7.0 Magnuson-Stevens Act

The Magnuson-Stevens Fishery Conservation and Management Act (MSA), as amended by the Sustainable Fisheries Act of 1996 (Public Law 104-267), established procedures designed to identify, conserve, and enhance Essential Fish Habitat (EFH) for those species regulated under a Federal fisheries management plan. The MSA requires Federal agencies to consult with NMFS on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH (MSA §305(b)(2)). An adverse effect means any impact that reduces the quality and/or quantity of EFH. Adverse effects may include direct (e.g., contamination or physical disruption), indirect (e.g., loss of prey, or reduction in species' fecundity), site-specific or habitat-wide impacts including individual, cumulative, or synergistic consequences of actions.

EFH means those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (MSA §3). For the purpose of interpreting this definition of EFH, waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include aquatic areas historically used by fish where appropriate. Substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities. Necessary means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. "Spawning, breeding, feeding, or growth to maturity" covers a species' full life cycle (50 CFR 600.10). Adverse effect means any impact, which reduces quality and/or quantity of EFH, and may include direct (e.g., contamination or physical disruption), indirect *(*e.g., loss of prey or reduction in species fecundity), site-specific or habitat-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810).

The objective of this EFH assessment is to describe potential adverse effects on designated EFH for Federally managed fisheries species within the proposed action area. It also references performance standards proposed to avoid, minimize, or otherwise offset potential adverse effects on designated EFH resulting from the proposed action.

For the Pacific West Coast, there are three Fishery Management Plans, covering groundfish, coastal pelagic species, and Pacific salmon. Due to the geographic scope of the Bridge Program, the proposed actions have the potential to impact only groundfish EFH and Pacific salmon EFH. Coastal pelagic EFH are therefore not addressed in this analysis.

Groundfish

EFH for Pacific coast groundfish is defined as the aquatic habitat necessary to allow for groundfish production to support long-term sustainable fisheries for groundfish and for groundfish contributions to a healthy ecosystem. Descriptions of groundfish EFH for each of the 82 species and their life stages result in more than 400 EFH identifications. When these EFHs are taken together, the groundfish EFH includes all waters from the mean higher high water line, and the upriver extent of saltwater intrusion in river mouths, along the coasts of Washington, Oregon and California seaward to the boundary of the U.S. Exclusive Economic Zone (EEZ) (200 nautical miles offshore).

Pacific salmon
EFH for the Pacific coast salmon fishery means those waters and substrate necessary for salmon production needed to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. To achieve that level of production, EFH includes all those streams, lakes, ponds, wetlands, and other currently viable water bodies and most of the habitat historically accessible to salmon in Washington, Oregon, Idaho, and California. In the estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments within state territorial waters out to the full extent of the EEZ (230 miles) offshore of Washington, Oregon, and California north of Point Conception. Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers (as identified by the PFMC), and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years).

Habitat Areas of Particular Concern (HAPC) are those areas of "EFH that are judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation." Among other things, habitat areas may be prioritized by the importance of ecological function and the relative contribution towards sustainable fisheries; and, the extent to which habitat is sensitive to environmental degradation.

The Pacific Fisheries Management Council (PFMC) has not yet designated any areas as HAPCs in Oregon or any of the area covered by the PFMC, but has begun laying the groundwork for future HAPC designations.

7.1 Essential Fish Habitat Applicability

The proposed action, as described in Section 3 of this document, lies within an area designated as EFH for two Federal fishery management plans: Pacific groundfish and Pacific salmon. A formal EFH assessment for Pacific salmon is not presented separately in this document, as the analysis of the proposed action on 14 salmonid ESUs listed under the ESA and their designated critical habitat is sufficient to fulfill this requirement for EFH. Further, the potential effects of the proposed action on nine non-listed ESUs of salmon EFH are not likely to be significantly different than those discussed for listed salmonids in the Effects Analysis (Section 5) of this BA.

The estuarine and offshore marine waters are designated EFH for various life stages of 82 species of groundfish. A detailed description and identification of EFH for groundfish is found in the Final Environmental Assessment/Regulatory Impact Review for Amendment 11 to The Pacific Coast Groundfish Management Plan (PFMC 1998a) and the NOAA Fisheries Essential Fish Habitat for West Coast Groundfish Appendix (Casillas et al. 1998). The proposed action area also encompasses EFH for 23 ESUs of salmon and steelhead. A description and identification of EFH for chinook and coho salmon is found in Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999).

7.2 Description of the Project/Proposed Action

The Bridge Program described in this BA includes the repair or replacement of 430 bridges that require Federal permits from either the ACOE for fill in waters of the U.S. or wetlands (Section 404 of the Clean Water Act) or for any activities in tidal or navigable waters (Section 10 of the Rivers and Harbors Act). Actions proposed under the Bridge Program are described in Section 3.

The spatial extent of the potential area of impact of the Bridge Program extends from the upriver limits of estuaries where bridges cross such rivers, seaward to US-101 and several other ODOT highways that cross estuaries or bays on bridges. The spatial extent of the potential area of impact of the Bridge Program encompasses the Estuarine, Rocky Shelf, and Non-rocky Shelf Composites of groundfish EFH: estuarine and nearshore areas of EFH for Pacific salmon, and freshwater EFH for salmon. No ODOT road or structure is in contact with Neritic Composite waters at depths of 33 feet or more.

Effects on Pacific salmon and groundfish EFH may occur as a result of bridge repair or replacement activities within or upstream of designated EFH. Effects are either water-borne (turbidity, chemical), habitat related (stream channel impacts and riparian impacts) or direct (stream work, flow diversion). Bridge repair or replacement activities in an EFH or upstream of a natural barrier upstream of an EFH may adversely affect that EFH. Program bridges within EFH for Pacific salmon or groundfish are shown in Figures 7.2-1 and 7.2-2, respectively.

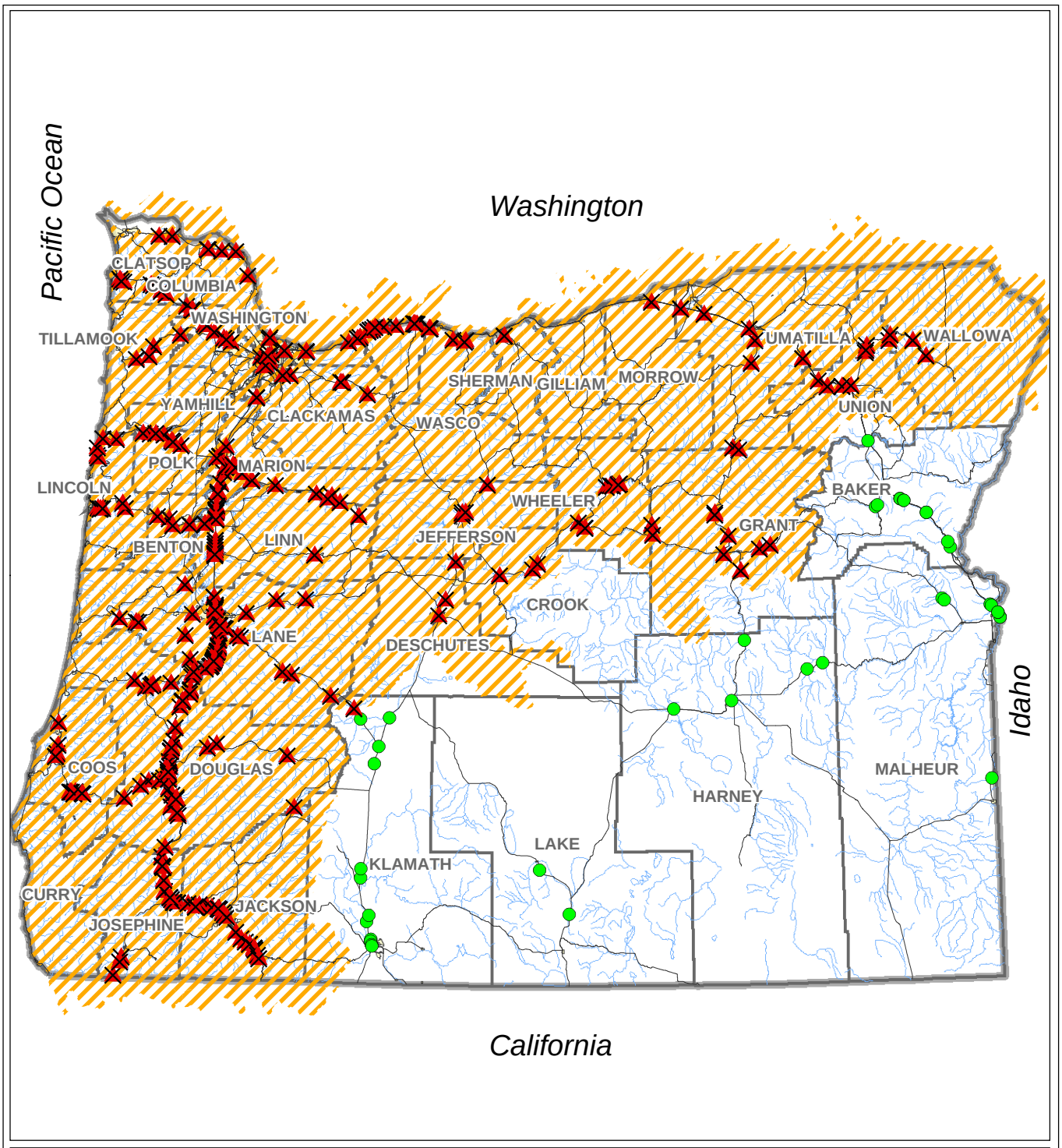
The Bridge Program may include activities at ODOT bridges that cross portions of an estuary or bay, including approach fills, abutments, wing walls, utility lines, pilings, or isolated bents. Bridge repair or replacement activities on bridges over estuaries could affect deeper subtidal waters around approach fills or isolated bents, with habitat features such as artificial rocky reefs (e.g., riprap) or around pilings driven into flat, soft (unconsolidated) bottom habitats including mud, sand, gravel, or cobble, into aquatic algal or seagrass beds, or into hard rocky bottom substrates.

7.3 Description of Species with EFH Potentially Affected by the Proposed Program

This section of the BA presents habitat descriptions, requirements, and life history of groundfish (Section 8.3.1) and Pacific salmon (Section 8.3.2). Information in this section has largely been obtained from ODOT's Draft EFH Analysis for the ODOT Maintenance Programmatic Biological Assessment (Floyd 2003). Numeric references in this section are contained in McCain (2003), cited within Floyd (2003) unless otherwise noted.

7.3.1 Groundfish

The waters and substrate that comprise groundfish EFH include rocky reefs, intertidal salt marshes, submerged aquatic vegetation, turbidity zones, and salinity gradients.



OTIA III Bridges

- Potential to Affect
- No Potential to Affect
- EFH Salmon Habitat: 4th Field HUC
- City
- County
- Streams and Rivers
- Highway
- State Boundary

This product is for informational purposes, and may not be suitable for legal, engineering or surveying purposes. This information or data is provided with the understanding that conclusions drawn from such information are the responsibility of the user.

Figure 7.2-1

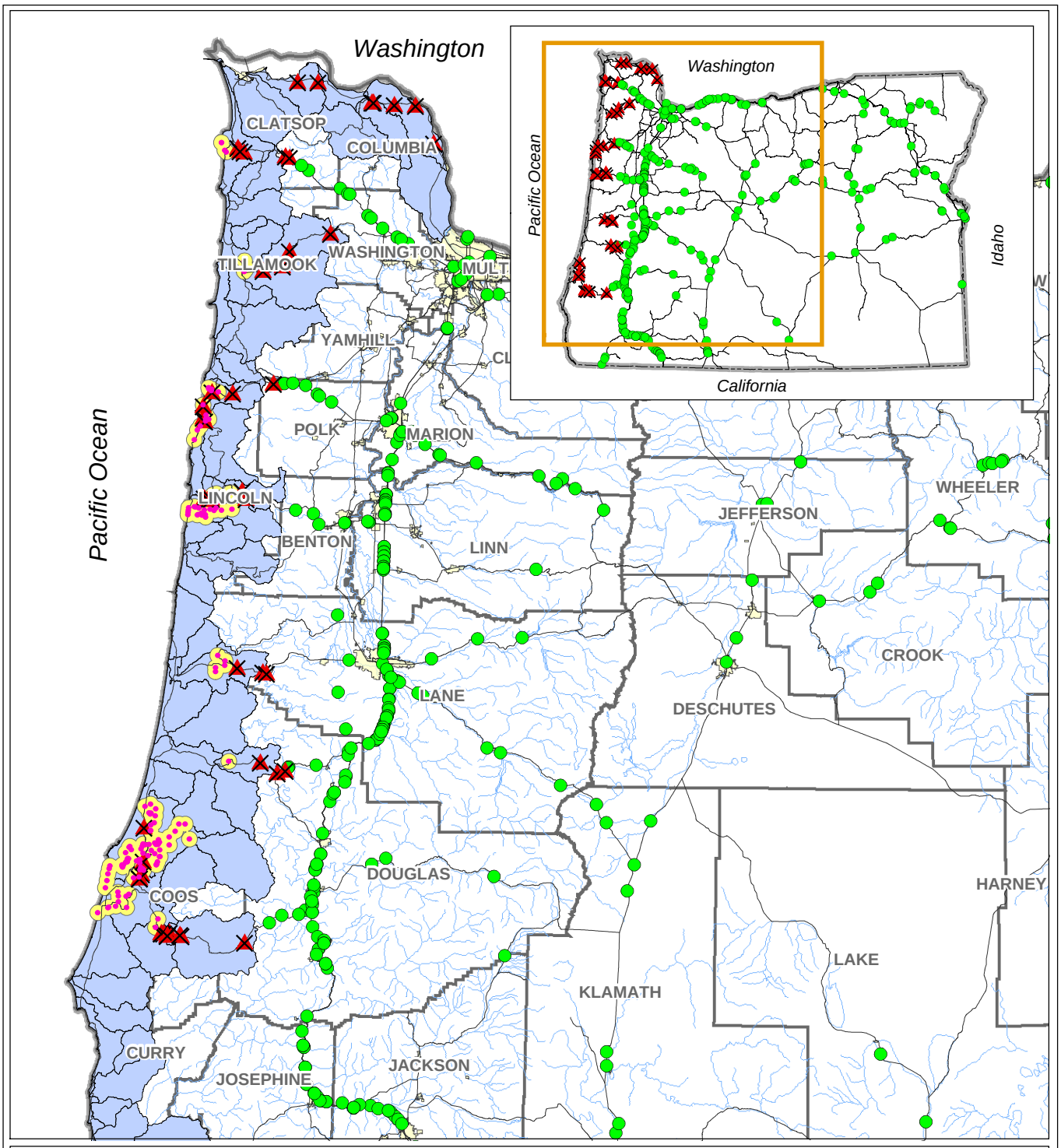
OTIA III: Statewide Bridge Delivery Program
EFH Salmon

N W E S

0 5 10 20 30 40
Miles

MB&G
Mason, Bruce & Girard, Inc.
Natural Resource Consultants since 1921

Spatial Data Source: See Document Bibliography.
screening/BA Figures/salmon2.mxd. Mar 1, 2004



OTIA III Bridges

- Potential to Affect
- No Potential to Affect
- Heads of Tide Used for Screening
- Heads of Tide 2-mile Buffer
- Groundfish EFH (5th HUC)
- City
- County
- Streams and Rivers
- Highway
- State Boundary

This product is for informational purposes, and may not be suitable for legal, engineering or surveying purposes. This information or data is provided with the understanding that conclusions drawn from such information are the responsibility of the user.

Figure 7.2-2

OTIA III: Statewide Bridge Delivery Program Groundfish EFH

N W E S

0 4 8 16 24 32 40

Miles

MB&G

Mason, Bruce & Girard, Inc.
Natural Resource Consultants since 1921

Spatial Data Source: See Document Bibliography.
screening/BA Figures/groundfish2.mxd. Mar 1, 2004

7.3.1.1 Groundfish EFH Composites

The West Coast Groundfish Fishery Management Plan (groundfish FMP) groups the various EFH descriptions for the 82 managed groundfish species into seven units called "composite" EFHs based on major habitat types. This approach focuses on ecological relationships among species and between the species and their habitat. Three of the composites, Estuarine, Non-rocky Shelf, and Rocky Shelf, are most susceptible to adverse impacts from non-fishing activities and could be affected by the Bridge Program. Two additional composites have been proposed in the draft revised appendix to the groundfish FMP (McCain 2003); one of these, the Intertidal Zone, also could be affected by the Bridge Program and is included here.

Estuarine

The Estuarine Composite EFH are those waters, substrates and associated biological communities within bays and estuaries of the EEZ, from mean higher high water level (MHHW, which is the high tide line) or extent of upriver saltwater intrusion (greater than 0.5 ppt ocean-derived salt) seaward to the respective outer boundaries for each bay or estuary as defined in 33 CFR 80.1 (Coast Guard lines of demarcation).

Non-rocky Shelf

The Non-rocky Shelf Composite EFH are those waters, substrates, and associated biological communities living on or within 5.5 fathoms overlying the substrates of the continental shelf, excluding the rocky shelf and canyon composites, from the high tide line MHHW to the shelf break (~109 fathoms).

Rocky Shelf

The Rocky Shelf Composite EFH are those waters, substrates, and associated biological communities living on or within 5.5 fathoms overlying rocky areas, including reefs, pinnacles, boulders and cobble, along the continental shelf, excluding canyons, from the high tide line MHHW to the shelf break (~109 fathoms). Habitats associated with the rocky shelf composite include kelp forests.

Intertidal Zone

The Intertidal Zone is between high tide (MHHW) and low tide (MLLW).

Species of groundfish and life-stages with designated EFH in the action area are presented in Tables 7.3.1-1, 7.3.1-2, 7.3.1-3, and 7.3.1-4.

Table 7.3.1-1. Estuarine Groundfish.
Groundfish species/life history stages within the Estuarine Composite EFH in Oregon.
Note: table legend at bottom of page

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Big Skate				NA		NA
California Skate	X	X	X	NA	X	NA
Longnose Skate				NA		NA
Leopard Shark[1]	X	X	X	NA	X	NA
Soupfin Shark	X	X	X	NA	X	NA
Spiny Dogfish	X		X	NA	X	X
Cabezon	X	X	X	X	X	X
Finescale Codling						NA
Kelp Greenling	X	X	X	X	X	X
Lingcod	X	X	X	X	X	X
Pacific Cod	X	X	X	X	X	NA
Pacific Rattail						NA
Pacific Whiting (Hake)	X	X	X	X	X	NA
Sablefish					X	
Spotted Ratfish	X	X		NA	X	NA
Arrowtooth Flounder						NA
Butter Sole						NA
Curlfin Sole						NA
Dover Sole						NA
English Sole	X	X	X	X	X	NA
Flathead Sole					X	NA
Pacific Sanddab	X		X	X	X	NA
Petrale Sole						NA

Table 7.3.1-1. (continued).

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Rex Sole	X				X	NA
Rock Sole	X	X	X	X	X	NA
Sand Sole						NA
Starry Flounder	X	X	X	X	X	NA
Aurora Rockfish						
Bank Rockfish[1]						
Black Rockfish	X				X	
Black-and-yellow Rockfish[1]						
Blackgill Rockfish						
Blue Rockfish						
Bocaccio				X	X	
Brown Rockfish	X	X	X	X	X	NA
Canary Rockfish						
Chilipepper						
China Rockfish						NA
Copper Rockfish	X	X	X	X	X	X
Cowcod						NA
Darkblotched Rockfish						
Flag Rockfish						
Gopher Rockfish[1]						
Grass Rockfish[1]						NA
Greenspotted Rockfish						NA

Table 7.3.1-1. (continued).

Greenstriped Rockfish						NA
Harlequin Rockfish[2]						
Longspine Thornyhead						NA
Pacific Ocean Perch						
Pink Rockfish[1]						
Quillback Rockfish	X	X	X	X	X	X
Redbanded Rockfish						NA
Redstripe Rockfish						NA
Rosethorn Rockfish						NA
Rosy Rockfish						NA
Rougheye Rockfish						NA
Sharpchin Rockfish						NA
Shortbelly Rockfish						
Shortraker Rockfish						NA
Shortspine Thornyhead						NA
Silverygray Rockfish						NA
Speckled Rockfish[1]						NA
Splitnose Rockfish						NA
Squarespot Rockfish[1]						NA
Stripetail Rockfish						NA
Tiger Rockfish						NA
Vermilion Rockfish						NA
Widow Rockfish						
Yelloweye Rockfish						NA

Table 7.3.1-1. (continued).

