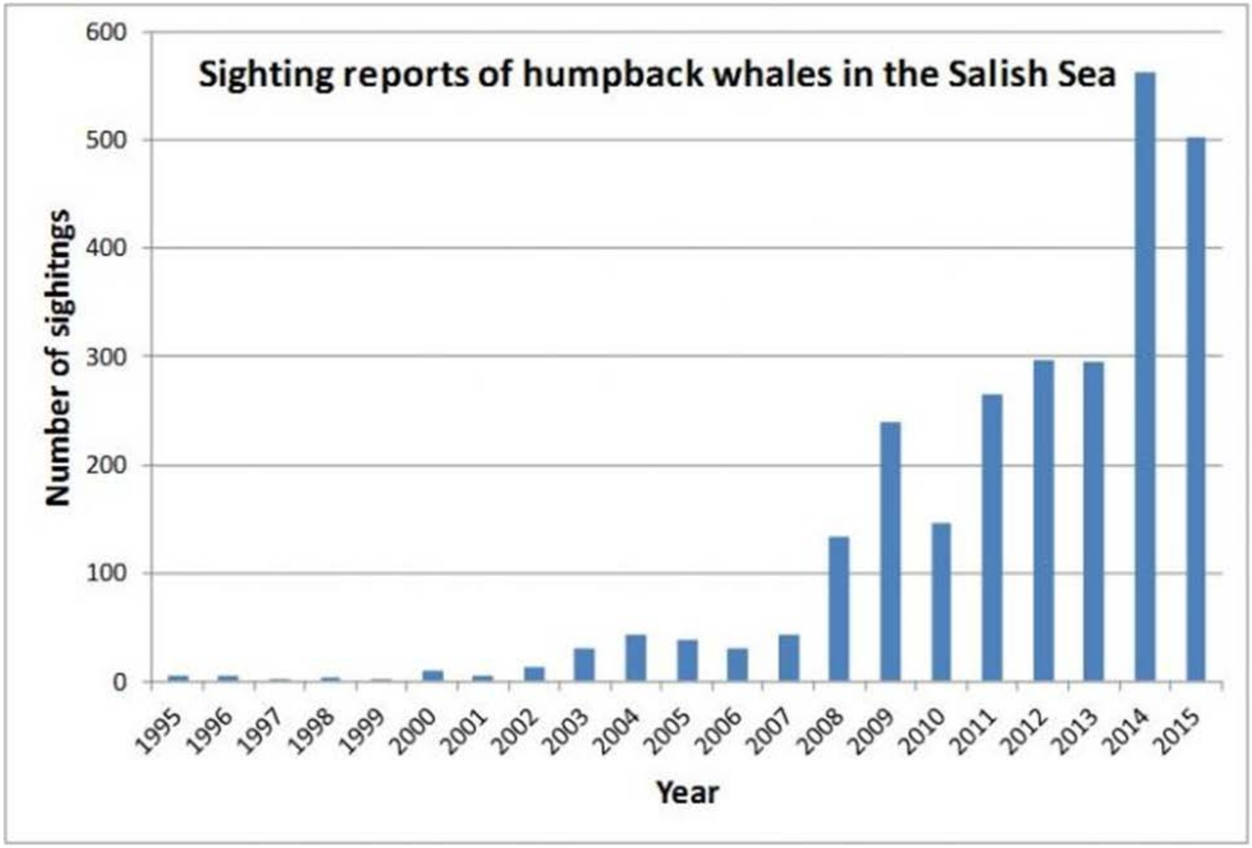

Figure B-1. Humpback Sightings by Year

Prey

Humpback whales forage either at or below the water surface. Humpback whales feed on benthic and pelagic organisms including euphausiids, copepods, and other crustacean zooplankton; small schooling fish such as sand lance and herring; and salmonids, pollock, capelin, and some cephalopod mollusks (Perry et al. 1999). Simenstad et al. (1979) listed four species of euphausiids and four species of small schooling fish found in stomachs of humpback whales taken in the eastern North Pacific Ocean.

The most significant prey item for humpback whales in Puget Sound is herring (American Cetacean Society 2009). A large herring holding area exists in the south Sound near the southern tip of Vashon Island (WDFW 2005c). Herring spawn on macroalgae, mainly eelgrass and kelp (WDFW 2005c).

Documented forage fish (prey species) spawning beaches are present at nine WSF facilities. Eelgrass and/or kelp that provide forge fish egg spawning habitat are present at 11 WSF facilities (Table B-1).

Facility	Documented Prey Species Spawning[1]	Eelgrass/Kelp Presence[2]
Anacortes	**Surf Smelt**	**Eelgrass**
Bainbridge	**Surf Smelt**	
Bremerton		
Clinton	**Surf Smelt**	**Eelgrass**
Coupeville		
Eagle Harbor		
Edmonds		**Eelgrass/Kelp**
Fauntleroy	**Sand Lance**	**Eelgrass**
Friday Harbor		**Eelgrass**
Kingston		**Eelgrass**
Lopez	**Surf Smelt**	
Mukilteo	**Sand Lance**	**Eelgrass**
Orcas		**Eelgrass**
Point Defiance		
Port Townsend	**Surf Smelt**	**Eelgrass**
Seattle		
Shaw		
Southworth	**Surf Smelt**	**Eelgrass**
Tahlequah		**Eelgrass**
Vashon	**Surf Smelt**	**Eelgrass**

Table B-1. Humpback Prey Species Presence

Southern Resident Killer Whale (*Orcinus orca*)

Status

The Southern Resident DPS of killer whales was listed as endangered on February 16, 2005 (Federal Register 2005b).