Yellowmouth Rockfish						NA
Yellowtail Rockfish						

Table Legend:

X = The EFH for the particular species and life stage occurs within the EFH composite in Oregon.
Blank = The EFH for the particular species and life stage is not currently known to occur within the EFH composite in Oregon, or insufficient information is currently available to identify its EFH.
NA = Not applicable

[1]absent from northern Oregon; [2]absent from southern Oregon

Table 7.3.1-2. Non-rocky shelf groundfish
Groundfish species/life history stages within the Non-rocky Shelf Composite EFH in Oregon.
Note: table legend same as for Estuarine Composite.

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Big Skate	X	X	X	NA	X	NA
California Skate	X	X	X	NA	X	NA
Longnose Skate	X	X	X	NA	X	NA
Leopard Shark[1]	X	X	X	NA	X	NA
Soupfin Shark	X	X	X	NA	X	NA
Spiny Dogfish	X		X	NA		X
Finescale Codling						NA
Lingcod	X					X
Pacific Cod	X	X	X		X	NA
Pacific Rattail	X	X			X	NA
Pacific Whiting (Hake)						NA
Sablefish	X					X
Spotted Ratfish	X	X	X	NA	X	NA
Arrowtooth Flounder	X	X			X	NA
Butter Sole	X	X				NA
Curlfin Sole	X	X				NA
Dover Sole	X	X			X	NA
English Sole	X	X			X	NA
Flathead Sole	X	X			X	NA
Pacific Sanddab	X	X			X	NA
Petrale Sole	X				X	NA
Rex Sole	X	X			X	NA
Rock Sole	X	X	X		X	NA

Table 7.3.1-2. (continued).

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Sand Sole	X	X			X	NA
Starry Flounder	X	X			X	NA
Aurora Rockfish	X	X				X
Bank Rockfish[1]	X				X	NA
Black Rockfish						X
Blue Rockfish						X
Bocaccio	X				X	X
Brown Rockfish						NA
Chilipepper	X		X		X	X
China Rockfish						NA
Copper Rockfish					X	NA
Cowcod					X	NA
Darkblotched Rockfish	X	X	X			X
Gopher Rockfish[1]	X				X	NA
Grass Rockfish[1]					X	NA
Greenspotted Rockfish	X		X		X	NA
Greenstriped Rockfish	X		X		X	NA
Longspine Thornyhead						NA
Pacific Ocean Perch	X					X
Pink Rockfish[1]	X				X	NA
Quillback Rockfish					X	
Redbanded Rockfish	X					NA
Redstripe Rockfish						NA

Table 7.3.1-2. (continued).

Rosethorn Rockfish	X		X			NA
Rosy Rockfish						NA
Rougheye Rockfish	X				X	NA
Sharpchin Rockfish	X		X			NA
Shortbelly Rockfish	X		X		X	
Shortraker Rockfish	X					NA
Shortspine Thornyhead	X				X	NA
Silverygray Rockfish	X					NA
Speckled Rockfish[1]						NA
Splitnose Rockfish	X		X		X	NA
Squarespot Rockfish[1]						NA
Stripetail Rockfish	X		X		X	NA
Tiger Rockfish						NA
Vermilion Rockfish					X	NA
Widow Rockfish	X	X	X		X	X
Yelloweye Rockfish						NA
Yellowmouth Rockfish						NA
Yellowtail Rockfish	X	X	X		X	X

Table 7.3.1-3. Rocky shelf groundfish.
Groundfish species/life history stages within the Rocky Shelf Composite EFH in Oregon.
Note: table legend same as for Estuarine Composite

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Big Skate				NA		NA
California Skate				NA		NA
Longnose Skate				NA		NA
Leopard Shark	X	X	X	NA	X	NA
Soupfin Shark	X	X		NA	X	NA
Spiny Dogfish	X	X		NA		X
Cabezon	X	X	X			X
Finescale Codling						NA
Kelp Greenling	X	X	X			X
Lingcod	X	X	X			X
Pacific Cod						NA
Pacific Rattail						NA
Pacific Whiting (Hake)						NA
Sablefish	X					
Spotted Ratfish	X	X	X	NA	X	NA
Arrowtooth Flounder						NA
Butter Sole						NA
Curlfin Sole						NA
Dover Sole						NA
English Sole	X	X			X	NA
Flathead Sole						NA
Pacific Sanddab						NA
Petrale Sole						NA
Rex Sole						NA

Table 7.3.1-3. (continued).

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Rock Sole	X	X	X		X	NA
Sand Sole						NA
Starry Flounder						NA
Aurora Rockfish	X				X	
Bank Rockfish	X				X	NA
Black Rockfish	X					X
Black-and-yellow Rockfish	X				X	NA
Blackgill Rockfish						X
Blue Rockfish	X	X			X	X
Bocaccio	X				X	X
Brown Rockfish	X	X	X		X	NA
Canary Rockfish	X		X		X	
Chilipepper	X		X			X
China Rockfish	X		X		X	NA
Copper Rockfish	X					X
Cowcod	X				X	NA
Darkblotched Rockfish	X	X	X		X	X
Flag Rockfish	X				X	NA
Gopher Rockfish	X				X	NA
Grass Rockfish	X		X		X	NA
Greenspotted Rockfish	X		X		X	NA
Greenstriped Rockfish	X		X		X	NA
Harlequin Rockfish	X					

Table 7.3.1-3. (continued).

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Longspine Thornyhead						NA
Pacific Ocean Perch	X	X	X		X	X
Pink Rockfish	X				X	NA
Quillback Rockfish	X		X		X	X
Redbanded Rockfish	X					NA
Redstripe Rockfish	X		X			NA
Rosethorn Rockfish	X		X			NA
Rosy Rockfish	X		X		X	NA
Rougheye Rockfish	X					NA
Sharpchin Rockfish	X		X			X
Shortbelly Rockfish	X		X		X	
Shortraker Rockfish	X					NA
Shortspine Thornyhead						NA
Silverygray Rockfish	X					X
Speckled Rockfish	X		X		X	NA
Splitnose Rockfish						NA
Squarespot Rockfish	X		X		X	NA
Stripetail Rockfish					X	NA
Tiger Rockfish	X					NA
Vermilion Rockfish	X				X	NA
Widow Rockfish	X	X	X		X	X
Yelloweye Rockfish	X		X		X	NA
Yellowmouth Rockfish	X		X			NA
Yellowtail Rockfish	X	X	X		X	X

Table 7.3.1-4. Intertidal groundfish.
Groundfish species/life history stages found within the intertidal zone in Oregon
Note: table legend same as for Estuarine Composite

Species	Adults	Spawning/ Mating	Eggs/ Parturition	Larvae	Juveniles/Small Juveniles	Large Juveniles
Cabezon					X	
Black Rockfish					X	
Black-and-yellow Rockfish[1]					X	
Blue Rockfish					X	
Canary Rockfish					X	
Gopher Rockfish[1]					X	
Grass Rockfish[1]					X	
Shortbelly Rockfish					X	
Yellowtail Rockfish					X	

7.3.1.2 Life History Information

Life history information for groundfish species with EFH potentially affected by the Bridge Program is presented below. Species using habitats in the Estuarine, Intertidal, or the inshore areas of Rocky Shelf and Nonrocky Shelf EFH composites, at any life stage, are included. Information in this section has largely been obtained from ODOT's Draft EFH Analysis for the ODOT Maintenance Programmatic Biological Assessment (Floyd 2003). Numeric references in this section are contained in McCain (2003), cited within Floyd (2003) unless otherwise noted.

LEOPARD SHARK (*Triakis semifasciata*)

Range
Leopard sharks are found from southern Oregon to Baja California, Mexico including the Gulf of California. The leopard shark reaches the northern extent of their range along the southern Oregon coast. In Oregon, both adults and juveniles are found near the bottom over a variety of substrates, from sandy bottoms to rocky reefs and kelp beds.

Habitat
A neritic species, the leopard shark is most abundant in California bays and estuaries and along southern California beaches. Although they are common in enclosed, muddy bays, other habitats of the leopard shark are flat, sandy areas, mud flats, and bottoms strewn with rocks near rocky reefs or kelp beds. It is common in littoral waters and around jetties

and piers. It is also known to congregate around warmwater outfalls of power plants. The leopard shark occurs in polyhaline (salt concentration between 18 and 30l) to euhaline (salt concentrations of 30-40l) waters.

Leopard sharks are most common on or near the bottom in waters less than 13 feet deep, but have been caught as deep as 300 feet. Estuaries and shallow coastal waters appear to be used as pupping and feeding/rearing grounds. Neonate pups occur in and just beyond the surf zone in areas of southern California, such as Santa Monica Bay.

Migrations and Movements
Leopard sharks often enter shallow bays and onto intertidal flats during high tides and retreat on ebb tides. Leopard sharks are active during the day, unlike other nocturnal sharks. They may form large nomadic schools that may be mixed with gray or brown smooth hounds or spiny dogfish.

In Elkhorn Slough, most adult leopard sharks leave by June and return by October whereas juveniles are most abundant there during the summer. Tagging studies in San Francisco Bay show most leopard sharks reside in the bay during March-September, but they also occur both inside and outside the bay from October-February.

Reproduction
Leopard sharks are gonochoristic, ovoviviparous, and iteroparous. Fertilization occurs internally and embryogenesis occurs within the female; there is no yolk-sac placenta. Leopard sharks have a gestation period of 10-12 months. Mating occurs soon after the females give birth, primarily in April and May. Coitus occurs while swimming. Females give birth to 7-36 pups from March-August.

Growth and Development
Young develop inside the mother but do not receive nourishment from her. Leopard sharks are born as juveniles ranging in size from 7-8 inches at parturition. The maximum recorded length of a leopard shark is 71 inches, but with a[n] average growth rate estimated at 0.5 inch per year, most do not exceed 63 inches in length. Females may take 10-15 years to reach maturity, while males may only take 7-13 years. Maximum age is reported to be 30 years.

Trophic Interactions
The leopard shark utilizes several major food sources without depending upon one, and food preference is dependent upon the size of the shark. Juveniles and adults are carnivorous, opportunistic, benthic and littoral feeders. Small sharks (<35 inches) in Elkhorn Slough are known to feed almost entirely on crabs and in San Francisco Bay, on crabs and shrimp, particularly of the genus Crangon (Floyd 2003). Leopard sharks 35-47 inches in length feed mostly on echiuroid worms (*Urechis caupo*). Sharks 47-51 inches feed on crabs, clams, fishes, fish eggs, and *Urechis caupo*. Fishes make up the greatest portion of food eaten by 51-55 inches long sharks. Leopard sharks also prey upon polychaete worms and octopi and feed rapidly on the eggs of herring, topsmelt, jacksmelt, and midshipmen when available. Presence of mud-burrowing prey in their diet

signifies that the leopard shark is feeding very close to or in the mud. The leopard shark must display a sucking or digging behavior to remove clam siphons and *Urecis caupo* from the mud.

In Elkhorn Slough, adult leopard sharks seasonally shift their diet preference. During the fall, when fish eggs are not abundant, they feed more on clams and crabs. During the winter and spring, the yellow shore crab decreases in importance whereas cancrid crabs, fish eggs, and *Urechis caupo* increase as prey items. Leopard sharks do not compete for food sources with neighboring shark species because their diets differ. The leopard shark probably has no major predators except man and possibly other shark species.

Leopard shark Life Stages and EFH Potentially Affected by Bridge Program

Adult Stage
Adults are pelagic, commonly near the bottom, and occur from southern Oregon southward, at depths <300 feet. Composites: estuarine, rocky shelf, non-rocky shelf, neritic

Mating Stage
During April and May, mating likely occurs within the known adult habitat from northern California southward. Composites: estuarine, rocky shelf, non-rocky shelf, neritic

Juvenile Stage
Juveniles are pelagic, commonly near the bottom, and occur from southern Oregon southward, at depths <300 feet. Composites: estuarine, rocky shelf, non-rocky shelf, neritic

Parturition
During March to August, pupping occurs in estuaries and shallow coastal areas from northern California southward. Composites: estuarine, rocky shelf, non-rocky shelf, neritic

The adult, mating, juvenile, and parturition stage of estuarine EFH, rocky shelf, non-rocky-shelf, and neritic for leopard shark could be affected by bridge repair and replacement projects. Estuarine EFH potentially affected by the Bridge Program includes muddy bays, flat, sandy areas, mud flats, littoral waters, and jetties and piers.

SOUPFIN SHARK (Galeorhinus zyopterus)

Range
Soupfin sharks are found from northern British Columbia to Abreojos Point, Baja California and the Gulf of California.

Habitat
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 the soupfin sharks are often found well offshore, they are not oceanic. Although soupfin shark often occur in waters as shallow as 7 feet, they also occur in submarine canyons up to 1,550 feet. The population of soupfin sharks along the western Pacific Coast is considered to be homogeneous.

Males and females apparently segregate by sex. Adult males favor deeper waters, whereas females occur closer inshore. The proportion of males is greater in northern waters off California whereas females occur mostly in southern California waters with a mix of sexes in central California waters. Young soupfin are abundant in southern California waters, probably in association with the larger number of females there.

San Francisco Bay, Tomales Bay, and southern California inshore areas (south of Point Conception) are used as pupping grounds.

Migrations and Movements
Soupfin sharks form dense shoals and has a coastwide movement that is not completely understood. The soupfin migrates north in summer and southward in the winter. They have extensive movements without recognizable patterns of up to 35 miles per day with sustained speeds of 10 miles per day for 990 miles.

Reproduction
Mating occurs during the spring and fertilization is internal. Eggs grow to a size of 2 inches in diameter before they are hatched within the mother. There is no yolk-sac placenta. After a gestation period of approximately 1 year, females move into bays to bear their live young. Litter sizes range from 6-52 young and average 35. The number of young depends on the size of the mother; larger females produce more young.

Growth and Development
Newborn soupfin range in size from 12-16 inches in length. Males mature at 47-67 inches while females mature at 50-73 inches in length. Males can reach a maximum length of 60-70 inches and females can grow to 70-77 inches. Estimated age of maturity and maximum age are reported as 12 and 40 years, respectively.

Trophic Interactions
Soupfin sharks are opportunistic, carnivorous feeders. They feed at the bottom, mid-depths, and at the surface. Diversity of pelagic and bottom-living prey indicates soupfin will pursue food where available. Soupfin feed primarily on moderate-sized bony fishes but also readily feed on invertebrates. Young may consume more invertebrate prey than adults.

Prey items include: herring, sardines and other clupeids, anchovies, salmon, smelt, hake, cod, lingcod, midshipmen, flying fish, mackerel and small tuna, barracuda, croakers, wrasses, opaleye, surfperches, damselfishes, gobies, kelp fish, halibut and other flatfishes, rockfishes and scorpionfish, sculpins, sablefish, cephalopods, marine snails, crab, shrimp, annelid worms, echinoderms, and uncommonly other chondrichthyians

such as ratfish, sharks, and small stingrays and skates. Predators include the spotted sevengill shark, the great white shark, marine mammals, and man.

Soupfin Shark Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are pelagic and occur all along the west coast at depths from 7-1,550 feet.

Composites: estuarine, rocky shelf, non-rocky shelf, canyon, neritic, oceanic

Mating Stage
During the spring, mating occurs in adult habitat, mainly off California.

Composites: estuarine, rocky shelf, non-rocky shelf, canyon, neritic, oceanic

Juvenile Stage
Juveniles are pelagic and occur within the adult habitat.

Composities: estuarine, rocky shelf, non-rocky shelf, canyon, neritic, oceanic.

Parturition
Females release young during the spring in bays and inshore areas.

Composites: estuarine, non-rocky shelf, neritic

Adult, mating, juvenile, and parturition stage of estuarine EFH for soupfin shark could be affected by the Bridge Program. Estuarine EFH potentially affected by the Bridge Program includes muddy shallows and bottom habitat of bays and estuaries.

The adult, mating, and juvenile stage of rocky shelf EFH for soupfin shark could be affected by the Bridge Program such as slope/bank stabilization, bridge repair, scour repair, concrete work, and temporary bridges.

The adult, mating, juvenile, and parturition stages of non-rocky shelf EFH for soupfin shark could be affected by the Bridge Program such as erosion repair, slope/bank stabilization, bridge repair, scour repair, pile replacement, concrete work, access roads, stockpiling, temporary detours, temporary bridges, and staging.

SPINY DOGFISH (*Squalus acanthias*)

Range
Spiny dogfish are found in temperate and subarctic latitudes in both the northern and southern hemispheres. In the northern and central Pacific Ocean, they occur from the Bering Sea to Baja California.

Habitat

For the North Pacific and Bering Sea, Allen and Smith report that the spiny dogfish is an inner shelf-mesobenthal species with a depth range of 0-2,950 feet. From survey data, they determined that most dogfish inhabit waters <1,150 feet. They occur from the surface and intertidal areas to greater depths [12, 23, 57, 189, 260], and are common in estuaries, such as San Francisco Bay [76] and Puget Sound [12], and in shallow bays from Alaska to central California [81]. Females move inshore to release their young [148, 260].

Adult females move inshore to shallow waters during the spring to release their young [148, 260]. Small juveniles (<10 years old) are neritic while subadults and adults are mostly sublittoral-bathyal [260]. Subadults are found on muddy bottoms when not found in the water column [260]. Spiny dogfish may occur in waters as deep as 3,280 feet, but occur more commonly at depths less than 1,150 feet [23, 57, 189, 260]. They also inhabit the mesobenthal (outer slope) zone [12]. Known physical and chemical requirements are euhaline waters of 3.7-15.6EC, with a preferred range of 43-52° F [260]. In southern California, spiny dogfish are often found in close association with white croaker [57, 83, 260].

Migrations and Movements

Dogfish often migrate in large schools, which feed avidly on their journeys [23]. Seasonal migrations are taken so as to stay in the preferred temperature range [57]. Schooling behavior occurs with inshore populations and with migratory offshore populations [81]. The schools, numbering in the hundreds, exhibit north-south coastal movements and onshore-offshore movements that are not completely understood [57, 83, 189]. The schools tend to divide up according to size and sex although the young, both male and female, tend to stay together [83, 260].

Spiny dogfish can travel long distances. In one instance a tagged dogfish from Queen Charlotte Sound in 1980 was recovered off the northeast coast of Japan in 1982 [83, 234]. They also make diel migrations from near bottom during the day to near surface at night [260].

Reproduction

Mating with internal fertilization occurs on the ocean bottom between October and January [147, 155, 260]. Spiny dogfish are ovoviviparous. Fecundity is 1-26 eggs per female, per season [57, 81, 147, 260]. Males mate annually and females mate biannually [147, 260]. Their gestation period lasts 18-24 months (usually 23 months), the longest of any vertebrate [23, 147, 256, 260, 301]. Females release their young during the spring in shallow waters.

Growth and Development

Small litters (4-7 pups) are common, but litter size may range from 2-20 pups. Newborn pups range in length from 8 to 9 inches [57, 147, 155, 189, 260]. Females reach sexual maturity at 23-35 years [345] and males reach maturity at 11-19 years. The maximum age

of females is about 70 years [345]. Females live longer than males, which only live to a maximum of 36 years [23, 57, 81, 83, 147, 155, 189, 234, 260].

Spiny dogfish seem to be larger at the northern end of their range. Adults usually range in size from 30-40 inches, although they may reach a maximum size of 50 inches (22 pounds) [12, 23, 260]. Their growth rate is 0.5-1.5 inches per year [57, 76].

Trophic Interactions
They are carnivorous and occasionally scavengers [260]. They are an opportunistic feeder, taking whatever is available. They are important predators on many commercial fishes and invertebrates [260]. Their diet consists primarily of fish and crustaceans, especially sandlance, herrings, smelts, cods, capelin, hake, ratfish, shrimps, and crabs. Fish become a more important dietary source as they grow larger [57, 83, 148, 260]. Other food items include worms, krill, squid, octopus, jellyfish, algae, and any carrion [23]. Although most of their diet consists of pelagic prey, they also feed on benthic organisms [260]. They are voracious predators that can be quite aggressive in pursuit of prey [57, 81, 83, 148].

Based on occurrences, 55% of the diet of dogfish off British Columbia was teleosts, 35% crustaceans, and five percent molluscs. The principal food items consisted of herring and euphausids [148]. Pelagic prey consisted of 80% of their diet and they consumed twice as much food in the summer as in the winter [148, 260].

Spiny dogfish may compete with sablefish, Pacific cod, soupfin shark, and sea lions [260]. They have few natural predators, except blue and tiger sharks and some marine mammals. For defense, it possesses a strong spine in front of its two dorsal fins that is partially sheathed by toxic tissue.