Critical Habitat

Critical habitat was designated for Southern Resident killer whales on November 29, 2006 (Federal Register 2006). Three specific areas are designated: the Summer Core Area in Haro Strait and waters around the San Juan Islands, Puget Sound, and the Strait of Juan de Fuca. Areas with water less than 20 feet deep relative to the extreme high water mark are not included in the critical habitat designation (Federal Register 2006).

NMFS has identified physical and biological PCEs essential for the conservation of the species that require special management considerations or protection. Based on the natural history of the Southern Residents and their habitat needs, NMFS has identified the following three PCEs for proposed critical habitat:

1. Water quality to support growth and development
2. Prey species of sufficient quantity, quality, and availability to support growth, reproduction, and development as well as overall population growth
3. Passage conditions to allow for migration resting and foraging

Biology and Distribution

Killer whales in the Eastern North Pacific region are categorized as resident, transient, or offshore whales. Residents in the North Pacific are further classified into Northern, Southern, Southern Alaska, and Western North Pacific groups. The Southern Resident killer whale group has been established as a DPS and a stock under the Marine Mammal Protection Act of 1972; this group contains the pods, or groups, of J pod, K pod, and L pod, and was estimated to include approximately 90 individuals in 2006 (Center for Whale Research 2006).

The geographic distribution of Southern Resident killer whales is year-round in the coastal waters off Oregon, Washington, Vancouver Island, and off the coast of central California and the Queen Charlotte Islands (Center for Biological Diversity 2001). In the summer, Southern Residents are typically found in the Georgia Strait, Strait of Juan de Fuca, and the outer coastal waters of the continental shelf. In the fall, the J pod migrates into Puget Sound, while the rest of the population makes extended trips through the Strait of Juan de Fuca. In the winter, the K and L pods retreat from inland waters and are seldom detected in the core areas until late spring. The J pod generally remains in inland waterways throughout the winter, with most of their activity in Puget Sound. Other winter movements and ranges of Southern Residents are not well understood.

Killer whales use the entire water column, including regular access to the ocean surface to breathe and rest (Bateson 1974; Herman 1991). They remain underwater 95 percent of the time, with 60 to 70 percent of their time spent between the surface and a depth of 20 meters, while diving regularly to depths of over 200 meters (Baird 1994; Baird et al. 1998). Southern Residents spend less than 5 percent of their time between depths of 60 and 250 meters (Center for Biological Diversity 2001). Time-depth recorder tagging studies of Southern Residents have documented that whales regularly dive to greater than 150 meters. In recent years, however, there has been a trend toward a greater frequency of shallower dives (Baird and Hanson 2004).

Prey

Residents tend to feed primarily on fish, whereas transients prey on other marine mammals (Morton 1990). Southern Residents primarily feed upon salmon species (Balcomb et al. 1980; Bigg et al. 1987). Chinook salmon dominate their diet, making up 78 percent of identified prey. Chum salmon (11 percent) are also a significant prey source especially in autumn. Other species eaten include coho salmon (5 percent), steelhead (2 percent), sockeye salmon (1 percent), and non-salmonids such as herring and rockfish (3 percent combined) (several sources *cited in* NMFS 2008a).

Southern DPS North American Green Sturgeon (*Acipenser medirostris*)

Status

The Southern DPS of green sturgeon was listed as threatened on April 7, 2006 (Federal Register 2006b).

Critical Habitat

On October 9, 2009, NMFS designated critical habitat for the Southern DPS of green sturgeon (Federal Register 2009). In this designation, NMFS identified the following areas as critical habitat in Washington:

- Nearshore marine areas comprising coastal waters within 361 feet (110 meters) depth from the Columbia River estuary north to the Washington/Canada border, and the Washington waters of the Strait of Juan de Fuca
- Estuarine areas of comprising the Columbia River estuary (includes all tidally influenced areas of the Columbia River downstream of Bonneville Dam
- Willapa Bay and Grays Harbor, Washington

PCEs of critical habitat are areas containing the physical and biological habitat features essential for the conservation of the species and that may require special management considerations or protection. PCEs may include, but are not limited to, the following: spawning site, feeding sites, seasonal wetland or dryland, water quality or quantity, geological formation, vegetation type, tide, and specific soil types. Only areas that contain one or more PCEs are, by definition, critical habitat. The different systems occupied by green sturgeon at specific stages of their life cycle serve distinct purposes and thus may contain different PCEs.

Based on the best available scientific information, NMFS identified PCEs for freshwater riverine systems, estuarine areas, and coastal marine waters. However, freshwater riverine systems in Washington are not designated as critical habitat. The PCEs for estuarine areas and nearshore marine waters are summarized below. The PCEs for freshwater riverine systems were excluded since no freshwater riverine systems were included in the critical habitat for Washington. Each specific area must contain at least one of the PCEs to be considered for critical habitat designation. These PCEs are described in detail beginning on page 52088 of the Federal Register (Federal Register 2009).