Spiny Dogfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults occur throughout the water column, often near the bottom, all along the west coast, commonly at depths <1,150 feet.

Composites: estuarine, rocky shelf, non-rocky shelf, canyon, continental shelf/basin, neritic, oceanic

Mating Stage
From October through January, mating occurs all along the west coast, near the bottom at depths from 490-1,310 feet.

Composites: non-rocky shelf, continental shelf/basin

Large Juvenile Stage
Large juveniles occur throughout the water column, often near the bottom, all along the west coast, commonly at depths 660< feet.

Composites: estuarine, rocky shelf, non-rocky shelf, neritic

Small Juvenile Stage
Small juveniles are pelagic all along the west coast, commonly at depths <330 feet.

Composites: estuarine, neritic

Parturition Stage
Females release their young all along the west coast during the spring in shallow, inshore waters, usually at depths <330 feet.

Composites: estuarine, non-rocky shelf

The adult, large juvenile, small juvenile, and parturition stages of estuarine, rocky shelf, and non-rocky shelf EFH for spiny dogfish could be affected by the Bridge Program. Estuarine EFH potentially affected by the Bridge Program includes intertidal areas and muddy bottoms of estuaries and shallow bays. Non-rocky shelf EFH for spiny dogfish potentially affected by the Bridge Program includes muddy bottoms in intertidal areas.

CALIFORNIA SKATE (Raja inornata)

Range
California skates range from the Strait of Juan de Fuca, Canada south to Cedros Island, central Baja California, Mexico. California skates are primarily found off the southern Oregon coast southward, but can occasionally occur throughout the area covered by this EFH analysis. They are associated with shallow bays, estuaries, and inshore muddy bottoms.

Fishery
Coastal trawl fleets account for the majority of the commercial catch off the west coast, although some are caught by trammel nets in California and longlines in Puget Sound. Only the pectoral fins, or "wings," are bought commercially. Skates are caught incidentally in fisheries for sole and rockfish. In California, the leading areas for skate landings are San Francisco and Monterey [212].

Habitat
The California skate is common off most of the California coast [315], as well as inshore and in shallow bays (60 feet of water or less) [81, 212]. The California skate has been taken as deep as 2,200 feet [81, 212]. California skates typically inhabit inshore muddy bottoms [315]. Egg cases are deposited on the bottom [120].

Migrations and Movements
Little is known about the movements of skates [212].

Reproduction
California skates, like other skates, are oviparous, have internal fertilization, and deposit their eggs on the bottom to develop and hatch [120]. When the eggs are laid, they are done so in a distinctive leathery case [315]. The egg case of California skates is smooth with horns [81]. When the eggs hatch, the young are fully developed although they do have a yolk sac that is gradually absorbed [368].

Growth and Development
Skates are long-lived creatures that grow and mature slowly [368]. Their lifespan is estimated at 20-30 years [368]. Females and males reach sexual maturity at approximately 20 inches in length and attain a maximum TL of 30 inches [212].

Trophic Interactions
The California skate feeds on shrimps and probably other invertebrates.

California Skate Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur primarily off southern Oregon through Central California, at depths <2,220 feet, commonly associated with inshore muddy bottom,

Composites: estuarine, non-rocky shelf, continental slope/basin

Mating Stage
Mating likely occurs within the adult habitat.

Composites: estuarine, non-rocky shelf, continental slope/basin

Juvenile Stage
Juveniles are demersal and likely occur within the adult habitat.

Composites: estuarine, non-rocky shelf, continental slope/basin

Egg Stage
Egg cases are deposited on the bottom in the adult habitat.

Composites: estuarine, non-rocky shelf, continental slope/basin

The adult stage, mating stage, juvenile stage, and egg stage of estuarine and non-rocky shelf EFH for California skate could be affected by bridge repair and replacement projects. Estuarine EFH for California skate potentially affected by the Bridge Program includes muddy bottoms of shallow bays and estuaries. Non-rocky shelf EFH for California skate potentially affected by the Bridge Program includes inshore muddy bottoms.

CABEZON (*Scorpaenichthys marmoratus*)

Range
Cabezon are found in southeast Alaska to as far south as central Baja California [114, 240, 263]. Cabezon occur throughout the area covered by this EFH analysis.

Habitat
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 [263]. Larvae have been found offshore as far as 200 miles [263]. Juveniles and adults reside primarily in shallow water bays and estuarine areas [114, 221]. Off Washington, adults are found as deep as 262 feet, but are most common intertidally to 82 feet [221].

Off Washington and Oregon, cabezon occur only infrequently at depths over 164 feet. However, off California, cabezon are found in moderate to great abundance in the waters along the inner shelf. 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 [332]. Eggs, juveniles and adults are not reported to occur far offshore. However, neustonic planktivorous larvae have been reported as far from shore as 200 miles [263, 332]. 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 [395]. Rocky bottoms and cobble substrates are utilized most frequently. Eelgrass beds and occasionally sandy bottoms are used [181, 219, 263]. Adults tend to move to somewhat deeper waters with increased size [263]. Females in Puget Sound are rarely found deeper than 30 feet [181]. Wilson-Vandenberg [395] reported that cabezon spawn their eggs on subtidal, algae-free rocky surfaces, which can be horizontal or vertical in orientation.

Movements and Migrations
Adult cabezon are not known to make any significant migrations. A tag-recapture study in Monterey Bay showed the cabezon to be residential [239]. Adults are known to move inshore with a flood tide, and retreat offshore on an ebb tide [239, 263]. Planktivorous larvae can be carried great distances by offshore oceanic currents. Wilson-Vandenberg [395] reported that cabezon spend most of their time sitting in holes on reefs, in pools, or on kelp blades beneath the canopy, but not actively swimming.

Reproduction
Egg masses are fertilized externally. The spawning season runs from late October to March and peaks in January in southern California [263], and is from November to early May in Puget Sound, peaking in March [180]. Cabezon spawn more than once per year, so absolute fecundity is not known. Cabezon males build and guard nests, and more than one female may spawn in the same male's nest. Batch fecundity of a 17-inch female is approximately 48,700 eggs. Based on estimated weight to batch fecundity relationships, a 5.5-pound female had an estimated 62,000 viable oocytes, whereas a 14-pound female contained an estimated 154,000 viable oocytes [180, 221].

Growth and Development
Fertilized eggs are adherent and 0.06-0.07 inches in diameter [181]. Eggs hatch in 12-16 days [263]. Larvae are 0.2-inch long with a yolk sac, which is absorbed by 0.4 inch [263]. These small juveniles are planktonic and settle out to the bottom at about 2.6 inches [181].

Male cabezon mature at 2-3 years and 9-12 inches. Females grow faster, larger and live longer than do males. Females mature at 3-5 years and 12-16 inches [197]. Cabezon may reach an age of more than 20 years [395].

Trophic Interactions
Larvae are planktivorous. Juveniles and adults are carnivorous, feeding opportunistically [114]. Larvae eat copepods, barnacle larvae, fish larvae, and fish eggs [114, 181, 221, 263]. Cannibalism of eggs and newly hatched larvae may be very high among the larvae. Newly metamorphosed juveniles eat amphipods and small shrimps. At 6 inches, cabezon begin to prey on crabs, which become the dominant crustacean in the cabezon diet thereafter [263]. In southern California, cabezon prey heavily on abalone [197].

Cabezon eggs, though toxic to humans, are eaten by scalyhead sculpin, striped surfperch and pile perch [181, 221]. Juveniles and adults may be preyed on by other rocky reef fishes like lingcod.

Cabezon Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur in estuaries and all along the west coast, at depths from 0-80 feet, commonly associated with kelp beds, jetties, rocky reefs and pinnacles.

Composites: estuarine, rocky shelf

Spawning Stage
Spawning occurs from late fall through late spring in estuaries and all along the west coast at depths <100 feet on rocky substrates.

Composites: estuarine, rocky shelf

Large Juvenile Stage
Large juveniles are demersal and occur in the adult habitat.

Composites: estuarine, rocky shelf

Small Juvenile Stage
Small juveniles are pelagic and occur in estuaries and probably over the shelf and slope.

Composites: estuarine, neritic, oceanic, intertidal (draft)

Larval Stage
Larvae are pelagic and occur in estuaries, over the shelf and slope.

Composites: estuarine, neritic, oceanic

Egg Stage
Eggs are deposited from late fall to late spring on rocky substrates in estuaries and along the west coast at depths <87 feet.

Composites: estuarine, rocky shelf

The juvenile/small juvenile stage of intertidal EFH for cabezon could be affected by ODOT bridge replacement and repair activities.

The adult stage, spawning stage, small juvenile stage, large juvenile stage, egg stage, and larval stage of estuarine EFH for cabezon could be affected by all ODOT replacement and repair activities. Estuarine EFH potentially affected by the Bridge Program includes shallow water bays and estuaries with cobble and rocky substrates, intertidal pools with hard bottoms, eelgrass beds, sandy bottoms, and jetties.

The adult, spawning, large juvenile and egg stages of rocky shelf EFH for cabezon could be affected by ODOT bridge activities such as erosion repair, slope/bank stabilization, culvert repair or removal, shoulder repair, bridge repair, scour repair, concrete work, and temporary bridges. Rocky shelf EFH for cabezon potentially affected by the Bridge Program includes intertidal waters, shallow, subtidal areas including isolated rocky reefs or pinnacles, shallow tide pools, rocky bottoms, cobble substrates, and subtidal, algae-free rocky surfaces.

KELP GREENLING (Hexagrammos decagrammus)

Range
Kelp greenling are relatively common all along the west coast of North America from the Gulf of Alaska to southern California. They are not commonly found south of Point Conception, California [94, 114, 152, 197]. Kelp greenling occur throughout the area covered by this EFH analysis. Larvae and small juveniles are pelagic. Other life stages are demersal and show a high affinity for rocky banks near dense algae or kelp beds, or in kelp beds (Garrison and Miller 1982). Adults, spawning adults, and large juveniles are most abundant in estuaries, and adults often live their whole lives in estuaries (Hart 1973).

Habitat
Adults, spawning adults, and large juveniles are most abundant in estuaries, and adults often live their whole lives in estuaries [94, 97, 114, 250]. Eggs are demersal and found subtidally [94]. Larvae and small juveniles are pelagic [97, 114, 221]. Large juveniles are demersal [221]. Adults are demersal and not commonly found below 66 feet [197], although they may range down to 171 feet [135]. In Puget Sound, adults are most

abundant between 23 and 39 feet and male kelp greenling are found an average of 10 feet deeper than females [94].

Adults inhabit rocky reefs of shallow nearshore areas. Kelp greenling show a very high affinity to rocky banks near dense algae or kelp beds, or in kelp beds [94, 97, 114, 152, 197, 221, 250]. Larvae and small juveniles are found in the upper 148 feet of the water column in spring and summer [152, 221], and may be found up to 600 miles offshore [94, 97].

For Puget Sound, Patten [276] found that kelp greenling adults, spawning adults, eggs and large juveniles prefer water temperatures between 48° F and 55° F, and favorable salinities were 27.5-29.9 ppt. Larvae and small juveniles experience accelerated growth in the warmer surface waters of the open ocean. Eggs will not hatch and many die when held at 72° F for 10 minutes. Larvae were torpid after 10 minutes at 68° F [276]. Allen, et al., [10] observed that kelp greenling showed a stronger affinity to habitat than to temperature; that is, rocky reefs, kelp beds and algae in water below 48° F or above 55° F is favored to sandy, muddy, or silty substrates in waters between 48° F and 55° F.

Migrations and Movements

Adult kelp greenling are not a migratory species. Matthews [221] reported that most adults are in 43 feet of water or less all year round, which inhibits migration. Moulton [250], in a series of dives in northern Puget Sound, found no changes in kelp greenling density, indicating that no individuals were leaving or entering the study area. However, newly hatched larvae move out of estuaries or shallow nearshore areas and into open waters [94, 97]; this migration may take up to a year [94].

Reproduction

Kelp greenling are oviparous with external fertilization [94]. Spawning occurs in the fall in Puget Sound, peaking in October and November [94, 250]. In the Gulf of Alaska, spawning is earlier in the fall, and Love [197] found that kelp greenling in California waters spawn in late fall to early winter.

Male and female kelp greenling mature at 3-5 years [197, 221]. The maximum age is 16 years [135].

Growth and Development

Fertilized eggs are laid on or between rocks, or in algae beds and guarded by males. Incubation time is estimated at about 20 days, because Garrison and Miller [94] reported newly hatched larvae were found in the water column in early December. Larvae are approximately 0.3 inch at hatching [97, 114, 250]. Larvae immediately move to open seas for about one year, and return as demersal juveniles. Female kelp greenling grow faster and larger than do males [197].

Kelp greenling are approximately 2 inches after one year [97]. Age at maturity for both sexes is 3-5 years. Love [197] observed that a typical 10-inch specimen is 6-9 years old. Kelp greenling may reach 21 inches and 12 years of age [114, 197].

Trophic Interactions
Pelagic kelp greenling larvae and juveniles feed on copepods and copepod nauplii, amphipods, brachyuran larvae, euphausiids and larval fish [97, 114]. Adult kelp greenling feed on just about anything present, with preferences for shrimps, crabs, worms, octopi, brittle stars, snails, and small fishes [197].

Eggs are preyed on heavily by other kelp greenling, other closely related species, and by the male guarding the egg mass. Larval kelp greenling are eaten by pelagic fishes like salmon and steelhead, and marine birds [114]. Adults are eaten by spiny dogfish, lingcod and other hexagrammids [114]. Kelp greenling compete very closely for preferred habitat and food with other fishes of the rocky reef assemblage.

Kelp Greenling Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur mainly from central California northward in estuaries and coastal areas <171 feet, commonly associated with rocky substrates and kelp.

Composites: estuarine, rocky shelf

Spawning Stage
Spawning occurs during the fall, probably in adult habitats.

Composites: estuarine, rocky shelf

Large Juveniles
Large juveniles are demersal and occur within adult habitats.

Composites: estuarine, rocky shelf

Small Juveniles
Small juveniles are pelagic and occur in the upper 148 feet of the water column, mainly from northern California northward.

Composites: estuarine, neritic, oceanic

Larval Stage
Larvae are pelagic and occur in the upper 148 feet of the water column, mainly from northern California northward.

Composites: estuarine, neritic, oceanic

Egg Stage
In the fall, eggs are deposited on rocky substrates in the adult habitats.

Composites: estuarine, rocky shelf

The adult, spawning, large juvenile, small juvenile, larval, and egg life stages of estuarine EFH for kelp greenling could be affected by all ODOT bridge activities. Estuarine EFH for kelp greenling potentially affected by the Bridge Program includes sand, mud, or silt substrates in estuaries.

The adult, spawning, large juvenile, and egg stages of rocky shelf EFH for kelp greenling could be affected by ODOT bridge activities such as erosion repair, slope/bank stabilization, culvert repair or removal, shoulder repair, bridge repair, scour repair, concrete work, and temporary bridges. Rocky shelf EFH for kelp greenling potentially affected by the Bridge Program includes rocky reefs of shallow nearshore areas and rocky banks near dense algae or kelp beds.

LINGCOD (*Ophiodon elongatus*)

Range
Lingcod occur from Baja California to Kodiak Island in the Gulf of Alaska. Highest densities are found from Point Conception, California to Cape Spencer, Alaska [240, 295]. Adults are most abundant from intertidal to 1,000 feet water depth, occurring in the shallower depths from central California northward. Juveniles occur to at least 656 feet, and move deeper with age.

Lingcod occur throughout the area covered by this EFH analysis and are associated with estuaries, rocky reefs and banks, and seaweed, kelp and eelgrass beds (Emmett et al. 1991, NOAA Fisheries 1990). Eggs, young larvae, older juveniles, and adults are demersal while very young juveniles and older larvae are epipelagic (Allen and Smith 1988, Phillips and Barraclough 1977, Miller and Geibel 1973). Spawning occurs from the intertidal zone to 98 feet deep, over rocky reefs with swift current. Juveniles prefer sandy substrates in subtidal zones and estuaries (Shaw and Hassler 1989). Oil and other petrochemical spills may reduce lingcod populations (Shaw and Hassler 1989). Estuarine dredging may alter natural open-sand rearing areas (Buckley et al. 1984).

Adults are common in Yaquina Bay, Oregon. Juveniles are common in most large estuaries between Puget Sound and San Pedro Bay, California. Larvae are common in Coos Bay. 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 prefer sandy substrates in subtidal zones and estuaries.

Habitat
In the North Pacific, lingcod occupy the estuarine-mesobenthal zone, occurring from intertidal areas to 1,560 feet [12]. Older larvae and very young juveniles are epipelagic, primarily found in the upper 10 feet of the water column [295] in waters <492 feet. Off California, pelagic juveniles occur in the upper 115 feet of surface waters [5]. Eggs, young larvae, older juveniles, and adults are demersal [12, 260, 331]. Spawning generally occurs in waters 10-33 feet below mean lower low water over rocky reefs in areas of

swift current [1, 5, 95, 96, 171]. Adults, spawning adults and eggs are common in Puget Sound, Hood Canal, and Skagit Bay in Washington and Humboldt Bay in California. Adults are also common in Yaquina Bay, Oregon. Juveniles are common in most large estuaries between Puget Sound and San Pedro Bay, California. Larvae are common in most Washington estuaries, as well as Coos Bay, Oregon and throughout San Francisco Bay, California [77]. 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 <492 feet.

Adults prefer two main habitat types: slopes of submerged banks 33-230 feet below the surface with seaweed, kelp and eelgrass beds that form feeding grounds for small prey fish, and channels with swift currents that flow around rocky reefs that concentrate plankton and plankton-feeding fish [77, 96, 260, 331].

Eggs masses are found in association with rocky reefs [95, 96]. Egg masses are usually found wedged in rock crevices or under overhanging boulders in areas with currents 70 miles per hour or greater to maintain interstitial oxygen levels in the center of the mass [88, 95, 114, 239]. Egg masses are also often located on rocky ledges with an opening directly behind the eggs to allow water to pass over the nest [5].

Juveniles prefer sandy substrates in subtidal zones and estuaries [77, 88, 114, 260, 331]. All life history stages occur in polyhaline to euhaline waters (18-30+ ppt) that are between 5-15EC, although juveniles may also be found in mesohaline waters (5-18 ppt) [77, 260, 331]. Aggregations of territorial males form to spawn in late fall to early spring, depending on latitude. Egg masses are laid in rock crevices and under rock ledges in water from intertidal depth to at least 410 feet. Males guard nests during egg incubation (5 weeks to 11 weeks). Pelagic larvae and young juveniles occur near the surface in nearshore waters; older juveniles settle to a variety of benthic habitats including sand, gravel, shell debris, and eelgrass beds in relatively shallow water (down to about 230 feet). Adult lingcod are mostly associated with rocks, although have been found over soft bottom especially in deep water. Older juveniles and adults likely are sedentary, although they seasonally migrate to shallow water to spawn. Some movement to at least 62 miles has been noted. These movements are thought to be made largely by immature fish.

Migrations and Movements

Adult lingcod are considered a relatively sedentary species, but migrations greater than 62 miles have been reported [145, 219, 227, 338]. Long migrations were typically done by sexually immature fish. Smith, et al., [338] found that tagged male lingcod can move up to 1,640 feet/day and tagged females can move more that 3,280 feet/day. Jagielo [145] and Matthews [227] noted that fish in the San Juan Islands migrated from estuaries in a general southwesterly direction to nearshore areas in spring, but this was mostly by immature fish. Mature females live in deeper water than males and move from deep water to shallow water in the winter to spawn [88, 114, 145, 171, 219, 227, 338]. Matthews [227] found that tagged lingcod move only at night.

Mature males may live their whole lives associated with a single rock reef, possibly out of fidelity to a prime spawning or feeding area [12, 298, 331]. Larvae are carried by tidal currents into estuaries to rear. Larvae metamorphose in early summer, and juveniles rear until winter before moving to deeper waters [219, 239].

Reproduction

Lingcod are oviparous, iteroparous and gonochoristic; fertilization is external [77, 94, 331]. Spawning takes place December through April. For the Humboldt Bay stock, peak spawning is January-February; Yaquina Bay stocks peak from late January-early March; in Washington (Puget Sound, Hood Canal, Skagit Bay), spawning peaks from February-March [1, 94, 295, 298]. Fecundity of female fish ranges from about 40,000 (30-inch fish) to about 500,000 (38-inch fish).

Lingcod achieve a maximum size of 5 feet and live to at least 20 years old. Females grow faster and larger than males. Most females are sexually mature at 3 years old and 30 inches in length; males mature at 2 years and 20 inches. As with most other fishes, fecundity of lingcod increases exponentially with age and size, from about 40,000 eggs per 30-inch female to about 500,000 eggs per 38-inch female. Lingcod recruitment has steadily declined from 1985 (Adams et al. 1999).

Growth and Development

Eggs are about 0.11 inch diameter when laid; they increase to 0.14 inch diameter after being water-hardened [88, 95]. Egg masses are adherent and usually laid in rock crevices or on rocky reefs [95, 96, 114, 171, 260]. Males guard the nest until hatching, usually about six weeks [95, 171, 331]. Embryonic development is indirect and external.

Larvae hatch at 0.3-0.4 inch with a yolk sac and stay on the bottom until it is absorbed, about 10 days. They then ascend into the water column. At 2-3 inches, they metamorphose into juveniles and settle out of the water column [77, 88, 260, 331]. Juveniles are 2-30 inches TL, depending on sex [77, 114, 239, 295, 331].

In Humboldt Bay and San Francisco Bay, newly hatched larvae occur in January and February. From March until June, lingcod larvae grow and transform into pelagic juveniles, which are taken in pelagic trawls in the upper 115 feet of the surface waters from April to June. After June, these juveniles disappear from surface waters and migrate to bottom habitats, frequently around kelp and eelgrass beds [5].

Lingcod are about 11 inches at one year and 18 inches at two years. At this point, females begin to grow faster than males. Males begin maturing at about 2 years and 20 inches, whereas females mature at 3+ years and 30 inches. In northern extents of their range, fish mature at an older age and larger size [77, 114, 219, 239, 331]. Maximum age is about 20 years [5].

Trophic Interactions

Larvae are zooplanktivores, feeding on all life stages of copepods, as well as small amounts of amphipods, euphausiids, and decapod larvae [260]. Small demersal juveniles

prey upon copepods, shrimps and other small crustaceans. Larger juveniles shift to clupeids and other small fishes [77, 260]. Adults feed primarily on demersal fishes (including smaller lingcod), squids, octopi and crabs [114, 239, 331]. Lingcod are a visual predator, feeding primarily by day. Eggs are eaten by gastropods, crabs, echinoderms, spiny dogfish, and cabezon. Juveniles and adults are eaten by marine mammals, sharks, and larger lingcod.

Lingcod Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur mainly from central California northward at depths <980 feet, commonly associated with rocky reefs and banks, often with seaweed, kelp or eelgrass beds.

Composites: estuarine, rocky shelf, non-rocky shelf, continental slope/basin

Spawning Adult Stage
From winter through spring and central California northward, spawning occurs from the intertidal zone to 98 feet deep over rocky reefs in areas of swift current.

Composites: estuarine, rocky shelf

Large Juvenile Stage
Large juveniles are demersal and occur mainly from central California northward at depths <492 feet, commonly associated with rocky reefs and banks, often with seaweed, kelp or eelgrass beds.

Composites: estuarine, rocky shelf, non-rocky shelf

Small Juvenile Stage
Small juveniles are pelagic and occur mainly from central California northward in surface waters, at depths <115 feet, in estuaries and over the continental shelf <492 feet deep.

Composites: estuarine, neritic

Larval Stage
After hatching and rising from the bottom, larvae are pelagic and occur mainly from central California northward in surface waters, at depths <246 feet in estuaries and over the continental shelf <492 feet deep.

Composites: estuarine, neritic

Egg Stage
From winter through spring in nearshore areas <98 feet deep from central California northward, eggs occur in nests deposited on the bottom, generally in association with rocky reefs and swift currents.

Composites: estuarine, rocky shelf

The adult, spawning adult, large juvenile, small juvenile, larval stage, and egg stage of estuarine EFH for lingcod could be affected by all ODOT bridge activities. Estuarine EFH for lingcod potentially affected by the Bridge Program includes benthic habitats including open sand, gravel, and shell debris, and eelgrass beds in relatively shallow water in estuaries.

The adult, spawning adult, large juvenile, and egg stages of rocky shelf EFH for lingcod could be affected by ODOT bridge activities such as erosion repair, slope/bank stabilization, bridge repair, concrete work, and temporary bridges. Rocky shelf EFH for lingcod potentially affected by the Bridge Program includes intertidal and subtidal water over rocks and rocky reefs.

The adult and large juvenile stages of non-rocky shelf EFH for lingcod could be affected by ODOT bridge activities such as erosion repair, slope/bank stabilization, bridge repair, scour repair, pile replacement, concrete work, access roads, stockpiling, temporary detours, temporary bridges, and staging. Non-rocky shelf EFH for lingcod potentially affected by the Bridge Program includes sandy substrates in subtidal zones, and gravel, shell debris, and eelgrass beds in relatively shallow water.

PACIFIC WHITING (PACIFIC HAKE) (*Merluccius productus*)

Range
Pacific hake of the coastal stock range from Sanak Island in the western Gulf of Alaska to Magdalena Bay, Baja California Sur. They are most abundant in the California Current System [21, 114, 197, 260]. There are three much smaller stocks with much smaller ranges: a Puget Sound stock, a Strait of Georgia stock, and a dwarf stock limited to waters off Baja California [22, 351].

Pacific whiting occurs throughout the area covered by this EFH analysis. Juveniles are pelagic and utilize shallow bays, estuaries, and coastal waters (Dark and Wilkins 1994, Bailey et al. 1982). Other life stages are pelagic and utilize deeper (131 – 1,640 feet) offshore waters.

Habitat
The coastal stock of Pacific hake is migratory and inhabits the continental slope and shelf within the California current system from Baja California to British Columbia [306].

Eggs and larvae of the coastal stock are pelagic in 130-460 feet of water [340]; adults are epi-mesopelagic [22, 260, 363]. Juveniles reside in shallow coastal waters, bays, and estuaries [20, 22, 66, 67, 72, 260, 328, 340]. Highest densities of Pacific hake are usually between 164 and 1,640 feet, but adults occur as deep as 3,020 feet and as far offshore as 248 miles [21, 22, 67, 72, 114, 260, 351]. Spawning is greatest at depths between 426 and 1,640 feet [22, 260, 340].

The Puget Sound and Strait of Georgia stocks live their whole lives in these estuaries [235, 330]. Smith [340] recognizes three habitats utilized by the coastal stock of Pacific hake: 1) a narrow 11,580 mile^2 feeding habitat near the shelf break of British Columbia, Washington, Oregon and California populated 6-8 months per year; 2) a broad 115,830 mile^2 open-sea area of California and Baja California populated by spawning adults in the winter and embryos and larvae for 4-6 months; and 3) a continental shelf area of unknown size off California and Baja California where juveniles brood. Eggs of the Pacific hake are neritic and float to neutral buoyancy [20, 22, 260]. All life stages are found in euhaline waters and at 48° F and 59° F [260].

Movements and Migrations

Coastal stocks spawn off Baja California in the winter, then the mature adults begin moving northward and inshore, following food supply and Davidson currents [260]. Hake reach as far north as southern British Columbia by fall. They then begin the southern migration to spawning grounds and further offshore [22, 72, 340, 351]. Juveniles move to deeper water as they get older [260]. Stocks in the Strait of Georgia and Puget Sound undergo similar migration patterns, but on a greatly reduced scale [235, 330]. Hake school at depth during the day, then move to the surface and disband at night for feeding [235, 364, 369].

Reproduction

Pacific hake are oviparous with external fertilization. The coastal stock spawns from December through March, peaking in late January [340]. In the Strait of Georgia, spawning occurs from March through May and peaks in late April [30, 330]. In Puget Sound, spawning occurs primarily during February through April, peaking in March (Floyd 2003). Spawning aggregations begin to form up to a month before actual spawning.

Hake may spawn more than once per season, so absolute fecundity is difficult to know. Coastal stocks have 180-232 eggs/gram body weight, but Puget Sound and Strait of Georgia stocks have only 50-165 eggs/gram body weight [214]. Bailey [21] estimated that an 11-inch female had 39,000 eggs, while a 24-inch female had 496,000 eggs.

Growth and Development

Eggs are spherical and approximately 0.05 inch in diameter with a single oil droplet [22]. Embryonic development is indirect and external [260]. Hatching occurs in 5-6 days at 48° F-50° F and 4-5 days at 52-55° F [21, 128]. Larvae hatch at approximately 0.1 inch total length [351, 363] with a yolk sac that is gone in 5-7 days [21]. Larvae metamorphose into juveniles at 1.4 inch, typically in 3-4 months [128]. Juveniles range from 1.4 to 16 inches depending on sex [22, 30, 128]. In Puget Sound and the Strait of Georgia, female Pacific hake mature at 15 inches and 4-5 years [235]. Females of the coastal stock mature at 3-4 years and 13-16 inches, and nearly all males are mature by 3 years and as small as 11 inches. Females grow more rapidly than males after four years; growth ceases for both sexes at 10-13 years [22].

Trophic Interactions
All life stages feed near the surface late at night and early in the morning [364]. Larvae eat calanoid copepods, as well as their eggs and nauplii [235, 364]. Juveniles and small adults feed chiefly on euphausiids [260]. Large adults also eat amphipods, squid, herring, smelt, crabs, and sometimes juvenile hake [21, 67, 235, 260]. Eggs and larvae of Pacific hake are eaten by pollock, herring, invertebrates, and sometimes hake. Juveniles are eaten by lingcod, Pacific cod and rockfish species. Adults are preyed on by sablefish, albacore, pollock, Pacific cod, marine mammals, soupfin sharks and spiny dogfish.

Pacific Whiting Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are pelagic and occur all along the west coast, mainly at depths from 164-1,640 feet and as far offshore as 248 miles. The Puget Sound stock is estuarine.

Composites: estuarine, neritic, oceanic.

Spawning Stage
From winter to spring, spawning occurs mainly off central and southern California at depths from 426-1,640 feet. The Puget Sound stock spawns in the estuary.

Composites: estuarine, neritic, oceanic

Juvenile Stage
Juveniles are pelagic and occur at depths <656 feet in coastal waters, bays, and estuaries all along the west coast.

Composites: estuarine, neritic

Larval Stage
Larvae are pelagic and occur at depths from 131-459 feet.
Composites: estuarine, neritic, oceanic

Egg Stage
From winter to spring, eggs occur in the same habitat as larvae.
Composites: estuarine, neritic, oceanic

The adult, spawning, juvenile, larval, and egg life stages of estuarine EFH for Pacific whiting could be affected by all ODOT bridge activities. Estuarine EFH for Pacific whiting potentially affected by the Bridge Program includes shallow bays and estuaries.

The ODOT Bridge Assessment will have no effect on neritic EFH for Pacific whiting.

SABLEFISH (*Anoplopoma fimbria*)

Range
Sablefish are very abundant in the north Pacific, from Honshu Island, Japan, north to the Bering Sea, and southeast to Cedros Island, Baja California. Large adults are uncommon south of point Conception [114, 197, 232, 233, 260]. Larvae and young juvenile sablefish occasionally occur throughout the area covered by this EFH analysis. Larvae are demersal until the yolk sac is absorbed, at which time they become pelagic. Small juveniles are also pelagic. They are often found drifting in kelp (NOAA Fisheries 1990), and are occasionally found in estuaries. Other life stages occur in deeper waters outside the territorial sea boundary.

Habitat
In the North Pacific, sablefish is considered an inner shelf-bathybenthal species. Adults are found as deep as 6,230 feet, but are most abundant between 656 and 3,280 feet [31, 151, 215]. In survey data for the North Pacific, nearly all sablefish were taken at depths <2,300 feet [12]. However, off southern California, sablefish were abundant to depths of 4,920 feet [230]. Spawning takes place at depths greater than 984 feet [42, 101, 114, 215].

Sablefish eggs, larvae (after yolk sac is absorbed), and age-0 juveniles are pelagic whereas older juveniles and adults are benthopelagic on soft bottoms. Eggs are usually found deeper than 984 feet [114, 151, 215]. Eggs and newly hatched larvae are found in these deep waters from January through March [101, 151, 215, 260]. Newly hatched larvae are demersal until the yolk sac is absorbed [215]. At this time, larvae become pelagic and rise to the neuston layer at the surface. Larvae and young juveniles are found up to 230 miles offshore often near drifting kelp [260]. Small (age-0) juveniles inhabit the upper 328 feet of the water column [230]. Larvae and small juveniles move inshore after spawning and may rear here for up to four years [42, 215]. Older juveniles and adults inhabit progressively deeper waters. Sablefish are an important groundfish over soft substrates in deep marine waters [197]. Adults and large juveniles commonly occur over sand and mud [232, 260]. They were also reported on hard-packed mud and clay bottoms in the vicinity of submarine canyons [230].

The preferred salinity range of spawning adults is between 33.7l -34.5l [215, 260], although eggs and larvae were occasionally found in less saline waters [260]. The optimal temperature range for egg incubation was 39-44° F [215]. The temperature range for larvae and epipelagic juvenile growth was found to range between 42-62° F and 53-62° F, respectively [151, 215, 260].

Migrations and Movements
Sablefish are not considered to be a migratory species, although some individuals have been recorded as moving up to 1,700 miles. Sexually mature adults do not undergo any spawning migration [31, 114, 215, 232]. Small juvenile sablefish descend to the bottom during the fall and remain in relatively shallow water for about a year before moving into deeper water [230]. Heifetz and Fujioka [116] reported that small fish move much more

than do large fish. Hart [114] recognized localized movement from shallow summer waters to deeper waters in the winter.

Reproduction
Sablefish are oviparous with external fertilization [260]. Spawning occurs annually in the late fall through winter in waters greater than 984 feet [114, 260]. Spawning occurs increasingly later in the winter in southern waters [51, 260]. A 21-inch female (5-7 years) may produce 100,000 eggs. A 39-inch female (10+ years) may produce as many as 1.3 million eggs [151, 215, 260].

Growth and Development
Fertilized eggs are spherical and about 0.08 inch in diameter [151, 197, 215, 233, 260]. Embryonic development is indirect and external; eggs hatch in about 15 days at 43° F [215, 260]. Larvae hatch at about 0.2 inch and metamorphose at about 1.5 inch [114, 215, 260]. Juveniles join the benthic community after 1-2 years in a pelagic stage. Females grow faster and larger and live longer than males. Age and size at maturity are difficult to know because sablefish exhibit such a discontinuous growth rate. It was estimated that 50% of females are mature at 5-6 years and 24 inches, and 50% of males are mature at 5 years and 20 inches. However, McFarlane and Beamish [236] found that tagged sablefish experienced significantly depressed growth, so length-age relationships may not be accurate. The growth rate after reaching maturity slows to 0.07-0.10 inch/year for males, and 0.22-0.26 inch/year for females [233].

Trophic Interactions
Sablefish larvae prey on copepods and copepod nauplii. Copepod eggs provide accelerated growth rates [101, 151, 260]. Pelagic juveniles feed on small fishes and cephalopods, (mainly squids [114, 215]. Demersal juveniles eat small demersal fishes, amphipods and krill [260]. Adult sablefish feed on fishes like rockfishes and octopus [114, 232].

Larvae and pelagic juvenile sablefish are preyed heavily upon by sea birds and pelagic fishes. Juveniles are eaten by Pacific cod, Pacific halibut, lingcod, spiny dogfish, and marine mammals, such as Orca whales [51, 114, 197, 215, 260]. Sablefish compete with many other co-occurring species for food, mainly Pacific cod and spiny dogfish.

<u>Sablefish Life Stages and EFH Potentially Affected by the Bridge Program</u>

Adult Stage
Adults are benthopelagic (associated with the bottom, but often farther off the bottom than most demersal species) all along the west coast. They mainly occur at depths <4,920 feet and are commonly associated with soft bottoms, although they also associate with pinnacles.

Composites: non-rocky shelf, rocky shelf, canyons, continental slope/basin

Spawning Stage
Spawning occurs from fall through winter in waters from 984-2,300 feet.

Composites: continental slope/basin

Large Juvenile Stage
Large juveniles are benthopelagic and occur at depths from 328-656 feet over soft bottom.

Composites: non-rocky shelf, canyon

Small Juvenile Stage
Small juveniles are pelagic and occur at depths <328 feet in the water column over the shelf and slope, and occasionally in estuaries.

Composites: estuarine, neritic, oceanic

Larval Stage
Larvae are demersal until the yolk sac is absorbed, then they become pelagic at depths <328 feet, up to 230 miles offshore.

Composites: neritic, oceanic

Egg Stage
From fall through winter, eggs occur at depths <2,300 feet in the water column over the continental slope/basin.

Composites: oceanic

The small juvenile stage estuarine EFH for sablefish could be affected by all ODOT bridge activities. The adult and large juvenile stages of non-rocky shelf EFH for sablefish could be affected by ODOT bridge activities such as erosion repair, slope/bank stabilization, scour repair, pile replacement, concrete work, access roads, stockpiling, temporary detours, temporary bridges, and staging. Non-rocky shelf EFH for sablefish potentially affected by the Bridge Program includes soft sand and mud substrates.

The adult stage rocky shelf EFH for sablefish could be affected by ODOT bridge activities such as erosion repair, slope/bank stabilization, culvert repair or removal, shoulder repair, bridge repair, scour repair, concrete work, and temporary bridges.

SPOTTED RATFISH (*Hydrolagus colliei*)

Range
Ratfish are found from Cape Spencer in southeast Alaska to Sebastian Vizcaino Bay, Baja California, and in the northern part of the Gulf of California [12, 240]. Ratfish occur all along the Oregon coast. They are generally a deepwater species, usually found from

164 to 1,310 feet. They prefer low relief rocky bottoms, including gravel and cobble (Allen 1982). In winter and spring, ratfish use shallow nearshore waters and estuaries for feeding and mating (Quinn et al. 1980). In summer and fall, ratfish move offshore into deep waters where egg cases are most commonly deposited (Johnson and Horton 1972).

Habitat

In the North Pacific, ratfish are considered a middle-shelf-mesobenthal species and have been reported at depths of 0-2,990 feet [12]. In survey data, they most frequently occur between 328-492 feet, with nearly all taken at depths of 164-1,310 feet [12]. Ratfish are a common demersal fish in larger estuaries throughout its range, especially from early winter to late spring [197, 304]. It is believed that ratfish enter estuaries to feed and mate [69]; they do not occur as often in estuaries in summer and fall [304]. In Puget Sound, ratfish often occur in less than 33 feet of water, depending on the time of day and season [304]. All free-swimming life history stages share essentially the same habitat; there is no partitioning by age or size [69].Generally, ratfish is a deepwater species that prefers low relief rocky bottoms [11]. Ratfish also prefer exposed gravel and cobble as a habitat and are not common on sand or over boulders [11]. Eggs are attached by the mother to rocks, or placed upright in the sand [69, 114, 146] in polyhaline to euhaline waters. In the summer and fall, ratfish move offshore into deep waters. It is in these deep waters that egg cases are most often deposited [69, 146].

Migrations and Movements

Although they are poorly understood, it is known that ratfish make significant seasonal and diel migrations [197, 218, 304]. In the winter, ratfish move into shallow nearshore waters and estuaries, probably for feeding and pre-spawn mate selection [146, 218, 304]. In Puget Sound and other estuaries, ratfish move from deep water by day to much shallower water at night. This diel migration is undertaken mostly by smaller fish, suggesting it is preferred feeding ground for young ratfish, or a means of predator avoidance [304]. Quinn [304] suggested that the migrations are completed to regulate ambient light conditions for ratfish because they have an all-rod retina and no means of regulating the amount of light entering their eyes.

Reproduction

Ratfish are oviparous and fertilization is internal [69, 146, 197, 218]. Spawning occurs at all times throughout the year, but seems to peak from late summer to early fall [69, 146]. Ratfish, regardless of size or age, produce only two egg cases per year [69].

Growth and Development

Fertilized egg capsules are elongate, diamond-shaped, and are about 5 inches long at extrusion [114]. The egg case hangs by capsular filaments from the mother's oviducts for 4-6 days before being deposited on rocks or placed in sand where it completes development and hatches [69, 114, 146, 197, 348, 397]. Full development of the egg may take up to a year. Larval stages are completed in the egg, and the hatched ratfish resembles a small adult [69]. Females grow faster and reach a larger mean size than do males [218, 304]. Female ratfish may reach 38 inches in length [197].

Trophic Interactions
Ratfish at all life history stages are opportunistic feeders; no one single food item usually makes up more than 25% of a ratfish's diet [12, 114, 197, 304]. Common foods are isopondylous fishes, mollusks, squid, nudibranchs, opisthobranchs, annelids, and small crustaceans. On more than one occasion, a ratfish was found with a stomach full of seaweed [69, 114, 197, 218, 304]. Off southern California, the most important prey were brittle stars, ostracods and amphipods [11]. Ratfish seek their food by smell [114] and weak electroreception in the pits on their heads [197]. Ratfish are in turn preyed upon by Pacific halibut, soupfin shark, and spiny dogfish [114, 197, 218, 304]. Ratfish have been recorded as being cannibalistic.