<u>Estuarine Areas</u>

1. **Food Resources** – Abundant prey items within estuarine habitats and substrates for juvenile, subadult, and adult life stages

2. **Water Quality** – Water quality, including temperature, salinity, oxygen content, and other chemical characteristics, necessary for normal behavior, growth, and viability of all life stages
3. **Migratory Corridor** – A migratory pathway necessary for the safe and timely passage of Southern DPS fish within estuarine habitats and between estuarine and riverine or marine habitats
4. **Water Depth** – A diversity of depths necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages (based on studies described on page 52089 of 73 FR 52084), shallow depths of less than 10 m for adults and subadults; and shallow waters of 1 to 3 m for juveniles)
5. **Sediment Quality** – Sediment quality (i.e., chemical characteristics) necessary for normal behavior, growth, and viability of all life stages

<u>Nearshore Marine Waters</u>

1. **Migratory Corridor** – *A migratory pathway necessary for the safe and timely passage of Southern DPS fish within marine* habitats *and between* estuarine and marine habitats
2. **Water Quality** – *Coastal marine waters with adequate dissolved oxygen levels and acceptably low levels of contamin*ants
3. **Food Resources** – *Abundant prey items for subadults and adults, which may include ben*thic invertebrates and fishes

Biology and Distribution

The Southern DPS of green sturgeon spawns in the Sacramento River (Adams et al. 2002) and is found along the west coasts of Mexico, the United States, and Canada. They are known to enter Washington estuaries during summer when estuary water temperatures are more than 2°C warmer than adjacent coastal water (Moser and Lindley 2007).

Green sturgeon are anadromous, and when not spawning, spend the majority of their lives in oceanic waters, bays, and estuaries. Early life-history stages reside in freshwater, with adults returning to freshwater to spawn. Spawning is believed to occur every 2 to 5 years (Moyle 2002). Adults typically migrate into freshwater beginning in late February; spawning occurs from March to July, with peak activity from April to June (Moyle et al.

1995). Juvenile green sturgeon spend 1 to 4 years in fresh and estuarine waters before dispersal to saltwater (Beamesderfer and Webb 2002). Juvenile green sturgeon can completely transition from fresh and estuarine waters to salt water by around 1.5 years in age (Allen and Cech 2007, as cited in NMFS 2008c). They disperse widely in the ocean after their out-migration from freshwater (Moyle et al. 1992).

Subadult male and female green sturgeon spend approximately 6 and 10 years at sea, respectively, before reaching reproductive maturity and returning to freshwater to spawn for the first time (Nakamoto et al. 1995, as cited in NMFS 2008c). Adults spend 2 to 4 years at sea between spawning events (Moyle 2002; Lindley and Moser, NMFS, pers. comm. 2008, cited inFederal Register 2005cand NMFS 2008c; Erickson and Webb 2007, as cited in NMFS 2008c), and spend up to 6 months in freshwater during their spawning migration. Upstream migrations begin in February, and the spawning period occurs from March to July and peaks in mid-April to mid-June (Moyle et al. 1992). Spawning habitat includes deep pools or "holes" in large, turbulent freshwater mainstems (Moyle et al. 1992). Eggs are likely broadcast over large cobble substrates, but substrates may range from clean sand to bedrock (Moyle et al. 1995).

Observations of green sturgeon in the Puget Sound region are much less common compared to coastal estuaries in Washington such as the Columbia River estuary, Grays Harbor, and Willapa Bay. Although two confirmed Southern DPS fish were detected in Puget Sound in 2006, the extent to which Southern DPS green sturgeon use Puget Sound remains uncertain and very few green sturgeon have been observed there (Federal Register 2009; DeLacy et al. 1972; Miller and Borton 1980). In addition, Puget Sound does not appear to be part of the coastal migratory corridor that Southern DPS fish use to reach overwintering grounds north of Vancouver Island (pers. comm. with Steve Lindley, NMFS, and Mary Moser, *as cited in* Federal Register 2009). There are no green sturgeon concentrations or spawning areas in Puget Sound.

Prey

Data from the Sacramento-San Joaquin delta showed that adults fed on benthic invertebrates including shrimp, mollusks, amphipods, and small fish (Moyle et al. 1992). Adult and subadult green sturgeon in the Columbia River estuary, Willapa Bay, and

Grays Harbor feed on crangonid shrimp, burrowing thalassinidean shrimp (primarily the burrowing ghost shrimp *Neotrypaea californiensis*), amphipods, clams, juvenile Dungeness crab (*Cancer magister*), anchovies, sand lance (*Ammodytes hexapterus*), lingcod (*Ophiodon elongatus*), and other unidentified fish species (as cited in NMFS 2008c: Foley, unpublished data cited in Moyle et al. 1995; Tracy, cited in Moyle et al. 1995; Langness, pers. comm., cited in Moser and Lindley 2007; Dumbauld et al. 2008).

Pacific Eulachon (*Thaleichthys pacificus*)

Status

The Southern DPS of Pacific eulachon was listed as threatened on March 18, 2010 (Federal Register 2010b).