Spotted Ratfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur in estuaries and all along the west coast from 164-1,310 feet, commonly associated with low relief rocky bottoms and exposed gravel and cobble.

Composites: estuarine, rocky shelf, non-rocky shelf, continental slope/basin

Mating Stage
Mating likely occurs within the adult habitat.

Composites: estuarine, rocky shelf, non-rocky shelf, continental slope/basin

Juvenile Stage
Juveniles are demersal and likely occur within the adult habitat.

Composites: estuarine, rocky shelf, non-rocky shelf, continental slope/basin

Egg Stage
Egg cases are deposited year round, on a variety of substrates offshore in deep water.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

The adult, mating, and juvenile life stages of estuarine EFH for spotted ratfish could be affected by all ODOT bridge activities. Estuarine EFH for spotted ratfish potentially affected by the Bridge Program includes exposed gravel.

The adult, mating, juvenile, and egg stages of rocky shelf EFH for spotted ratfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for spotted ratfish potentially affected by the Bridge Program includes rocky bottoms, rocks, and cobble.

The adult, mating, juvenile, and egg stages of non-rocky shelf EFH for spotted ratfish could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for spotted ratfish potentially affected by the Bridge Program includes sand and exposed gravel bottoms.

BUTTER SOLE (*Isopsetta isolepis*)

Range
Butter sole are found from the south Bering Sea and Aleutian Islands south to Ventura, Southern California [160, 240]. Butter sole is a demersal species that occurs throughout the area covered by this EFH analysis, at depths less than 366 m. They are associated with muddy or silty bottoms (Eschmeyer et al. 1983). Shallow waters off the Oregon coast are important for benthic recruitment and early growth (Hogue and Carey 1982). Larvae are pelagic and float in nearshore coastal waters (PFMC 1998b).

Habitat
Butter sole are common in shallow water, occasionally as deep as 1,200 feet [81] and are found on muddy or silty bottoms [160]. They are usually found in coastal waters within 11 miles of shore [310]. They utilize shallow water off the Oregon coast as a site of benthic recruitment and early growth [124]. Little information is available, but they do occur in Puget Sound [310].

Migrations and Movements
No information.

Reproduction
Spawning takes place primarily in coastal areas rather than bays and estuaries and occurs from winter to spring [310]. Spawning of butter sole occurs at the same time as English sole. The young of these species avoid competition for habitat by segregating: butter sole larvae move offshore and English sole larvae move into bays and estuaries [310]. Off British Columbia, butter sole spawn at depths of 89-208 feet [188]. Their eggs are planktonic, spherical and transparent [310]. The specific gravity of fertilized eggs is 1.0208-1.0219 [188]. Butter sole eggs sink at salinities less than or equal to 26.61‰ [310].

Growth and Development
Larvae and eggs are part of the zooplankton community. Either they float near-surface or in the surface layer, or like most flatfish, control their specific gravity so as to float somewhere below the surface [323]. Early and middle stage eggs of butter sole co-occur with eggs of English sole, sand sole, and starry flounder [310]. Larvae are abundant in nearshore coastal waters off Oregon and Washington in the winter and spring [310]. Butter sole transformation from larval to juvenile form takes place at 0.7 to 0.9 inch [310]. Settling time is restricted to May-August over a broad depth range, 29-197 feet [124]. Recently- transformed benthic individuals of butter sole are usually found offshore for their first year of life rather than in the bay or nearshore habitats occupied by young and juvenile English sole [310]. Butter sole adults can reach a maximum size of 22 inches [160], but are usually less than 12 inches [81]. The maximum age of butter sole is 11 years [323].

Trophic Interactions
Butter sole is a large-mouthed predator, feeding on elusive prey items, primarily fish and shrimp [365]. Butter sole larger than 1.4 inch SL feed mainly on amphipods, cumaceans, and decapods. Larger fish consume larger prey.

Butter Sole Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur all along the west coast at depths <1,200 feet, on soft bottoms.

Composites: non-rocky shelf, continental slope/basin

Spawning Stage
Spawning occurs mainly from northern California northward at depths from 89-210 feet, over soft bottom.

Composites: non-rocky shelf

Juvenile Stage
Insufficient information to define EFH.

Larval Stage
Larvae are pelagic and float in surface waters in nearshore coastal waters.

Composites: neritic

Egg Stage
Eggs are pelagic and float in surface waters over the continental shelf.

Composites: neritic

The adult and spawning stages of non-rocky shelf EFH for butter sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for butter sole potentially affected by the Bridge Program includes soft muddy or silty bottoms.

CURLFIN SOLE (*Pleuronichthys decurrens*)

Range
Curlfin sole are found along the Pacific Coast of North America from the Bering Sea south to San Quintin, Baja California [85, 160, 240, 261]. Curlfin sole is a demersal species associated with soft bottoms (Eschmeyer et al. 1983). They are usually found in waters shallower than 295 feet. Eggs are pelagic and occur in nearshore waters.

Distribution in the EEZ
Curlfin sole have been taken between 23 and 1,740 feet [81], but most occur shallower than 295 feet [85]. They are found on soft bottoms [81, 160].

Migrations and Movements
No information.

Reproduction
Transparent eggs have been noted in curlfin sole ovaries from November-June. They spawn from late April-August [85]. Eggs are pelagic with specific gravity equal to that of sea water [85]. The eggs are spherical ranging from 0.07-0.08 inch [362]. Each egg is enclosed in a thin membrane which appears translucent because of a hexagonal pattern throughout its thickness. The yolk is clear and transparent and contains no oil globule [85].

Growth and Development
Curlfin sole eggs hatch in slightly less than 7 days (160 hrs) after fertilization [85]. Curlfin sole larvae are heavily pigmented, even at hatching [362]. Newly hatched larvae measure 0.15 inch [85]. Of flatfishes, curlfin sole are the largest at hatching and attain the largest size before transformation [362]. In laboratory experiments, the left eye begins to migrate when larvae attain 0.4 inch SL, but had not completed migration in a larva 0.8 inch SL [362]. The maximum size of adult curlfin sole is 15 inches [81, 85, 160]. The maximum weight of curlfin sole is 25 ounces [85]. As adults, females are generally larger than male curlfin sole [85].

Trophic Interactions
Curlfin sole feed primarily on polychaete worms, nudibranchs or tectibranchs, crustacean (possibly crab) eggs and brittle star fragments.

Curlfin Sole Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur all along the west coast at depths from 125-1,150 feet, associated with soft bottoms.

Composites: non-rocky shelf, continental slope/basin

Spawning Stage
Spawning occurs from April-August, probably within adult habitat.

Composites: non-rocky shelf, continental slope/basin

Juvenile Stage
No information.

Larval Stage
No information.

Egg Stage
Eggs are pelagic and occur in nearshore and sometimes far offshore.

Composites: neritic, oceanic

The adult and spawning life stages of non-rocky shelf EFH for curlfin sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for curlfin sole potentially affected by the Bridge Program includes soft bottoms.

DOVER SOLE (*Microstomus pacificus*)

Range
Dover sole are distributed from the Navarin Canyon in the northwest Bering Sea and westernmost Aleutian Islands to San Cristobal Bay, Baja California [109, 114, 260]. Dover sole is a demersal species associated with soft bottom substrates at depths from 33 to 1,800 feet (Allen and Smith 1988). Eggs and larvae are found in surface and midwaters.

Habitat
Dover sole are a dominant flatfish on the continental shelf and slope from Washington to southern California. In the North Pacific, they are regarded as an inner shelf-mesobenthal species [12]. Adults are found from 30-4,760 feet, with highest abundance below 656-984 feet. The majority inhabit waters <1,640 feet [12]. Spawning occurs in waters 262-1,800 feet deep at or near the bottom [94, 109, 114, 283].

Eggs are epipelagic; larvae are epi-mesopelagic. Juveniles and adults are demersal [94]. Eggs are found primarily in the upper 164 feet of the water column [283]. Larvae are found as deep as 1,970 feet, but the majority are found from the surface to 164 feet of depth, and up to 522 miles offshore [94, 260, 283]. Juveniles are sublittoral-bathyal and found from 328-2,300 deep; most are found >656 feet [114, 260]. Dover sole populations spawn, rear, and grow in Puget Sound and off Vancouver Island, as well as other estuaries along the west coast. Summer feeding grounds of offshore populations may be in shallow-water estuaries and bays, often as shallow as 180 feet off British Columbia [391]. Juveniles are often found in deep waters of the nearshore domain. Winter spawning grounds are located as deep as 1,800 feet. Dover sole are an important flatfish of soft-bottom marine and estuarine environments [260]. Adults and juveniles show a high affinity toward soft bottoms of fine sand and mud. All life stages of Dover sole are found in euhaline water at 39-60° F [260]. Egg and larval development was found to be best at 46-50° F [94]. Spawning may occur at sub-zero temperatures.

Movements and Migrations
Dover sole are considered to be a migratory species. In the summer and fall, mature adults and juveniles can be found in shallow-water feeding grounds. By late fall, the sole

begin moving offshore into deep waters (1,310 feet) to spawn. Westrheim and Morgan [391] found the movements to be onshore-offshore in nature, with little coastal north-south migration. Larvae are transported offshore and to nursery areas by ocean currents and winds. Juvenile fish move into deeper water with age, and begin seasonal spawning-feeding migrations upon reaching maturity.

Reproduction
Dover sole are oviparous; fertilization is external. Spawning occurs from January-August in the Gulf of Alaska, November-April off Oregon and California, and January-March in Puget Sound [94, 114, 260, 283]. Dover sole are a batch spawner; total fecundity of a 17-inch female is estimated at 52,000 eggs, whereas a 23-inch female was estimated to have 266,000 eggs [138, 403].

Growth and Development
Fertilized eggs average 0.08-0.10 inch in diameter [283]. Embryonic development is indirect and external. The eggs hatch in 40 days at 5EC; 24 days at 8EC; and 15 days at 54° F [48]. Larvae hatch at about 0.25 inch [260]. Metamorphosis may begin as early as 1.4-1.9 inches; however, larvae are planktonic for up to two years, and metamorphosis may not begin until the sole has reached 4 inches [48, 114, 211, 373]. Settlement to benthic living occurs mid-autumn to early spring off Oregon, and February-July off California [211]. Juveniles grow to a size of 12-18 inches over the first four years of life [138].

Trophic Interactions
Dover sole larvae eat copepods, eggs and nauplii, as well as other plankton. Juveniles and adults eat polychaetes, bivalves, brittlestars and small benthic crustaceans. Dover sole feed diurnally by sight and smell [67, 91, 114, 260].

Larvae are eaten by high seas pelagic fishes like albacore, jack mackerel and tuna, as well as sea birds. Juveniles and adults are preyed upon by sharks, demersally feeding marine mammals, and to some extent by sablefish [260]. Dover sole compete with various eelpout species, rex sole, English sole, and other fishes of the mixed species flatfish assemblage.

Dover Sole Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults occur all along the continental shelf and slope at depths between 33 and 1,800 feet on soft bottom, primarily sand, silt, or mud.

Composites: non-rocky shelf, continental slope/basin

Spawning Adult Stage
From November through April, spawning adults occur from the northern border of the EEZ to north of the Channel Islands, in offshore areas at depths between 262 and 1,800 feet on soft bottom, primarily sand, silt, or mud.

Composites: non-rocky shelf, continental slope/basin

Juvenile Stage
Juveniles occur all along the continental shelf and slope of the EEZ at depths between 328 and 2,300 feet on soft bottom, primarily sand, silt, or mud.

Composites: non-rocky shelf, continental slope/basin

Larval Stage
Larvae occur all along the coast in surface and midwaters up to 1,640 feet deep and up to 522 miles offshore.

Composites: neritic, oceanic

Egg Stage
From November through May, eggs occur all along the coast in surface and midwaters up 164 feet deep and up to 522 miles offshore.

Composites: neritic, oceanic

The adult, spawning adult, and juvenile life stages of non-rocky shelf EFH for dover sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for dover sole potentially affected by the Bridge Program includes soft bottoms of sand, silt, or mud.

While estuaries are not designated as EFH for dover sole, the species does occur in estuaries and could be affected by the Bridge Program.

ENGLISH SOLE (*Parophrys vetulus*)

Range
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 [12]. English sole is a demersal species associated with soft bottom substrates. Eggs, larvae, and juveniles utilize shallow coastal areas including estuaries and bays (Krygier and Pearcy 1986). Spawning occurs over soft bottom substrates at depths of 164 to 230 feet (Ketchen 1956).

Habitat
In the North Pacific, English sole is an inner shelf- mesobenthal species, occurring to 180 feet [12]. In research survey data, nearly all occurred at depths <820 feet [12]. It is 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 [260].

Eggs and larvae are pelagic; juveniles and adults are demersal [94]. Larvae are found primarily in waters <656 feet deep [172]. Juveniles reside primarily in shallow-water coastal, bay, and estuarine areas [154, 166, 174, 268, 284, 316, 372, 375, 387]. Small juveniles settle in the estuarine and shallow nearshore areas all along the coast, but are less common in southerly areas, particularly south of Point Conception. As they grow, they move to deeper water. Large juveniles commonly occur up to depths of 492 feet. Spawning occurs over soft-bottom mud substrates at depths of 164-230 feet [154]. Adults, spawning adults, and eggs have been found in Puget Sound, Hood Canal, Skagit Bay and Grays Harbor in Washington and in Santa Monica Bay, California. Adults are also common in San Pedro Bay, California. Larvae and juveniles occur in most estuaries between Puget Sound and San Pedro Bay, California [77]. English sole uses nearshore coastal and estuarine waters as nursery areas [166, 316].

English sole is a very important flatfish in shallow-water, soft-bottom marine and estuarine environments along the Pacific coast [77]. Adults and juveniles prefer soft bottoms composed of fine sands and mud [154] but also are reported to occur in eelgrass habitats [289]. In Puget Sound, juveniles and adults prefer shallow (<40 feet deep) muddy substrates [33]. Males show a preference for fine sediments [34].

Eggs are neritic and buoyant, but sink just before hatching [114]. Eggs are mostly found in polyhaline waters at temperatures of 39-54° F, optimally at 25-28 ppt and 46-48° F [94]. Adults are found primarily in euhaline waters. Juveniles and larvae occur in polyhaline and euhaline waters. Optimum conditions for larval survival were found to be salinities of 25-28 ppt and temperatures of 46-48° F [6]. No spawning occurs at temperatures below approximately 46° F [142]. Temperatures >64° F appear to be the upper thermal tolerance (reduced daily ration and growth) for juvenile English sole [401]. The upper lethal limit for this species is 80° F [17].

Migrations and Movements

Adults make limited migrations. Those off Washington show a northward post-spawning migration in the spring on their way to summer feeding grounds, and a southerly movement in the fall [94]. Tagging studies have identified separate stocks based on this species' limited movements and meristic characteristics [149]. Tidal currents appear to be the mechanism by which English sole move into estuaries [38]; larvae are transported to nearshore nursery areas (i.e., shallow coastal waters and estuaries) by these currents. Larvae metamorphose into juveniles in spring and early summer and rear until fall/winter at which time most emigrate to deeper waters [268]. Although many postlarvae may settle outside of estuaries, apparently most will enter estuaries during some part of their first year of life [105]. Early- and late-stage larvae undergo diel vertical migrations [241, 242]. There is a general movement to deeper waters as fish grow [154]. Smaller fish tend to be restricted to shallow waters, with larger fish more abundant in deeper water [78, 241, 347].

Reproduction

English sole are gonochoristic, oviparous, and iteroparous; eggs are fertilized externally [94]. Spawning occurs from winter to early spring depending on the stock: in Monterey

Bay stocks, from January to May, peaking in March or April [46]; in Bodega Bay-Point Monterey stocks, from December to April, peaking in January or February [379]; cited in [94]; in Santa Monica Bay-Santa Barbara Channel stocks, from December to April; in Eureka-Oregon border stocks from October to May [149]; in Oregon stocks from January to April, peaking in February or March [113]; in Puget Sound stocks, from January to April, peaking in February or March [341]. Five- to six-year-old females (14-15 inches in length) can produce about 1 million eggs, whereas large fish (17 inches long) may produce nearly 2 million eggs [88, 113, 153].

Growth and Development

Fertilized eggs are spherical and average 0.04 inch in diameter [271]. Embryonic development is indirect and external. The planktonic eggs hatch in 3.5 days at 12EC, or 11.8 days at 39° F [6]. After hatching, larvae float with their yolk sac up. The yolk sac is absorbed in 9-10 days [271], with the planktonic larvae taking from 8-10 weeks to metamorphose to benthic living juveniles [173]. Larvae are 0.08-0.11 inch TL at hatching [271] and grow to 0.7-1.0 inch before becoming juveniles [94, 242]. Juveniles range in size from 0.7 to about 10 inches long, depending on sex [113]. Growth appears to be affected by upwelling [163] and cohort abundance of age-1 fish [293]. Some females mature as 3-year-olds and 10 inches long, but all females over 14 inches long are mature. Males mature earlier, beginning at 2 years and 8 inches in length. All males are mature at lengths >11 inches [113]. In Puget Sound, all 2-year-old males are mature, but most females do not mature until they are 4 years old [341].

Trophic Interactions

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 [44]. Juveniles and adults are carnivorous, apparently feeding primarily during daylight hours [33]. Juveniles feed on harpacticoid copepods, gammarid amphipods, cumaceans, mysids, polychaetes, small bivalves, clam siphons, and other benthic invertebrates [11, 33, 124, 337]. Small juvenile English sole concentrate their feeding on harpacticoid copepods and other epibenthic crustaceans until they reach approximately 2-2.5 inches in length, then they switch to feeding primarily on polychaetes [372]. Off Oregon, adult English sole feed on a variety of benthic organisms, but primarily polychaetes, amphipods, molluscs, ophiouroids, and crustaceans [162]. English sole feed primarily by day, using sight and smell, and sometimes dig for prey [11, 137].

Larvae are probably eaten by larger fishes. A juvenile English sole's main predators are probably piscivorous birds such as great blue heron (*Ardea herodias*), larger fishes and marine mammals. Adults may be eaten by marine mammals, sharks, and other large fishes. The English sole's sharp anterior anal spine may provide a defense against predators [11]. English sole competes with slim sculpin, blackbelly eelpout, Pacific tomcod, ratfish, Dover sole, and white croaker [11, 142]. It occasionally interbreeds with starry flounder and produces a hybrid.

English Sole Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults occur all along the continental shelf and slope, mainly from central California northward, at depths <820feet.

Composites: estuarine, rocky shelf, non-rocky shelf, continental slope/basin

Spawning Adult Stage
From early winter through spring, spawning adults occur all along the continental shelf, mainly from central California northward, between 164 and 230 feet on soft bottom, primarily silt or mud.

Composites: estuarine, rocky shelf, non-rocky shelf

Juvenile Stage
Juveniles occur all along the continental shelf, mainly from central California northward, at depths <492 feet on soft bottom, primarily sand, silt, or mud.

Composites: estuarine, rocky shelf, non-rocky shelf

Larval Stage
Larvae occur all in estuaries and along the coast, mainly from central California northward, in surface and midwaters <656 feet deep.

Composites: estuarine, neritic

Egg Stage
From early winter through spring, eggs occur in estuaries and along the coast, mainly from central California northward, in surface and midwaters <656 feet deep.

Composites: estuarine, neritic

All life stages of estuarine EFH for English sole could be affected. Estuarine EFH for English sole potentially affected by the Bridge Program includes soft bottom substrates composed of fine sands and mud and eelgrass habitats in shallow-water.

The adult, spawning adult, and juvenile stages of rocky shelf EFH for English sole could be affected by ODOT bridge replacement and repair activities.

The adult, spawning adult, and juvenile stages of non-rocky shelf EFH for English sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for English sole potentially affected by the Bridge Program includes soft bottoms of sand, silt, or mud.

FLATHEAD SOLE (*Hippoglossoides elassodon*)

Range
Flathead sole are found on the Pacific coast of North America from Point Reyes, northern California northward through the Gulf of Alaska and across the Bering Sea [9, 81, 240, 261]. Flathead sole is a demersal species that occurs mainly from northern Oregon northward, in waters up to about 984 feet, over soft bottoms (PFMC 1998bb). Larger individuals occur in deeper waters. Estuaries, bays, and coastal areas are important as nursery areas.

Habitat
Flathead sole commonly inhabit the continental shelf of the North Pacific Ocean [319]. They inhabit water as deep as 1,800 feet, but usually occur in depths less than 1,200 feet [319]. The flathead sole often occurs in trace amounts in trawl samples off Washington and Oregon and is found more frequently as one moves northward [319]. Flathead sole are mesobenthic [323] with larger individuals occurring in deeper waters [319].

Nursery areas along the northern Pacific coast are usually shallow (<328 feet) estuaries, bays, and nearshore coastal areas [127]. Young flathead sole are also frequently encountered in shallow depths of the inside waters of Puget Sound northward [319]. Age-0 and age-1 flathead sole are mainly captured deeper than 131 feet [127]. Flathead sole inhabit soft [81], silty or muddy bottoms [160]. They also occur on mud mixed with gravel or sand [127]. Newly spawned eggs are buoyant in salinities of 25-27‰ or greater. Incubating eggs are euryhaline. Newly hatched larvae are buoyant in salinities of 17-18‰ or greater. Total hatch and viable hatch are highest (>90%) at 25‰, 43° F and 25‰, 7EC. Post hatching flathead sole develop normally from 25-39.58‰ and at temperatures from 42-51° F or greater [9]. Adult flathead sole occur in water 27-34‰ [9]. The preferred temperature range of adult flathead sole is 36-39° F [278]. Bottom temperatures during spawning season are from 43-46° F [9].

Migrations and Movements
Adult fish migrate from wintering grounds on the upper continental slope onto the shelf during the spring and summer [319]. In Auke Bay, southeastern Alaska, flathead sole larvae perform diel vertical migrations, including nocturnal ascent, nocturnal descent, and nocturnal diffusion [110]. During the day larvae concentrate at 16 feet. At twilight they appear to descend somewhat, but still have peak densities at 16-33 feet. At midnight there are relatively high numbers at the surface [110].

Reproduction
Flathead sole are oviparous and iteroparous. Eggs are fertilized externally and fecundity ranges from 72,000-600,000, varying with the size of the female [319]. Flathead sole spawn from May-June at 240-420 feet [323]. The eggs of the flathead sole range from 0.11-0.14 inch in diameter [323].

Growth and Development

The larvae and eggs of the flathead sole are part of the zooplankton community. Either they float near-surface or on the surface layer or, like most flatfish, control their specific gravity so as to float somewhere below the surface [323]. Larger eggs occur when the water salinity is between 20 and 27.5‰ [9]. The eggs incubate for 7.2-20.9 days. Absorption of the yolk occurs at 6-17 days [9]. Flathead sole metamorphosize and settle to the bottom beginning in late summer [319]. Larvae grow at 0.02 inch/day at lower temperatures and 0.04 inch at higher temperatures [9]. Flathead sole larvae average 0.5-1.4 inch SL [45]. Adults can grow to 22 inches [160].

Males and females may mature as young as 2-3 years in Puget Sound, but not until 6 years in the Bering Sea [260]. Males live to 17 years and females to 21 years [260].

Trophic Interactions

Flathead sole feed on a wide variety of small mobile prey both on and off the bottom. Dominant prey items vary with area and season. They are opportunistic predators [319] and are considered to be piscivorous feeders because they actively pursue prey [323]. Around Kodiak Island, Alaska, young flathead sole feed mostly on crustaceans. In order of importance, age-0 flathead sole preyed on amphipods, bivalves, mysids, and shrimps. Age-0 flathead sole in depths of 33-131 feet and 230-262 feet consumed mainly gammarid amphipods; at depths of 164-197 feet they split their diet among Caridea, Mysidea, and Gammaridea; and at depths of 262-295 feet they consumed primarily Bivalvia [127]. For one-year-old flathead sole off Kodiak Island, Alaska, their diet (in order of importance) consisted of mysids, shrimps, amphipods, and bivalves. Age-1 flathead sole in depths 66-131 feet and 164-197 feet primarily consumed mysids; at depths of 33-66 feet and 131-164 feet they consumed nearly equal amounts of mysids and caridean shrimps; and in 262-295 feet depths, mysids, amphipods, shrimps, and chaetognaths were of similar importance in their diet [127]. Minimal dietary requirements of flathead sole ranges from 2.2-6.2% of body weight per day during its first year [277]. Around the San Juan Islands in Washington, adult flathead sole prey upon mysids, fishes, shrimps, polychaetes, and clams. The commonest fish in their diet is Pacific herring, Clupea pallasi [238]. Mysids are important contributors to the diet for all size groups, although primarily only in the summer and fall for larger sole. Shrimps are important in the diet of sole 7 inches and larger. Fishes and clams are important in the diet of sole 10 inches and larger. Polychaetes were of some importance in the diet of medium-sized sole in the summer and early fall [238]. With the exception of larger fish, feeding decreases in the winter months.

<u>Flathead Sole Life Stages and EFH Potentially Affected by the Bridge Program</u>

Adult Stage

Adults are demersal and occur mainly from northern Oregon northward, at depths <984 feet, over soft bottom.

Composites: non-rocky shelf, continental slope/basin

Spawning Stage
Spawning occurs during late spring and early summer, at depths from 164-984 feet over soft bottom.

Composites: non-rocky shelf, continental slope/basin

Juvenile Stage
Juveniles are demersal and occur at depths <984 feet over soft bottom.

Composites: non-rocky shelf, continental slope/basin

Larval Stage
Larvae are pelagic in waters <459 feet.

Composites: neritic, oceanic

Egg Stage
Eggs are pelagic and occur in neritic waters and occasionally in oceanic waters.

Composites: neritc, oceanic

The adult, spawning, and juvenile stages of non-rocky shelf EFH for flathead sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for flathead sole potentially affected by the Bridge Program includes soft, silty or muddy bottoms or mud mixed with gravel or sand.

PACIFIC SANDDAB (*Citharichthys sordidus*)

Range
Pacific sanddab are found from Cape Lucas, Baja California, to the Bering Sea [27, 94, 114]. Pacific sanddab is a demersal species that occurs throughout the area covered by this EFH analysis at depths up to 492 feet over sand or gravel substrates (Garrison and Miller 1982). Both adults and juveniles are found in shallow coastal waters, bays, and estuaries (Hart 1973). Older individuals also occur in shallower water (Sakuma and Larson 1995a).

Habitat
Pacific sanddab inhabit the shallow sublittoral zone of Puget Sound [114], and the inner continental shelf along the west coast [16, 27, 162]. Adults are found in estuaries and coastal waters to as deep as 1,000 feet, but highest abundance is in waters <492 feet [114]. Pearcy and Hancock [279] found that sanddab were most abundant off Oregon and Washington between 121 and 295 feet. In Puget Sound, adults may be found to 492 feet, but are common in <66 feet of water [94]. Barss [27] reported adult sanddab occur in San Francisco Bay, and Leos [187] found adults in Monterey Bay.

Eggs and larvae are pelagic; juveniles and adults are demersal [94]. Larvae may be found as far offshore as 450 miles in the upper 656 feet of the water column [327]. Juveniles are primarily found in shallow coastal waters, bays and estuaries [114].

Off Oregon, Pacific sanddab are numerically the most abundant species on sandy bottom habitats between 243 and 335 feet [279]. Small juveniles <2.8 inches prefer substrates of silty sand, whereas adults prefer coarser sediments [282].

Eggs are found in mostly in polyhaline waters at 4-12EC, optimally at 46-48° F [94]. Adults are found in high salinity areas correlated with upwelling [327, 328]. Larvae are found offshore in areas of lower salinity [327]. Pearcy [279] and Sakuma and Larson [327] report that older fish occur in shallower water and nearer shore than younger fish.

Movements and Migrations

Pacific sanddab make limited migrations that are poorly studied and understood. Pearcy [279] reported that sanddab are absent from deep-water trawls made off Oregon during the summer and fall, but present in the same areas in the winter and spring. This is thought to be a migration between winter-spring spawning grounds and summer-fall feeding grounds [279]. Coastal movements are minimal. Larvae are carried by wind and ocean currents as far offshore as 450 miles [327].

Reproduction

Pacific sanddab are oviparous and iteroparous, and eggs are fertilized externally [94]. Spawning occurs from late winter through summer, depending on stock and location. In Puget Sound, spawning begins in February and continues through spring, peaking in March and April [94, 114]. Off California, spawning takes place July through September, peaking in August [19, 94]. Female sanddab may spawn twice per season [19, 94, 114].

Growth and Development

Fertilized eggs are spherical, translucent and contain a single oil globule [94, 114]. Eggs are 0.02-0.03 inches in diameter [94]. Embryonic development is indirect and external.
Larvae hatch at <0.2 inches [94] and are pelagic and planktonic. This pelagic stage may last up to 271 days [327]. Settlement to benthic living occurs at 0.8-1.5 inches [327]. Juveniles range in size from 0.8 inches to over 7 inches [19, 114].

In Puget Sound, 50% of the species is mature by age 2 (both sexes) [94]. In California, 50% of sanddab are mature by 7.5 inches and 3 years [19, 114]. Off Oregon, Pacific sanddab may reach 13 years of age (Floyd 2003). Both sexes grow at the same rate for the first four years, at which time females grow faster [19].

Trophic Interactions

Juveniles and adults are carnivorous. Unlike many sympatric species, Pacific sanddab are mainly pelagic feeders; the only evidence of benthic feeding is annelid worms found in stomachs of some specimens [282]. The main food items of large sanddab are crab larvae, squids, octopi and northern anchovy [282]. Smaller sanddab eat euphausiids, amphipods, shrimps and some fish [162, 282]. The diet of the sanddab is determined

mainly by food availability; crab larvae are present only in certain months, and fish consumption is higher in the summer months [282]. Pacific sanddab are often found with Dover sole, slender sole and rex sole.

Pacific sanddab Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults occur all along the continental shelf at depths <492 feet, primarily on sand or gravel bottom.

Composites: non-rocky shelf

Spawning Adult Stage
From late winter through summer, spawning adults occur all along the continental shelf, mainly from central California northward, between 164 and 230 feet on soft bottom, primarily silt or mud.

Composites: non-rocky shelf

Juvenile Stage
Juveniles occur in bays and estuaries and in shallow waters all along the inner continental shelf on soft bottom, primarily sand, silt, or mud.

Composites: estuarine, non-rocky shelf

Larval Stage
Larvae occur all along the continental shelf and slope in surface and midwaters <656 feet deep and as far offshore as 435 miles.

Composites: estuarine, neritic, oceanic

Egg Stage
From late winter through summer, eggs occur along the coast, mainly over the continental shelf from central California northward.

Composites: estuarine, neritic, oceanic

The juvenile, larval, and egg stages of estuarine EFH for Pacific sanddab could be affected by all ODOT bridge replacement and repair activities. Estuarine EFH for Pacific sanddab potentially affected by the Bridge Program includes sand bottoms.

The adult, spawning adult, and juvenile stages of non-rocky shelf EFH for Pacific sanddab could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for Pacific sanddab potentially affected by the Bridge Program includes sand, silty sand, or gravel bottoms.

PETRALE SOLE (Eopsetta jordani)

Range
Petrale sole are found form Cape St. Elias, Alaska to Coronado Island, Baja California. The range may possibly extend into the Bering Sea, but the species is rare north and west of southeast Alaska and in the inside waters of British Columbia [94, 114]. Petrale sole is a demersal species that occurs throughout the area covered by this EFH analysis at depths up to 984 feet over soft substrates, primarily sand, silt or mud. Estuaries are used by juveniles, adults, and overwintering sub-adults (NOAA Fisheries 1990). Larger individuals utilize deeper water.

Habitat
Petrale sole is an inner shelf-mesobenthal species [12] and is an important predator on the continental shelf from British Columbia to central California [260]. Eggs are pelagic; juveniles and adults are demersal [94]. Larvae are neritic and epipelagic. Young juveniles are generally found between 59-269 feet and larger juveniles at 82-476 feet. Adults are found from the surf line to 1,800 feet, but their highest abundance is <984 feet [260]. Adults migrate seasonally between deep water, winter spawning areas to shallower, spring feeding grounds [260]. Larvae are often found in the upper 164 feet of the water column far offshore [260]. Spawning occurs over the continental shelf and continental slope to as deep as 1,800 feet.

Spawning adults, as well as eggs, larvae and juveniles, are found in Puget Sound and the waters around Vancouver Island. Juveniles of offshore stocks often spend time rearing in estuaries. Adults may utilize summer feeding grounds in estuaries, and non-migrating subadults may overwinter in estuaries [260, 291, 292]. Over a range of shallow to deep water, petrale sole are an important flatfish and benthic predator. They show an affinity to sand, sandy mud and occasionally muddy substrates [260]. Eggs are found primarily in waters 39-50° F and salinities of 25-30l [94]. Optimum conditions for egg incubation and larval growth were 43-45° F and 27.5-29.5l [7]. No egg hatching was found to occur below 40° F [7]. Adults and juveniles are found in euhaline waters.

Movements and Migrations
Petrale sole move from shallow summer feeding grounds to deep-water spawning grounds in the winter. There seems to be little north-south movement up and down the coast, but distances of 390 miles have been reported [94, 114]. Eggs and larvae are transported from offshore spawning areas to nearshore nursery areas by oceanic currents and wind. Petrale sole tend to move into deeper water with increased age and size. Nine separate breeding stocks have been identified, although all stocks intermingle on summer feeding grounds [7, 114, 260]. Of these nine, one occurs off British Columbia, two off Washington, two off Oregon and four off California [260].

Reproduction
Petrale sole are oviparous, and fertilization is external. The petrale sole is a broadcast spawner [260]. In British Columbia, Washington and Oregon waters, the spawning season lasts from December - April, and peaks in February - March [94, 283]. In

California, spawning begins slightly earlier. Petrale sole spawn in the same area year after year.

A 16-inch female petrale sole may produce 400,000 eggs, whereas a 22-inch female may produce as many as 1,200,000 eggs [94, 260].

Growth and Development
Embryonic development is indirect and external. The planktonic eggs hatch in 13.5 days at 41° F, and 6 days at 47° F [94]. Larvae hatch at approximately 0.12 inch with a yolk sac. The yolk sac is gone by the time the larvae reaches 0.22 inch, about 10-16 days [94]. Larvae metamorphose into juveniles at 0.9 inch and six months of age, and settle to the bottom of the inner continental shelf [283].

Petrale sole begin maturing at three years. Half of males mature by seven years, and 11-17 inches and half of the females are mature by eight years, and 17 or more inches [291, 292]. Near the Columbia River, petrale sole mature one to two years earlier [291, 292].

Trophic Interactions
Larvae are planktivorous. Larvae prey on copepods, their eggs and nauplii. Small juveniles eat mysids, sculpins and other juvenile flatfishes. Large juveniles and adults eat shrimps and other decapod crustaceans, as well as euphausiids, pelagic fishes, ophiuroids and juvenile petrale sole [94, 114, 162, 260, 283, 291, 292]. Petrale sole eggs and larvae are eaten by planktivorous invertebrates and pelagic fishes. Juveniles are preyed upon (sometimes heavily) by adult petrale sole, as well as other large flatfishes. Adults are preyed upon by sharks, demersally feeding marine mammals, and larger flatfishes and pelagic fishes [260].

Petrale sole competes with other large sympatric flatfishes. It has the same summer feeding grounds as lingcod, English sole, rex sole and Dover sole.

Petrale Sole Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults occur all along the continental shelf and upper slope, mainly from central California northward, at depths from 0 to 984 feet on soft bottom, primarily sand, silt, or mud.

Composites: non-rocky shelf, continental slope/basin

Spawning Adult Stage
From early winter through spring, spawning adults occur all along the upper continental slope, mainly from northern California northward, between 900-1,200 feet on soft bottom, primarily silt or mud.

Composites: continental slope/basin

Juvenile Stage
Juveniles occur all along the continental shelf, mainly from central California northward, at depths between 59 and 476 feet on soft bottom, primarily sand, silt, or mud.

Composites: non-rocky shelf

Larval Stage
Larvae occur all along the coast, mainly from northern California northward, in surface and midwaters <328 feet deep over the continental shelf and slope.

Composites: neritic, oceanic

Egg Stage
From early winter through spring, eggs occur along the coast, mainly from northern California northward, in waters <1,150 feet deep over the continental shelf and slope, but primarily in surface waters.

Composites: neritic, oceanic

The adult and juvenile life stage of non-rocky shelf EFH for petrale sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for petrale sole potentially affected by the Bridge Program includes soft bottoms of sand, silt, or mud.

ODOT bridge replacement and repair activities may take place where adult and juvenile petrale sole occur in estuaries; however, the estuarine composite has not been designated as EFH for petrale sole.

ROCK SOLE (*Lepidopsetta bilineata*)

Range
Rock sole are distributed continuously on the Pacific west coast from southern California to the Gulf of Alaska [114, 130]. Rock sole is a demersal species associated with sandy or gravelly substrates (Garrison and Miller 1982). They occur at depths up to 984 feet (Horton 1989). Larvae are pelagic; all other life stages are demersal.

Habitat
Adult rock sole are found as deep as 2,400 feet, but they are uncommon below 984 feet [130]. Juveniles and adults are demersal and found primarily in shallow water bays over the continental shelf [14, 87, 130]. They overwinter on the edge of the continental slope at depths of 410-902 feet [130] and occupy the shelf during the summer at depths of 59-262 feet. In Puget Sound, rock sole are uncommon below 180 feet and spawning occurs in shallow water [94], even intertidally.

Eggs are demersal and adhesive [130]. Larvae are pelagic and primarily found in the upper 98 feet of the water column [110, 114, 130]. Small juveniles settle all along the coast, with a much higher occurrence further north. Juveniles move into deeper waters

with increased size. Eggs occur in polyhaline to euhaline waters, from sub-zero temperatures to 59° F [94, 130]. Adults are found almost exclusively in euhaline waters. Juveniles and larvae occur in polyhaline to euhaline waters. Larval development was most successful at 43° F [130]. Temperatures above 64° F inhibit egg and larval growth, as well as adult feeding. The upper lethal limit for this species is 77° F [130].

Adults and juveniles prefer sandy or gravel substrates on the Pacific coast, and also show an affinity to steep rock slopes in Puget Sound [94, 114, 130]. Garrison and Miller [94] also reported that rock sole occur over soft bottoms. Spawning occurs over a variety of substrates, from rocky banks to sand and mud [94, 130].

Migrations and Movements

Rock sole are sedentary [94, 130]. They undergo a southerly movement to deeper water in the winter to spawning grounds, and a northward post-spawning migration to summer feeding grounds in the shallow waters over the continental shelf [14, 87, 114]. Haldorson, et al., [110] reported that larvae migrate from 16-33 feet during the day to 98 feet at night, most likely following the peak abundances of copepod nauplii. Larvae are transported by wind and tidal currents. Rock sole also move into deeper water with increased size [335].

Reproduction

Rock sole are oviparous with external fertilization [94]. Spawning occurs from winter through early spring depending on location of the stock. In Puget Sound, spawning occurs from December-April, peaking in March. In southern California, spawning occurs from November-March, peaking in February. In the Bering Sea, spawning occurs from March-June, peaking in April [94, 114, 130, 197, 335]. A 14-inch fish may produce 400,000 eggs per year, whereas an 18-inch fish may produce up to 1,300,000 eggs per year [94, 130].

Growth and Development

Fertilized eggs are spherical and 0.03-.04 inch in diameter [130]. Embryonic development is indirect and external. The eggs hatch in 6.4 days at 52° F, 9-18 days at 44-46° F, and 25 days at 37° F [14]. Larvae hatch at 0.13-0.2 inch with a yolk sac that is absorbed in 10-14 days [14]. Metamorphosis occurs at 0.7-0.8 inch [94, 130]. Juveniles range from 0.7 to 13 inches, depending on sex [383].

Rock sole females mature at 4-5 years and 13-14 inches. Males mature at 3-4 years and 12 inches [87, 94, 114]. In Puget Sound, female rock sole mature in 3-4 years at 12-13 inches, and males mature at 2 years [94]. After 2-3 years, females grow faster than males and reach a larger average size. Growth of both sexes decreases after 8 years. Rock sole may live up to 25 years (Floyd 2003).

Trophic Interactions

Larvae are planktivorous. Juveniles and adults are carnivorous, feeding during the daylight hours [269]. Juveniles consume mobile prey, such as cumaceans, carideans, and gammarid amphipods. Adults feed on more sedentary foods, such as polychaetes,

echiuroids, mollusks, echinoderms, benthic fishes and urochordates [269]. Polychaetes may constitute up to 62% of an adult rock sole's diet [170]. Depending on the season, clam siphons may be consumed almost exclusively [114]. Diet variation results as much from food availability as it does from prey preference [170]. Larvae are probably eaten by larger fishes and perhaps sea birds. Juveniles are eaten by larger fishes. Cannibalism by adults on larvae and juveniles can be very detrimental to populations [14]. Adult rock sole may be eaten by sharks, marine mammals, and larger fishes.