Critical Habitat

Pacific eulachon critical habitat has been designated, but none is located near any of the WSF facilities (Federal Register 2011).

Biology and Distribution

Eulachon (also called Columbia River smelt, candlefish, or hooligan) are a member of the osmerid family (smelts) and are endemic to the northeastern Pacific Ocean, ranging from northern California to southwest and south-central Alaska and into the southeastern Bering Sea. The Southern DPS of eulachon consists of populations spawning in rivers south of the Nass River in British Columbia, Canada, to, and including, the Mad River in California. Within this range, major production areas or "core populations" for this species include the Columbia River and Frasier River.

The Columbia River and its tributaries support the largest known eulachon run in the world (Gustafson et al. 2008). Within the Columbia River Basin, the major and most consistent spawning runs return to the mainstem of the Columbia River (from just upstream of the estuary, river mile (RM) 25, to immediately downstream of Bonneville Dam, RM 146, and the Cowlitz, Grays, Kalama and Lewis Rivers. Table B-1 contains a list and classification of all known eulachon spawning areas in Washington, based on the 2008 Eulachon Status Review (Gustafson et al. 2008).

Table B-1
Eulachon Spawning and Estuarine Areas in Washington

Eulachon Spawning Areas	Spawning Regularity[1]	Estuary
Columbia River Mainstem	Regular	Columbia River
Grays River	Regular	Columbia River
Skamokawa Creek	Rare	Columbia River
Elochoman River	Irregular	Columbia River
Cowlitz River	Regular	Columbia River
Toutle River	Rare	Columbia River
Kalama River	Regular	Columbia River
Lewis River	Regular	Columbia River
Washougal River	Rare	Columbia River
Klickitat River	Anecdotal	Columbia River
Bear River	Occasional	Willapa Bay
Naselle River	Occasional	Willapa Bay
Nemah River	Rare	Willapa Bay
Wynoochie River	Rare	Grays Harbor
Quinault River	Occasional	Coast
Queets River	Occasional	Coast
Quillayute River	Rare	Coast
Elwha River	Occasional	Juan de Fuca
Puyallup River	Rare	Puget Sound

Notes:
Table from Gustafson et al. 2008
1 **Regular –** occurring yearly or in most years
Rare, Irregular, Anecdotal, Occasional – sporadic, infrequent occurrence, does not occur every year and may not occur in most years, especially those rivers with a spawning regularity of "rare." Eulachon are described as "common" in Grays Harbor and Willapa Bay on the Washington coast, and "abundant" in the Columbia River (Gustafson *et al.* 2008).

Eulachon typically spend 3 to 5 years in saltwater before returning to fresh water to spawn from late winter through early summer. River entry and spawning begin as early as December and January in the Columbia River Basin, and last through May with peak entry and spawning during February and March (see Table B-2; WDFW and ODFW 2002; Gustafson et al. 2008; Shaffer et al. 2007). Entry into the spawning rivers appears to be related to water temperature and the occurrence of high tides (Ricker et al. 1954; Smith and Saalfeld 1955; Spangler 2002), although eulachon have been observed ascending well beyond tidally influenced areas (Wilson et al. 2006; Lewis et al. 2002).

Table B-2
Range and Peak Timing of Documented Washington River-entry and/or Spawn-timing for Eulachon

Basin	Source	December	January	February	March	April	May
Columbia Basin							
Columbia River	1						
Cowlitz River, WA	1						
Juan de Fuca							
Elwha River, WA	2						

Notes:
Gray shading = range
Black shading = peak
Table from Gustafson et al. 2008
1 WDFW and ODFW 2002
2 Shaffer et al. 2007

Spawning grounds are typically in the lower reaches of larger rivers fed by snowmelt (Hay and McCarter 2000). Spawning typically occurs at night. Spawning occurs at temperatures from 4 degrees to 10 degrees Celsius in the Columbia River and tributaries (WDFW and ODFW 2002). In the Cowlitz River, spawning generally occurs at temperatures from 4 degrees to 7 degrees Celsius (Smith and Saalfeld 1955). Eulachon broadcast spawn over sand, coarse gravel, or detrital substrates. Preferred spawning habitat consists of coarse, sandy substrates (WDFW and ODFW 2002).

Eggs are fertilized in the water column, sink, and adhere to the river bottom typically in areas of gravel and coarse sand. Approximately 7,000 to 31,000 eggs are laid, depending on the size of the female (WDFW and ODFW 2002). Eggs are spherical and 1 mm in diameter (WDFW and ODFW 2002). Eulachon eggs hatch in 20 to 40 days, with incubation time dependent on water temperature. Within days of hatching, the larvae, ranging from 4 to 8 mm in length, are rapidly carried downstream and dispersed by estuarine and ocean currents. Eulachon larvae are found in the scattering layer of nearshore marine areas when they reach the sea (Morrow 1980). Juveniles rear in nearshore marine areas at moderate or shallow depths, and acquire lengths of 46 to 51 mm within 8 months (Barraclough 1964). As eulachon grow, they migrate out to deeper water depths and have been found as deep as 625 m (Allen and Smith 1988). Adult eulachon range in size from 14 to 30 cm and return to freshwater to spawn at 3 to 5 years of age, with the majority of adults returning as 3-year-olds (WDFW and ODFW 2002).