Rock Sole Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur all along the west coast, at depths <984 feet.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Spawning Stage
Spawning occurs from winter through early spring, at depths <984 feet.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Juvenile Stage
Juveniles are demersal and occur at depths <984 feet.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Larval Stage
Larvae are pelagic, primarily in the upper 98 feet of the water column.

Composites: neritic

Egg Stage
Eggs are demersal and occur at depths <984 feet, within adult habitat.

Composites: rocky shelf, non-rocky shelf, continental slope/shelf

The adult, spawning, juvenile, and egg stages of rocky shelf EFH for rock sole could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for rock sole potentially affected by the Bridge Program includes steep rock slopes and rocky banks.

The adult, spawning, juvenile, and egg stages of non-rocky shelf EFH for rock sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for rex sole potentially affected by the Bridge Program includes soft bottoms of sand, mud, or gravel substrates.

SAND SOLE (*Psettichthys melanostictus*)

Range
Sand sole occur from southern California north as far as the Alaskan Peninsula and the Bering Sea [94, 114]. Sand sole is a demersal species that occurs over soft substrates at depths up to 600 feet (Allen and Smith 1988). Spawning occurs over sandy or muddy substrates in water 66 to 98 feet deep (Garrison and Miller 1982). Adults, larvae, and juveniles use estuaries (Hart 1973).

Habitat
Sand sole are considered an inner shelf-outer shelf species and occur as deep as 1,065 feet, but nearly all <492 feet [12]. Eggs, larvae and small juveniles are pelagic; older juveniles and adults are demersal [110]. Larvae are generally found in the upper 33 feet of the water column of waters <656 feet deep [94, 110]. Small juveniles may remain pelagic for some time, and in Puget Sound, usually occur in 16-66 feet of water [94]. Adults and older juveniles are found as deep as 600 feet, but do not occur in high densities below 262 feet of water [114, 318, 346]. Spawning occurs over sandy and muddy substrates in water 66-98 feet deep [94].

Adults are found year-round in some estuaries, and spawning adults, eggs and larvae are found winter-spring in Puget Sound, Bellingham Bay and East Sound [114, 346]. Larvae and juveniles occur in most estuaries along the west coast. Sand sole show a high affinity to shallow waters with sandy and muddy substrates all along the Pacific coast [94, 114, 346].

Eggs are pelagic and float up just before hatching [114, 346]. Egg and larval development is fastest between 39° F and 54° F [94]. Adults are found from sub-zero temperatures to as warm as 61° F [346]. All life stages are found in euhaline water [110].

Migrations and Movements
Sand sole are not considered to be a migratory species. Adults may move into shallow nearshore waters in early winter to spawn, then move south and offshore in the summer to feed [318]. Adults and demersal juveniles tend to move to deeper waters with increased size and age [94]. Larvae and small juveniles are transported to estuaries and shallow nearshore bays by tidal currents [110].

Reproduction
Sand sole are oviparous with external fertilization [94, 346]. Spawning occurs in winter and spring. In Puget Sound, the spawning season is January-April, peaking in February. In Bellingham Bay, spawning peaks in March. In northern British Columbia, spawning peaks in late April. On the west coast of Vancouver Island, spawning peaks in July [94, 114, 346]. An 11-inch female may produce 900,000 eggs, while a 15-inch fish may produce 1,400,000 eggs.

Growth and Development
Fertilized eggs are spherical and 0.04 inch in diameter [114, 346]. Embryonic development is indirect and external. The planktonic eggs hatch in 6-7 days at 35° F, 5 days at 45-48° F, and 3.5 days at 54° F [94, 114]. Larvae hatch at 0.11 inch and float with their yolk sacs up [346]. The yolk sac is absorbed in 10-12 days. Larvae begin metamorphosis into juveniles between 0.9 and 1.1 inches [114]. Juveniles range in size from 0.9 to 9 inches, depending on sex.

Sommani [346] reported that all females were mature by age 3, and males by age 2. These ages correspond to 9 inches for males, and 11 inches for females [114]. After 2 years, females begin to grow more rapidly than males. Sand sole may attain 10 years of age (Floyd 2003).

Trophic Interactions
Larvae and small juveniles feed on copepods, their eggs and nauplii. Juveniles feed on small crustaceans such as mysids and crangons, worms and mollusks [26, 114, 346]. Adults feed mainly on speckled sanddabs, herring, anchovies, crustaceans, worms, and mollusks [26, 114, 318, 346]. Large adults eat more mobile prey; crabs and fish may make up to 80% of their diet [26]. Eggs and larvae are preyed upon by small fishes and sea birds. Juveniles are preyed on by larger fishes. Adults are eaten by larger fishes, sharks and marine mammals.

<u>Sand Sole Life Stages and EFH Potentially Affected by the Bridge Program</u>

Adult Stage
Adults are demersal and occur from central California northward, at depths <600 feet, over soft bottoms.

Composites: non-rocky shelf

Spawning Stage
Spawning occurs during winter and spring at depths <98 feet over soft bottoms.

Composites: non-rocky shelf

Juvenile Stage
Juveniles are demersal and occur at depths <600 feet over soft bottoms.

Composites: non-rocky shelf

Larval Stage
Larvae are pelagic and may occur at depths <66 feet.

Composites: neritic

Egg Stage
Eggs are pelagic and occur mainly over the shelf.

Composites: neritic

The adult, spawning, and juvenile stages of non-rocky shelf EFH for sand sole could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for sand sole potentially affected by the Bridge Program includes sandy or muddy substrates.

ODOT bridge replacement and repair activities may take place where adult, juvenile, and larval sand sole occur in estuaries; however, the estuarine composite has not been designated as EFH for sand sole.

STARRY FLOUNDER (*Platichthys stellatus*)

Range
Starry flounder are found in the western Bering Sea and north of the Bering Strait south to Los Angeles Harbor, California. They are common in Puget Sound [94, 114, 260]. Starry flounder is a demersal species that occurs over soft substrates at depths up to 492 feet (NOAA Fisheries1990). Larvae, juveniles, and adults utilize estuaries. Spawning occurs in waters less than 148 feet deep over soft substrates.

Habitat
Starry flounder is an important member of the inner continental shelf and shallow sublittoral communities [260]. Older juveniles and adults are found from 75 miles upstream to the outer continental shelf at 1,230 feet, but most adults are found in less than 492 feet [260]. Most spawning occurs in estuaries or sheltered inshore bays [270], in less than 148 feet of water.

Eggs and larvae are epipelagic; juveniles and adults are demersal [94]. Eggs occur at or near the surface over water 66-230 feet deep [63, 94, 114]. Larvae are found in estuaries to 23 miles offshore. Juveniles are found in estuaries and the lower reaches of major coastal rivers [114, 270]. Adults also occur in estuaries or their freshwater sources year-round in Puget Sound [94]. Juveniles prefer sandy to muddy substrates, and adults prefer sandy to coarse substrates [260]. Eggs are found in polyhaline to euhaline waters; juveniles are found in mesohaline to fresh water; adults and larvae are found in euhaline to fresh water [63, 94, 270]. All life stages can survive and grow at temperatures below 32° F to 55° F [260].

Movements and Migrations
Starry flounder is not considered to be a migratory species. However, adults move inshore in late winter-early spring to spawn and offshore and deeper in the summer and fall, but these coastal movements are generally less than 3 miles [63]; [260]. Some starry flounder have shown movements of >124 miles [63], but this is not considered typical. Adults and juveniles are known to swim great distances up major coastal rivers (>75

miles) but not following any migratory trend. Larvae may be transported by oceanic currents great distances.

Reproduction

Starry flounder are oviparous; eggs are fertilized externally [94]. Spawning occurs annually in a short time frame in winter and spring, with the exact timing depending on location. In California, starry flounder spawn from November-February, peaking in December [94, 270]. In Puget Sound, spawning occurs from February-April, peaking in March [94, 114]. In British Columbia and the Gulf of Alaska, spawning occurs from February-May, peaking in early April [114]. In the Bering Sea, females of 15-19 inches produced between 900,000 and 2,500,000 eggs [260]. In California, a 22-inch fish had 11,000,000 eggs [270].

Growth and Development

Fertilized eggs are spherical and between 0.03 and 0.04 inch in diameter [114, 260]. Embryonic development is indirect and external. Eggs hatch in 2.8 days at 55° F, 4.6 days at 50° F, and 14.7 days at 36-42° F [94, 114, 300].

Larvae hatch at approximately 0.08 inch and float with their yolk sacs up [94, 114, 300]. The yolk sac is gone in 4-5 days, by the time the larvae reaches 0.24 inch [94]. Metamorphosis to the benthic juvenile form occurs at 0.4-0.5 inch [94, 299]. Sexually immature juveniles range in size from 0.4 to 18 inches, depending on sex [63, 114, 197, 270].

Females begin maturing at 9 inches and 3 years, but some may not mature until 18 inches and 4-6 years [94, 114, 197, 270]. Males begin maturing at 2 years and 9 inches, but some may not reach maturity until 4 years and 14 inches [94, 114, 197]. After 2 years, females grow faster than males and reach larger sizes. Maximum age is reported as 21 years [260].

Trophic Interactions

Larvae are planktivorous. Juveniles and adults are carnivorous. At 0.2-0.5 inch, larvae eat copepods, eggs and nauplii as well as barnacle larvae and diatoms [114, 300]. Small juveniles feed on copepods, amphipods and annelid worms [231]. Barry, et al., [26] reported that adult starry flounder in Elkhorn Slough, California fed on 87 different taxa of prey over one year, yet mollusks and infaunal worms made up >65% of their diet. Large fish fed on a wider variety of items, including crabs and other more mobile foods. In other areas, clams and benthic fishes are an important part of the starry flounder's diet [260]. Starry flounder do not feed during spawning or coldwater periods [260].

Larvae are eaten by larger fish and herons. Juveniles and adults are eaten by pinnipeds, larger fishes, sharks and marine mammals [260]. Wading and diving seabirds such as herons and cormorants feed on juvenile starry flounder [115].

Starry flounder probably competes with other soft-bottom benthic fishes of estuaries and shallow nearshore bays. It occasionally interbreeds with the English sole to produce a hybrid.

Starry Flounder Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur mainly from central California northward, in estuaries and at depths <492 feet, over soft bottoms.

Composites: estuarine, non-rocky shelf

Spawning Stage
Spawning occurs during winter and spring at depths <148 feet, over soft bottoms.

Composites: estuarine, non-rocky shelf

Juvenile Stage
Juveniles are demersal and occur at depths <328 feet, over soft bottoms.

Composites: estuarine, non-rocky shelf

Larval Stage
Larvae are pelagic and occur in waters <230 feet.

Composites: estuarine, neritic

Egg Stage
Eggs are pelagic and occur at depths from 66-230 feet.

Composites: estuarine, neritic

All life stages of estuarine EFH for starry flounder could be affected by all ODOT bridge replacement and repair activities. Estuarine EFH for starry flounder potentially affected by the Bridge Program includes sandy to muddy substrates to coarse substrates throughout estuaries including upriver portions of estuaries.

The adult, spawning, and juvenile stages of non-rocky shelf EFH for starry flounder could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for starry flounder potentially affected by the Bridge Program includes sandy to muddy substrates, and sandy to coarse substrates.

The ODOT Bridge Assessment will have no effect on neritic EFH for starry flounder.

BLACK ROCKFISH (*Sebastes melanops*)

Range
Black rockfish are found from southern California (San Miguel Island) to the Aleutian Islands (Amchitka Island), and they occur most commonly from San Francisco northward [114, 240, 296, 352]. Black rockfish occur throughout the area covered by this EFH analysis. Larvae and young juveniles are pelagic. Larger juveniles are demersal. They are found in nearshore habitats, including estuaries, over a variety of substrates including rocky or sandy bottoms and kelp or eelgrass beds (Stein and Hassler 1989). Adults are pelagic, and are usually associated with rocky bottoms and kelp. They may occur in estuaries (PFMC 1998bb).

Habitat
Black rockfish occur from the surface to greater than 1,200 feet; however, they are most abundant at depths less than 177 feet [352]. Off California, black rockfish make up the kelp-rockfish assemblage along with the blue, olive, kelp, black-and-yellow, and gopher rockfishes, and they are distinguished, to some degree, from offshore species [112]. However, they can occur far offshore [74]. Juveniles occur well up in the water column, usually near or in such shelter as kelp or pilings, though they may live in deeper waters in the winter [352]. Adults are also usually observed well up in the water column [112]. In the water column, the frequency of black rockfish occurring closer (<2 feet) to vertical Macrocystis fronds is significantly greater than that expected had they been randomly distributed [55].

Black rockfish larvae and young juveniles (<1.6-2.0 inches) are pelagic but are benthic at larger sizes [39, 175]. When benthic, juvenile black rockfish inhabit waters less than 66 feet and can occur over sand bottom [175]. As described by Stein and Hassler [352], juveniles in the kelp beds of Monterey Bay, California, live both in the canopy and on bottom, often associated with kelp holdfasts and sporophylls. They are recruited to the bottom primarily in June. Off Oregon, age-0 juveniles occur seasonally from June to October. The June transition from pelagic to benthic habitat is marked by a distinct inshore movement to estuaries, tidepools and nearshore depths of less than 66 feet. In nearshore areas of central California, postpelagic newly settled black rockfish were first observed at the seaward, sand-rock interface of nearshore reefs in depths of 20-66 feet. They are associated with crevices, sand channels among the rocks, or depressions in the reef [377]. Small juveniles occur in three habitats: pelagic individuals offshore at <2.4 inches SL in summer; nearshore on bottom at 1.6-2.8 inches SL in June, and in estuaries at 1.4-3.6 inches SL from April to October, often in eelgrass. Larger juveniles up to 6 inches may live in rocky holes. Black rockfish use low rock and high rock substrata during the summer recruitment period [55]. Juvenile black rockfish may inhabit intertidal eelgrass beds from March-October in Yaquina Bay, Oregon [39].

The abundance of black rockfish in shallow water declines in the winter and increases in the summer [352]. Densities of black rockfish decrease with depth during both the upwelling and non-upwelling seasons [112, 294]. Off Oregon larger fish seem to be in

deeper water (66-164 feet) [352]. Black rockfish are also found in the Strait of Juan de Fuca [60].

Migrations and Movements

Black rockfish off the northern Washington coast and outer Strait of Juan de Fuca exhibit no significant movement. However, fish appear to move from the central Washington coast southward to the Columbia River, but not into waters off Oregon. Also, movement displayed by black rockfish off the northern Oregon coast is primarily northward to the Columbia River [65]. Black rockfish form mixed sex, midwater schools, especially in shallow water [114, 352]. In the summer, schools of feeding black rockfish are commonly seen at the surface along the kelp-lined shores of the western Juan de Fuca Strait, particularly near Duncan Rock (about 1.7 miles north, northwest of Cape Flattery) [74]. Schools of black rockfish occur above shallow water British Columbia reefs only from June-September [352]. In kelp beds, larger adult black rockfish seem to migrate outside the kelp diurnally, returning before dusk; juveniles and small adults remain in the kelp and also tend to be closer to the bottom at night [352]. Black rockfish may travel up to 370 miles, but they usually remain in one area [352].

Reproduction

Black rockfish have internal fertilization and annual spawning [352]. Parturition occurs from February-April off British Columbia, January-March off Oregon, and January-May off California [39, 133, 352]. Spawning areas are unknown, but spawning may occur in offshore waters because gravid females have been caught well offshore [74, 114, 352].

Growth and Development

Age of 50% maturity for black rockfish off California is estimated at 7 years (Floyd 2003). Black rockfish can live to be more than 20 years in age. Off California males may be sexually mature at 3 years (10 inches); all are mature by 10 years (17 inches). Females off California may mature at 5 years (12 inches); all are mature by 11 years (19 inches). Off Oregon, males may mature in 5 years, and females in 6 years. The maximum length attained by the black rockfish is 24 inches [114, 352]. After age 7, females are larger than males of the same age [352].

Trophic Interactions

Off Oregon, black rockfish primarily prey on pelagic nekton (anchovies and smelt) and zooplankton such as salps, mysids, and crab megalops. Off central California, juveniles eat copepods and zoea, while adults prey on juvenile rockfish, euphausiids, and amphipods during upwelling periods; during non-upwelling periods they primarily consume invertebrates. Most feeding probably occurs during the day or at twilight [352]. Black rockfish feed almost exclusively in the water column [65]. Black rockfish have a dietary overlap with black-and-yellow rockfish, kelp rockfish, and gopher rockfish [112] and probably other species of Sebastes (Floyd 2003). Black rockfish are known to be eaten by lingcod and yelloweye rockfish.

Black Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
From the northern boundary of the EEZ to San Miguel Island, California, adults are pelagic throughout the water column to depths up to 1,200 feet, but most commonly up to 177 feet deep over rocky habitat and associated with kelp.

Composites: estuarine, neritic, oceanic

Mating Adult Stage
No specific information, but may occur offshore based on capture of gravid females.

Large Juvenile Stage
From the northern boundary of the EEZ to San Miguel Island, California, demersally over depths less than 66 feet and a variety of substrates, most commonly over rocky habitat and associated with kelp or eelgrass.

Composites: rocky shelf, non-rocky shelf

Small Juvenile Stage
Small juveniles occur in three habitats: pelagic individuals offshore in summer; nearshore on the bottom at depths less than 66 feet in early summer; and in estuaries from spring through fall, often in eelgrass.

Composites: estuarine, neritic, intertidal (draft)

Larval Stage
No specific information, but probably move from offshore to inshore waters as they develop.

Parturition
No information except timing: during winter and spring, but may occur offshore based on capture of gravid females.

The adult and small juvenile stages of estuarine EFH for black rockfish could be affected by all ODOT bridge replacement and repair activities. Estuarine EFH for black rockfish potentially affected by the Bridge Program includes pilings, rocky or sandy bottoms, and eel grass beds of estuaries. Larval black rockfish may occur in estuaries where ODOT bridge replacement and repair activities could take place, but no EFH composites have been designated for the larval stage.

The small juvenile stage of intertidal EFH for black rockfish could be affected by all ODOT bridge replacement and repair activities. Juvenile black rockfish may inhabit intertidal eelgrass beds from March-October in Yaquina Bay, Oregon (Boehlert and Yoklavich 1983).

The large juvenile stage of rocky shelf EFH for black rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for black rockfish potentially affected by the Bridge Program includes rocky bottoms and tidepools.

The large juvenile stage of non-rocky shelf EFH for black rockfish could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for black rockfish potentially affected by the Bridge Program includes sandy bottoms and eelgrass beds.

BLACK-AND-YELLOW ROCKFISH (*Sebastes chrysomelas*)

Range
Black-and-yellow rockfish are found from Eureka to central Baja California and are common from about Mendocino County southward to about San Diego [197].

Habitat
Black-and-yellow rockfish are considered a kelp forest or inshore rockfish species [112]. Black-and-yellow rockfish occur from the intertidal zone down to 121 feet [240], but are most common in waters <18 feet [197] in kelp beds and rocky areas [240].

Juvenile black-and-yellow rockfish live in the surface kelp canopy [123]. Young initially occupy the surface and mid-depth portions of the water column in very close proximity with the Macrocystis canopy. Gradually they migrate down the kelp stipes and assume a demersal existence in close proximity to benthic algal cover, and cracks and crevices within the rocky substratum. Once assuming a bottom residence, young apparently sequester in cracks and holes [112]. Black-and-yellow rockfish defend a shelter hole, which they inhabit during turbulent days, and a feeding area, where they rest in more exposed positions during calm days and at night [179]. They spend most of their time sheltering in rocky holes and crevices, or perching on the bottom in the open [178].

Migrations and Movements
Adults are demersal, sedentary residents [129]. Black-and-yellow rockfish are more active at dusk than during the daytime and are more active during the summer than winter [178]. They are territorial and agonistic encounters included simple chases, often accompanied by displays, sounds, and biting by the resident fish [178]. Black-and-yellows rockfish defend their territories from all but very small fish [179]. If artificially or naturally displaced up to 0.7 mile from their home site they have the ability to find their way back home and can do so relatively quickly [222]. Some movement may also occur with the pursuit of better habitat [222].

Reproduction
Black-and-yellow rockfish reach sexual maturity at 3-4 years, at sizes of 5 inches SL or greater [178]. Mating occurs from late January to early February. Females then carry eggs internally until hatching, which occurs from March-May [178].