Although adults can repeatedly spawn, most die shortly after spawning (WDFW and ODFW 2002).

Similar to salmon, juvenile eulachon are thought to imprint on the chemical signature of their natal river basins. However, juvenile eulachon spend less time in freshwater environments than do juvenile salmon. Researchers believe that this short freshwater residence time may cause returning eulachon to stray more from their natal spawning sites than salmon (Hay and McCarter 2000). This short freshwater residence time may result from the spawning grounds occurring in snowmelt-fed rivers that have a pronounced peak freshet in the spring, rapidly flushing eggs and larvae out of the spawning river reach. As such, eulachon may tend to imprint and hone in on the larger local estuary rather than to individual spawning rivers (Hay and McCarter 2000). Adults and juveniles commonly forage at moderate depths (15 to 182 m) in inshore waters (Hay and McCarter 2000). Eulachon are very important to the Pacific coastal food web due to their availability during spawning runs and their high lipid content. Avian predators include harlequin ducks, pigeon guillemots, common murres, mergansers, cormorants, gulls, and eagles. Marine mammal predators include baleen whales, orcas, dolphins, pinnipeds, and beluga whales. Fish that feed on eulachon include white sturgeon, spiny dogfish, sablefish, salmon sharks, arrowtooth flounder, salmon, Dolly Varden, Pacific halibut, and Pacific cod. Eulachon and their eggs provide a significant food source for white sturgeon in the Columbia River.

Prey

Eulachon feed on zooplankton, primarily eating crustaceans such as copepods and euphausiids, including *Thysanoessa* spp. (Barraclough 1964; Hay and McCarter 2000), unidentified malacostraceans (Sturdevant et al. 1999), and cumaceans (Smith and Saalfeld 1955). Eulachon larvae and post-larvae eat phytoplankton, copepods, copepod eggs, mysids, barnacle larvae, worm larvae, and eulachon larvae (WDFW and ODFW 2002).

Bocaccio Rockfish (*Sebastes paucispinus*)

Status

The Georgia Basin DPS of bocaccio rockfish was listed as endangered on April 28, 2010 (Federal Register 2010c).

Critical Habitat

Critical habitat for bocaccio rockfish was designated in 2015. All WSF facilities are within rockfish nearshore (less than or equal to 98 feet in depth) critical habitat (Federal Register 2015).

Biology and Distribution

Bocaccio are large piscivorous rockfish (of the scorpaenid family) ranging in eastern Pacific coastal waters from Stepovac Bay, Alaska, to Punta Blanca, Baja California (NMFS 2008b; COSEWIC 2002). Bocaccio are most notably identified by a large jaw that extends often past the eye. They can range in color from olive orange to burnt orange or brown on the back. Bocaccio are one of the largest rockfish reaching up to 36 inches in length and living up to 55 years. Other names for bocaccio include rock salmon, salmon rockfish, Pacific red snapper, Pacific snapper, and Oregon snapper (Stanley et al. 2001). Most commonly, bocaccio are found from Oregon to California and were once common on steep walls of Puget Sound (Love et al. 2002). Genetic studies suggest that there are two DPSs of coastal bocaccio consisting of northern (north of the Oregon/California border) and southern (California south). However, based on the limited mobility and typical travel distance of rockfish species, it was determined that the Georgia Basin represented a third DPS for the species (NMFS 2008b).

Recreational catch data reported between the mid-1960s and the 1970s suggested that bocaccio were rare in Puget Sound proper (south of Admiralty Inlet) (NMFS 2008b). However, throughout the late 1970s, the Washington State Department of Fish and Wildlife (WDFW) Washington State Sport Catch Reports documented that 8 to 9 percent of catches included bocaccio. These reports were primarily (66 percent) in punch card area 13 (south of the Tacoma Narrows Bridge). Specifically, the reports indicated high abundance numbers of bocaccio at Point Defiance and the Tacoma Narrows for the years 1975 to 1986 (NMFS 2008b). Between 1996 and 2007, bocaccio were not documented in dockside surveys of recreational catches. WDFW catch reports and REEF surveys between 1994 and 2001 contain sporadic observations of bocaccio in Areas 5 (Seiku), 6 (Port Townsend/Port Angeles), 7 (Island County), and 11 (Tacoma and Vashon Island) (NMFS 2008b). REEF survey data for January 1996 through May 2009 indicates that bocaccio are identified in less than 0.1 percent of surveys and those observed were in the Tacoma area (REEF 2009). The latest records of bocaccio sightings in 2001 documented three observations of 2 to 10 fish in Area 13 (Tacoma Narrows south). In North Puget Sound and the Straight of Georgia, records and observations of bocaccio are rare, sparse, in isolated inlets, and often based on anecdotal reports (NMFS 2008b).

Male bocaccio are somewhat smaller than females and mature slightly earlier, between ages three and seven. Females typically mature between age four and eight (Wyllie Echeverria 1987). At maturity, males range from 16.5 to 21.6 inches (42 to 55 cm) in length, while females are 18.9 to 23.6 inches (48 to 60 cm). Maturity is reached at later ages in the northern populations of the species (NMFS 2008b). Bocaccio, as with all rockfish, are livebearers. Females produce 20,000 to 2,298,000 eggs annually. Copulation and fertilization generally occur in the fall between August and November (Table B-3). Embryonic development takes about 1 month. In Washington, the females release the larvae beginning in January through April, peaking in February (NMFS 2008b).

Table B-3
Lifestage, Water Column, and Timing of Bocaccio in the Georgia Basin

Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Copulation/Fertilization												
Embryonic Development												
Larval Release												
Pelagic Juveniles												
Settlement of Juveniles												

Notes:
Table from NMFS 2008b
Gray shading = range
Black shading = peak

Larvae are 4.0 to 5.0 mm (less than 0.2 inch) long at release, generally well-developed, and have functional organs and the ability to swim and regulate buoyancy (NMFS 2008b). Larvae are highly dispersal and are generally associated with surface waters, significant patches of kelp, and drifting kelp mats (NMFS 2009). The larvae metamorphose into pelagic juveniles after 3.5 to 5.5 months (typically 155 days) and settle to shallow, algae covered rocky areas or eelgrass and sand over several months (Love et al. 1991). As the juveniles age into adulthood, the fish move into deeper waters where they are found on rocky reefs and near oil platforms. As juveniles age, they move into deeper waters. Tagging data indicates that juveniles will migrate as much as 92 miles (0.9 to 148 km) within 2 years of tagging (NMFS 2008b). However, once bocaccio reach adulthood, they settle and remain relatively localized as they age.

Bocaccio will make short forays outside home ranges or vertically in the water column to feed (COSEWIC 2002; NMFS 2008b). Adults are most commonly found in waters between 164 and 820 feet in depth, but can inhabit waters 39 to 1,568 feet deep (NMFS 2008b). Adults are very unlikely to occur within the immediate terminal areas because of ferry facility shallower depths (64 ft. MLLW maximum depth).

Although rockfish are generally associated with hard substrata, bocaccio are found in nearly all types of substrate. They are typically not associated with the bottom and tend to be more pelagic than other rockfish species (NMFS 2009). Adult bocaccio seem to be limited to certain areas in southern Puget Sound around the Tacoma Narrows and Point Defiance (NMFS 2009). Chinook salmon, terns, and harbor seals are known predators of bocaccio (Love et al. 2002).

Prey

The diet of the larval bocaccio consists of larval krill, diatoms, and dinoflagellates. Pelagic juveniles continue to be planktivores, eating fish larvae, copepods, krill, and other small prey. As adults, bocaccio are piscivorous and eat other rockfish, hake, sablefish, anchovies, lanternfish, and squid.

Yelloweye Rockfish (*Sebastes ruberrimus*)

Status

The Georgia Basin DPS of yelloweye rockfish was listed as threatened on April 28, 2010 (Federal Register 2010c).

Critical Habitat

Critical habitat for yelloweye rockfish was designated in 2015. All WSF facilities are within rockfish nearshore (less than or equal to 98 feet in depth) critical habitat (Federal Register 2015).

Biology and Distribution

Yelloweye rockfish are one of the longest lived in the scorpaenid family (rockfish), living up to 118 years (NMFS 2009). They are also one of the largest (up to 25 pounds) and most noticeable, given the bright yellow eyes and red-orange coloring. Yelloweye rockfish are also known by the common names rock cod, red snapper, rasphead rockfish, red cod, and turkey-red rockfish. This species ranges from northern Baja California to the Aleutian Islands in Alaska. Most commonly, yelloweye rockfish are found between central California and the Gulf of Alaska, but are rare in Puget Sound Proper (Table B-4), south of Admiralty Inlet (NMFS 2008b; Love et al. 2002). When observed, yelloweye rockfish are more frequently observed in north Puget Sound than in south Puget Sound (Miller and Borton 1980), likely due to the larger amount of rocky habitat in north Puget Sound.

Table B-4
Observations and Distribution of Yelloweye Rockfish in Inland Washington Waters as Reported in REEF Surveys Between January 1996 and May 2009

Survey Area	Individual Sighting Frequency[1]	YOY Sighting Frequency[1]
Strait of Georgia	10.7	-
Texada Island (NE Georgia Strait)	60	-
Jervis Inlet (NE Georgia Strait)	64.3	-
Agamemnon Bay Area (N Georgia Strait)	70	-
Gulf Islands (N. of Orcas Island)	23.8	-
Pt Atkinson – Squamish (N. of Vancouver, BC)	2.3	-
Saanich Inlet (Eastern Vancouver Is.)	2.3	-
Moses Point/Albert Head, Victoria (W. Orcas Is)	2.4	-
Straight of Juan de Fuca	1.9	-
W. of Discovery Island and Cadboro Point	2.3	-
San Juan Islands	1.5	-
Orcas Island	3.2	-
Cypress Island	2.7	-
Decatur Island	14.3	-
Hood Canal	1.4	-
Dabob Bay	1.4	-

Survey Area	Individual Sighting Frequency[1]	YOY Sighting Frequency[1]
Quatsap Pt/Misery Pt – Potlatch State Park	1.3	-
Mt Vernon/Everett	1.5	-
Whidbey Island	1.5	-
Everett to Seattle	0.5	0.2
Edmonds	0.5	0.2
Seattle/Olympia	0.1	0.1
Vashon Island	1.6	-
Tacoma	-	0.2
Olympic Peninsula	1.7	-
Dungeness Bay to Kydaka Point	1.0	-
Kydaka Point - Cape Flattery	2.5	-

Notes:

Table from REEF 2009

1 Sighting frequency represents the percentage of surveys conducted that contained individuals of yelloweye rockfish. Individual = adults and juveniles combined. YOY = young of year only

Yelloweye rockfish are consistently observed throughout the Georgia Basin. However, significantly higher observation frequencies occur in north Puget Sound and the Georgia Strait within British Columbian waters (see Table B-4). REEF surveys indicate the further south in Puget Sound, the lower the potential for yelloweye rockfish presence or use, except around Decatur Island in the San Juan Islands where there is a spike in observations (REEF 2009). This is likely due to the fewer areas of rocky habitat in southern Puget Sound (Miller and Borton 1980).

Adults typically occupy waters deeper than 120 feet (Love et al., 2002). Adults are very unlikely to occur within the immediate terminal areas because of ferry facility shallower depths (64 ft. MLLW maximum depth).

General distribution occurs in the Georgia Strait and around the Gulf Islands in British Columbia (Yamanaka et al. 2006; NMFS 2008b; REEF 2009). Between 2000 and 2008, WDFW recreational catch surveys have documented a progressive decline in the number of yelloweye rockfish caught (WDFW 2009). In 2000, approximately 5,800 individuals were caught in recreational catches. By 2008, fewer than 1000 were recorded (WDFW 2009).

As with other rockfish species, juveniles are generally found in shallow waters and move deeper as they age. Juveniles are found throughout the life stage between 49 and 1,801 feet in depth (NMFS 2008b). As juveniles settle, they are found in high relief areas, crevices, and sponge gardens (NMFS 2009; Love et al. 1991). Adults are typically found at depths between 300 and 590 feet (NMFS 2008b). The adult yelloweye rockfish tend also toward rocky, high relief zones (NMFS 2009). The adults have very small home ranges, generally site attached and affiliated with caves, crevices, bases of rocky pinnacles, and boulder fields (Richards 1986). Adult yelloweye rockfish are rarely found in congregations, but are more commonly seen as solitary individuals (Love et al. 2002; PFMC 2003).

Males generally have slightly larger mean sizes than females, with both species topping out at approximately 35 inches (NMFS 2008b). Maturity in yelloweye rockfish is attained much later than some rockfish, between 15 and 20 years and as early as 7 years (NMFS 2008b). Sperm is stored in males for many months (September to April) prior to fertilization. Females can produce up to 300 eggs per gram of body weight, which totals between 1.2 and 2.7 million eggs per cycle (Hart 1973). In Puget Sound, eggs are fertilized between winter and summer months (NMFS 2009). Parturition occurs in Puget Sound in early spring through late summer. Although rockfish generally spawn once per year, there is some evidence that yelloweye rockfish in Puget Sound spawn up to twice per year (Washington et al. 1978). Larvae remain pelagic for 2 months or more and then begin to settle to deeper waters (NMFS 2008b). Although the specific larval duration is unknown, it is assumed to be similar to that of bocaccio or canary rockfish (116 to 155 days) (NMFS 2009). Settling size is slightly less than 1 inch. Presence timing for various rockfish life stages in the Georgia Basin is given in Table B-5.

Table B-5
Lifestage, Water Column, and Timing of Yelloweye Rockfish in the Georgia Basin

Lifestage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Copulation/Fertilization												
Embryonic Development												
Larval Release												
Pelagic Juveniles												
Settlement of Juveniles												

Notes:
Table from NMFS 2008b

Gray shading = range
Black shading = peak

Typical predators of yelloweye rockfish include salmon and orca (Love et al. 2002; NMFS 2009).

Prey

Yelloweye rockfish have a diverse diet and are typically opportunistic feeders (NMFS 2008b). As larvae and juveniles, they typically eat larval krill, diatms, dinoflagellates, fish larvae, copepods, and krill. Prey size increases and diversifies as yelloweye rockfish age (due to their large size) to include small yelloweye rockfish, sand lance, gadids, flatfishes, shrimp, crabs, and gastropods.

USFWS – Listed Threatened, Endangered, and Proposed Species

Bull Trout (*Salvelinus confluentus*)

Status

Bull trout were listed as threatened on November 1, 1999 (Federal Register 1999ab).

Critical Habitat

On January 13, 2010, USFWS published the Final Rule for designating critical habitat for the Coastal-Puget Sound DPS of bull trout in the Federal Register (Federal Register 2010a).

Critical habitat designates areas that contain the physical and biological habitat features (called PCEs) essential for the conservation of a threatened or endangered species and that may require special management considerations. Areas providing at least one of the following nine PCEs are designated as critical habitat:

1. Springs, seeps, groundwater sources, and subsurface water connectivity (hyporehic flows) to contribute to water quality and quantity and provide thermal refugia.
2. Migratory habitats with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and freshwater and marine foraging habitats including, but not limited to, permanent, partial, intermittent, or seasonal barriers.

3. An abundant food base, including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.
4. Complex river, stream, lake, reservoir, and marine shoreline aquatic environments and processes with features such as large wood, side channels, pools, undercut banks and substrates to provide a variety of depths, gradients, velocities, and structure.
5. Water temperatures ranging from 2 to 15°C (36 to 59°F), with adequate thermal refugia available for temperatures at the upper end of this range.; specific temperatures within this range will vary depending on bull trout life-history stage and form, geography, elevation, diurnal and seasonal variation, shade such as that provided by riparian habitat, and local groundwater influence.
6. Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival; a minimal amount (e.g., less than 12 percent) of fine substrate less than 0.85 mm (0.03 inches) in diameter and minimal embeddedness of these fines in larger substrates are characteristic of these conditions.
7. A natural hydrograph, including peak, high, low, and base flows within historic and seasonal ranges or, if flows are controlled, minimal departures from a natural hydrograph.
8. Sufficient water quality and quantity such that normal reproduction, growth, and survival are not inhibited.
9. Few or no nonnative predatory (e.g., lake trout, walleye, northern pike, smallmouth bass), inbreeding (e.g., brook trout), or competitive (e.g., brown trout) species present.

In marine nearshore areas, the inshore extent of critical habitat is the mean higher high water line (MHHW; average of all the higher high-water heights of the two daily tidal levels), including tidally influenced freshwater heads of estuaries. Adjacent shoreline riparian areas, bluffs, and uplands are not included in the critical habitat designation. The offshore extent of critical habitat for marine nearshore areas is to the depth of 33 feet (10 meters) relative to MLLW (average of all the lower low water heights of the two daily tidal levels), which is the average depth of the photic zone.

Biology and Distribution

Bull trout are members of the char subgroup of the salmon family. Bull trout feed on terrestrial and aquatic insects and, as they grow in size, their diets include whitefish, sculpins, and other trout. Bull trout spawn from August through November when they reach maturity (between 4 and 7 years) and when temperatures begin to drop, in cold, clear streams. Bull trout can spawn repeatedly, and can live over 20 years. Resident forms of bull trout spend their entire lives in freshwater, while anadromous forms live in tributary streams for 2 or 3 years before migrating to estuaries as smolts. Char species are generally longer-lived than salmon; bull trout up to 12 years old have been identified in Washington (Brown 1992).

In northern Puget Sound, bull trout occur in the Nooksack, Skagit, Stillaguamish, and Snohomish basins. Sub-adult and adult bull trout feed mostly on fish in marine/estuarine areas of northern Puget Sound (i.e., smelt, herring and juvenile salmonids). They are also believed to return to overwinter in lower mainstem rivers following their first summer in saltwater, before returning to saltwater the following spring (Kraemer 1994).

Prey

Bull trout are opportunistic feeders that prey on other organisms. Prey selection is primarily a function of size and life-history strategy. Resident and juvenile migratory bull trout prey on terrestrial and aquatic insects, macrozooplankton, and small fish. Adult migratory bull trout feed almost exclusively on other fish species (Federal Register 2010a).

Marbled Murrelet (*Brachyramphus marmoratus marmoratus*)

Status

The marbled murrelet was listed as threatened on October 1, 1992 (Federal Register 1992).

Critical Habitat

The USFWS designated revised critical habitat for the marbled murrelet in 2011. Designated critical habitat includes old growth stands and other suitable nesting areas. No critical habitat has been designated near WSF ferry facilities (Federal Register 1996).

Biology and Distribution

Marbled murrelets are small seabirds that occur along the Pacific Coast from the Bering Sea to central California, with the largest population occurring in southeastern Alaska and northern British Columbia. Marbled murrelets feed in the nearshore marine environment, usually up to 350 to 2,000 feet off the shoreline. They forage year-round in waters generally less than 90 feet deep and are most frequently within 1,500 feet of protected shoreline waters. Marbled murrelets generally do not forage in shallow waters less than 30 feet deep.

Although marbled murrelets feed primarily on fish and invertebrates in nearshore marine waters, they fly inland to nest on large limbs of mature conifers. Most nesting habitat likely occurs within 50 miles of the marine environment (USFWS 1997). The nesting period is between April 1 and September 23, with peak activity occurring between July and August when adults are increasing foraging trips to feed their young. Old-growth or mature forest stands appear to be crucial for breeding and foraging, and most nests are in conifers over 150 years old, and in trees greater than 55 inches diameter at breast height (dBH). Most nests have been found on large flat conifer branches that are covered with thick moss (WDW 1991).

Murrelets undergo two periods of molting: one preceding (prealternate) and one following (prebasic) the molting season. The prealternate molt is incomplete and the birds retain their ability to fly, while the prebasic molt is comlete and renders them unable to fly for up to 2 months (Nelson 1997). Timing of molts varies year-to-year and by location, but in general, the prealternate molt occurs from late February to mid-May and the prebasic molt from mid-July through December (Carter and Stein 1995). In Washington, there is some evidence that the prebasic molt extends from mid-July through late August or as late as September (USFWS 2004a).

Prey

In the Pacific Northwest, marbled murrelets live near shore, feeding on fish, small crustaceans, and invertebrates. Marbled murrelets prefer to forage near kelp beds and at stream mouths, and feed on a variety of prey including sand lance, Pacific herring, and northern anchovy.

REFERENCES

References for Appendix B are included in Section 5 of the BAR.