Growth and Development
Planktonic larvae settle in their adult habitats in early summer [178]. Black-and-yellow rockfish grow to 15 inches [201] and have been aged to 21 years (Floyd 2003)

Trophic Interactions
Juvenile black-and-yellow rockfish pick zooplankton out of the water and fall prey to a variety of predators, including birds [123]. Small black-and-yellow rockfish eat zooplankton such as copepods and crab larvae [197] and larger ones eat crabs, shrimps, and occasionally fish and octopi [129, 178, 179, 197]. Black-and-yellow rockfish have a high similarity in diet with Sebastes melanops, S. atrovirens, and S. carnatus, owing to their common predation on juvenile rockfishes.

Black-and-Yellow Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur off California, primarily over rocky substrates at depths <121 feet, commonly associated with kelp.

Composites: rocky shelf

Mating Stage
Mating occurs from late January to early February, probably in adult habitat.

Composites: rocky shelf

Juvenile Stage
Juveniles live in the surface canopy of kelp beds off California.

Composites: rocky shelf, intertidal (draft)

Larval Stage
Larvae are pelagic and settle in adult habitats in early summer.

Composites: neritic

Parturition
Parturition occurs from March through May, probably in adult habitat.

Composites: rocky shelf

The juvenile stage of intertidal EFH for black-and-yellow rockfish could be affected by all ODOT bridge replacement and repair activities.

The adult, mating, juvenile, and parturition stages of rocky shelf EFH for black-and-yellow rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH

for black-and-yellow rockfish potentially affected by the Bridge Program includes intertidal rocky areas.

BLUE ROCKFISH (*Sebastes mystinus*)

Range
Blue rockfish are found from San Tomas, Baja California north as far as the Bering Sea, but their distribution is inconsistent north of Vancouver Island [114, 240]. Blue rockfish occur throughout the area covered by this EFH analysis. Adults are demersal and are usually found over rocky substrates from 82 to 131 feet. They are strongly associated with kelp beds (Lea 1992). Larvae and young juveniles are pelagic and are found in nearshore waters. All other life stages are demersal.

Habitat
Off California, blue rockfish reportedly range in depth from tidepools to 328 feet, but adults are usually taken over rocky depths of 82 to 131 feet [134]. They are not caught in large numbers south of the Channel Islands or north of Eureka, California [134]. Blue rockfish adults have been found in water as deep as 1,800 feet [114] and show a strong affinity for kelp forests [182].

Larvae and early-stage juveniles are pelagic, whereas older juveniles, subadults and adults are semi-demersal or demersal [200]. Larvae live in the surface waters for several months. In nearshore areas of central California, postpelagic newly settled blue rockfish were first observed at the seaward, sand-rock interface of nearshore reefs in depths of 20-66 feet. They were associated with crevices, sand channels among the rocks, or depressions in the reef [377]. Juveniles appear, often in massive swarms, in the kelp canopy and shallow rocky areas by April or May [134]. Adults are most common over deep rocky reefs, but are also found over hard, flat substrates [199].

Movements and Migrations
As described by Houk [134] in inshore kelp bed areas, blue rockfish form loose to compact aggregations. They can also often be found as solitary, wandering individuals moving in and about the kelp or swimming along with other rockfish species, such as olive, black, and kelp rockfishes. Under dense kelp canopies, they will sometimes form a column as wide as 13 feet and as deep as 82 feet. In deeper waters, they form dense aggregations that may extend from the surface to the bottom, but are usually in the mid-depth levels from 59 to 118 feet.

Blue rockfish are not considered to be a migratory species. Love et al. [199] report that movements that do occur are most likely related to changes in water temperature or water turbulence. Early life history stages are generally found in shallower water than adults, suggesting a movement toward deeper water with age. Diel movements have been noted, with the fish moving slightly off the bottom during the day to feed [199].

Reproduction
Blue rockfish are ovoviviparous [94]. In southern California, mating begins in November and continues through early spring [199].

A 9-inch female may give birth to as many as 50,000 larvae, and a 13-inch female may give birth to as many as 300,000 larvae [94]. Hart [114] reported that fecundity may be as high as 524,000 larvae, but it was not specified if this was over a whole breeding season or in a single birthing event. Blue rockfish may give birth twice in a breeding season [199].

Growth and Development
Embryonic development is internal, and larvae are born at about 0.14 inch [94]. Larvae are considered juveniles after acquiring a full complement of meristic characters, but specific lengths or ages for this were not found.

Wyllie Echeverria [398] estimated that 50% of males are mature at age 5 and 50% of females at age 6. Nearly all are mature by age 11 (Floyd 2003).

Trophic Interactions
Tunicates, hydroids, jellyfishes, and larval and juvenile fishes of many species are the main prey items of the blue rockfish [114, 200, 208]. Juvenile blue rockfish prey heavily on all life stages of calanoid copepods and euphausiids [112]. The blue rockfish competes with other species of rockfishes for space and food; two of the main competitors are the kelp bass and olive rockfish.

Blue Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are generally demersal and occur mainly off northern and central California, at depths <328 feet, commonly associated with rocky reefs and kelp.

Composites: rocky shelf

Mating Stage
Mating occurs from November through early spring, probably within adult habitat.

Composites: rocky shelf

Large Juvenile Stage
Large juveniles are generally demersal and occur mainly off northern and central California.

Composites: rocky shelf, non-rocky shelf

Small Juvenile Stage
Small juveniles are pelagic in nearshore areas.

Composites: neritic, intertidal (draft)

Larval Stage
Larvae are pelagic in surface waters.

Composites: neritic

Parturition
No information.

The small juvenile stage of intertidal EFH for blue rockfish could be affected by all ODOT bridge replacement and repair activities. The adult, mating, and large juvenile stages of rocky shelf EFH for blue rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for blue rockfish potentially affected by the Bridge Program includes rocky areas and tidepools.

The large juvenile stage of non-rocky shelf EFH for blue rockfish could be affected by ODOT bridge replacement and repair activities.

BOCACCIO (*Sebastes paucispinis*)

Range
Bocaccio are found in the Gulf of Alaska off Krozoff and Kodiak Islands, south as far as Sacramento Reef, Baja California [114, 240]. Bocaccio have been taken from the Alaska Peninsula to central Baja California, but have been most abundant historically from Oregon to northern Baja California. Currently, there are just a few sites that still hold numbers of bocaccio, off British Columbia, along the southern California coast, and off northern Baja. These sites probably represent the remnants of a once-coastwide bocaccio population. Adults are most abundant in 164-820 feet water depth, and juveniles generally occur at shallower depths. Bocaccio recently have been identified as a candidate for National Marine Fisheries Service's (NMFS) List of Endangered and Threatened Species (ETS).

Larval and juvenile Bocaccio are found within the area covered by this EFH analysis. Larvae and small juvenile bocaccio are pelagic and may occur in estuaries and other nearshore habitats. All other life stages are parademersal (Sakuma and Ralston 1995b) and are associated with a variety of habitats including eelgrass and kelp beds, rocky bottoms, and firm sand-mud substrates (PFMC 1998bb).

Bocaccio achieve a maximum size of 36 inches and, although difficult to age, conceivably live to about 50 years old. The age of female bocaccio about 34 inches in length recently has been validated to be 30 years using radiochemical techniques (Cailliet et al. 1999). Females probably live longer than males, and are sexually mature starting at

about 3 years old. Fifty percent of the females off southern California are mature at 1.4 inches in length, and all are mature by 17 inches; size at maturity increases northward with females off Oregon just beginning to mature at 21 inches in length. As with most other fishes, fecundity of bocaccio increases exponentially with age and size; while a female of 15 inches in length produces about 20,000 eggs per year, a 30-inch long female can produce 2.3 million young every year.

Bocaccio have infrequent recruitment success; in most years relatively few young survive to reproductive age. It is likely that an outstanding year class may occur only once in about 20 years. For example, the last strong year class for bocaccio was 1977, which has been harvested since the early 1980s. Recruitment success is linked to environmental factors (Ralston and Howard 1995), and has been depressed since the onset of coastal ocean warming in the late 1970s. To sustain the resource, spawning biomass needs to be high enough to produce a large year class during those few years when environmental conditions are conducive to high recruitment success.

Habitat

The bocaccio is classified as a middle shelf-mesobenthal species [12]. In survey catches, Allen and Smith [12] found bocaccio to be most common at 328-492 feet over the outer continental shelf; nearly all were between 164 and 984 feet. Sakuma and Ralston [328] categorized bocaccio as both a nearshore and offshore species. Larvae and small juveniles are pelagic; large juveniles and adults are semi-demersal [94]. Larvae and small juveniles are commonly found in the upper 328 feet of the water column, often far from shore [230]. They are most often found in shallow coastal waters over rocky bottoms associated with algae [328]. Postpelagic newly settled larvae in central California are first observed associated with the giant kelp canopy, but are also seen throughout the water column [377]. Adults are commonly found in eelgrass beds, or congregated around floating kelp beds [201, 328]. Young and adult bocaccio also occur around artificial structures, such as piers and oil platforms [230]. Although juveniles and adults are usually found around vertical relief, adult aggregations also occur over firm sand-mud bottoms [230]. Juvenile bocaccio also have been reported in 26-66 feet in Diablo Canyon [201].

All life stages of bocaccio are found in euhaline waters, and may congregate in local areas of high salinity [328]. Warm temperatures are preferred, at least by larvae; Sakuma and Ralston [328] found highest larval densities in water 54° F or higher. Bocaccio reportedly occur in typical marine waters with salinities of 31 to 34l, temperatures of 43-60° F and dissolved oxygen concentrations of 1.0 to 7.0 ppm [230]. Pelagic larval and juvenile bocaccio are found in surface waters from nearshore to as far offshore as 300 miles. They often associate with drifting kelp, and settle to benthic nearshore habitats after 3-5 months. Juveniles occur over rocks and sand patches with vegetation; in some years high numbers of young bocaccio recruit to oil platforms and piers off southern California. Juveniles (8-9 inches long) tagged in water <180 feet moved up to 92 miles over 2 years as they settled to deeper habitats (443-722 foot depth); (Hartmann 1987 *in* Floyd 2003). Significant movements of adults have not been documented, but it is conceivable that young adults (14-24 inches long) move limited distances (of 16 tagged

fish, 6 stayed in the 4 mile^2 study area at least 45% of the time; 5 stayed in the area more than 75% of the time; 10 bocaccio occupied the study area less than 10% of the time; Floyd 2003). Adults aggregate over rocks of relatively high relief, and have been observed well off the bottom in mixed-species groups of chilipepper, and widow, canary, and vermilion rockfishes. The largest individuals of the population likely are sedentary and most abundant under rock ledges and in crevices of boulder fields, in association with lingcod, cowcod, and greenspotted and yelloweye rockfishes (Yoklavich et al. In Press).

Movements and Migrations

Adult bocaccio may move more than 1.2 miles per day and they are known to be transient around oil platforms around Santa Barbara, California; large aggregations may remain near a platform for months and then disappear suddenly [230]. Also, large adults disappear from traditional commercial fishing grounds during winter spawning and reappear in the spring [230]. Bocaccio move into shallow waters during their first year of life [114], then move into deeper water with increased size and age [94].

Reproduction

Bocaccio are ovoviviparous [94, 114]. Love et al. [201] reported the spawning season to be protracted and last almost year-round (>10 months). Parturition occurs during January to April off British Columbia and Washington, November to March off northern and central California, and October to March off southern California [230]. In California, bocaccio may become pregnant in October, give birth in November, and prepare immediately for a second brood to be born in March [94, 114]. Two or more broods may be born in a year in California [201]. The spawning season is not well known in northern waters. Although age-at-size calculations were not given, a 15-inch female may give birth to 20,000 young, while a 30-inch specimen may give birth to 2.3 million young [94, 114]. MacGregor [209] estimated that a female produces 339 eggs/gram of body weight.

Growth and Development

Mature eggs measure about 0.02 in diameter [94]. Eggs develop for 40-50 days in the ovary, hatch, and yolkless larvae are released about one week later at 0.16-0.24 inch [94, 114]. Larvae remain pelagic for up to 150 days [328, 396]. Metamorphosis to a semi-demersal juvenile stage occurs near 1.2 inches TL [94, 114]. Males mature at 3 to 7 years with 50% mature in 4 to 5 years. Females mature at 3 to 8 years with 50% mature in 4 to 6 years [230].

Trophic Interactions

Larval bocaccio often eat diatoms, dinoflagellates, tintinnids, and cladocerans [364]. Copepods and euphausiids of all life stages (adults, nauplii and egg masses) are common prey for juveniles [364]. Adults eat small fishes associated with kelp beds, including other species of rockfishes, and occasionally small amounts of shellfish [364]. Bocaccio probably locate prey by sight and feed mostly at night [230]. Bocaccio are eaten by sharks, salmon, other rockfishes, lingcod and albacore, as well as sea lions, porpoises, and whales [230]. Bocaccio directly compete with chilipepper and widow, yellowtail, and shortbelly rockfishes for both food and habitat resources.

Bocaccio Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are parademersal all along the west coast, at depths from 164-984 feet, commonly associated with rocky habitat and kelp.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Mating Stage
No information.

Large Juvenile Stage
Large juveniles occur at depths from 0 to 984 feet.

Composites: rocky shelf, non-rocky shelf, canyon, continental slope/basin

Small Juvenile Stage
Small juveniles are pelagic and usually occur in the top 328 feet of water.

Composites: estuarine, neritic

Larval Stage
Larvae are pelagic and usually occur in the top 328 feet of water.

Composites: estuarine, neritic

Parturition:
Parturition occurs during fall through spring. Insufficient information to define EFH

The small juvenile and larval life stages of estuarine EFH for bocaccio could be affected by all ODOT bridge replacement and repair activities. Estuarine EFH for bocaccio potentially affected by the Bridge Program includes rocky bottoms associated with algae or rocks and sand patches with vegetation.

The adult and large juvenile stages of rocky shelf EFH for bocaccio could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for bocaccio potentially affected by the Bridge Program includes rocks, rock ledges, and boulder fields.

The adult and large juvenile stages of non-rocky shelf EFH for bocaccio could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for bocaccio potentially affected by the Bridge Program includes firm sand-mud bottoms and sand patches with vegetation.

BROWN ROCKFISH (*Sebastes auriculatus*)

Range
Brown rockfish are found from central Baja, California to southeastern Alaska [81, 114, 197, 225, 240, 352]. Brown rockfish occur throughout the area covered by this EFH analysis and are common in shallow water areas, including bays and estuaries (PFMC 1998bb). Estuaries are used as nursery grounds, and young fish are typically found in shallower waters than adults. Brown rockfish are demersal and are usually found over hard substrates (Lea 1992).

Habitat
Brown rockfish are common in shallow water [224, 225] and occur from the surface to 420 feet [81]. However, they are most common from 20 feet down and are widely distributed in shallow water bays [197]. Juveniles usually live in shallower water than adults [197]. Brown rockfish use estuaries as nursery grounds [352] and they are common in Puget Sound [114]. There, brown rockfish initially settle at 0.71-0.99 inch TL, to shallow, vegetated habitats such as beds of kelp or eelgrass [386]. Off California, young brown rockfish recruit to hard substrate and low (<3 feet) relief reefs [199]. Brown rockfish are bottom dwellers, living on hard bottom such as low profile siltstone [182] or sand. They aggregate near rocks, oil platforms, sewer pipes, and even old tires [197, 225]. Off California, some frequent sewer outfalls [352]. In Puget Sound, highest densities are reported on artificial reefs, natural reefs, and rock piles in water less than 98 feet [225]. In California they are primarily found on sandy, low-relief areas [225]. Adults occupy higher-relief portions and young-of-the-year occupy lower-relief portions [386].

Brown rockfish maintain small home ranges on high relief rocky reefs and display strong reef fidelity that is not affected by season. On artificial reefs in Puget Sound, they maintain small home ranges (most within 323 feet^2). In the summer, artificial reefs become less suitable and considerable off-reef movement occurs. On low relief reefs, they maintain considerably larger home ranges (most within 4,300 feet^2 and some up to 16,150 feet^2). The low relief reefs are only inhabited during the summer and brown rockfish only return to low relief reefs in the summer coincident with peak algal cover [224]. Because brown rockfish inhabit shallow water, they are exposed to a relatively broad range of seasonal temperature variations, of at least 50° F-63° F [352]. Their capacity for acclimation is higher than that of rockfishes living below the thermocline and they can tolerate higher temperatures to at least 72° F [352]. Occurrence in estuaries and oceanic waters suggests a relatively broad salinity tolerance [352].

Migrations and Movements
Movements of greater than 2 miles are rare for brown rockfish [216, 224] and they are said to have a strong homing tendency [197]. Juveniles gradually move into deeper water as they mature [197].

Reproduction
Off Oregon, 50% of brown rockfish mature at 12 inches (5 years) and all are mature at 15 inches (10 years) [197]. Brown rockfish mate in March and April in Puget Sound [352].

In Puget Sound they are carrying young in May and probably give birth in June [114]. Off Oregon, spawning occurs in May and June; the spawning season is longer off central California, at least from December to July [197]. Also, off California females spawn more than once per season [197]. In Puget Sound they spawn once per year [352]. A 12-inch female brown rockfish produces approximately 52,000 young and a 19-inch female produces 339,000 [114].

Growth and Development
Brown rockfish are 0.20-0.23 inch in length at birth [352]. Brown rockfish can grow to a length of 22 inches [114, 197]. Brown rockfish measuring 20 inches have been aged at 18 years [197]. Males and females probably grow at the same rate and mature at similar ages and lengths [197].

Trophic Interactions
Brown rockfish eat small fishes, crabs, shrimps, isopods, and polychaetes.

Brown Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur all along the west coast, at depths <420 feet, often associated with rocky habitat.

Composites: estuarine, rocky shelf

Mating Stage
Mating apparently occurs during late winter and spring, probably within adult habitat.

Composites: estuarine, rocky shelf

Juvenile Stage
Juveniles usually occur in similar habitats, but shallower water than adults.

Composites: estuarine, rocky shelf

Larval Stage
Insufficient information to define EFH

Parturition:
Parturition occurs from winter to summer, probably within adult habitat.

Composites: estuarine, rocky shelf

The adult, mating, juvenile, and parturition life stages of estuarine EFH for brown rockfish could be affected by all ODOT bridge replacement and repair activities. Estuarine EFH for brown rockfish potentially affected by the Bridge Program includes shallow, vegetated habitats such as beds of eelgrass, on hard bottom such as low profile siltstone or sand, near sand-rock interfaces

and rocky bottoms of artificial and natural reefs, in eelgrass beds; near sewer pipes or old tires, on rock piles, or over sandy, low-relief areas (young-of-the-year) in shallow water.

The adult, mating, juvenile, and parturition stages of rocky shelf EFH for brown rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for brown rockfish potentially affected by the Bridge Program includes hard substrates, low relief rocky reefs, low profile siltstone, and rock piles.

CANARY ROCKFISH (*Sebastes pinniger*)

Range
Canary rockfish are found between Cape Colnett, Baja California, and southeastern Alaska. Canary rockfish occur throughout the area covered by this EFH analysis. Canary rockfish inhabit shallow water when they are young and deep water as adults (Mason 1995). Larvae and juveniles are pelagic and can occur from tide pools to beyond the continental shelf (Richardson and Laroche 1979). Adults are demersal and are associated with hard bottom substrates. They mainly occur beyond the territorial sea boundary, but some occur in the deeper portions of Oregon's waters.

Habitat
Canary rockfish are considered a middle shelf-mesobenthal species [12]. There is a major population concentration of canary rockfish between latitude 44E30' and 45EN off Oregon [311]. Canary rockfish have a depth range from the surface (juveniles) to 900 feet [36, 114, 197], but primarily inhabit waters 300-600 feet deep [37]. Larvae and juveniles are pelagic [37, 311]. Larvae can be captured over a wide area, from 8-190 miles offshore, and pelagic juveniles occur mostly beyond the continental shelf [311]. Young-of-the-year rockfish can also be found in tide pools [197].

Canary rockfish inhabit shallow water when they are young and deep water as adults [216]. Canary rockfish are associated with pinnacles and sharp drop-offs [197]. They are also found near, but usually not on the bottom, often associating with yellowtail, widow, and silvergray rockfish [197]. Canary rockfish are most abundant above hard bottoms [37]. In the southern part of its range, the canary rockfish appears to be a reef-associated species [36]. In central California, newly settled canary rockfish are first observed at the seaward, sand-rock interface and farther seaward in deeper water 60-80 feet. They are often seen hovering above sand or small rock piles [377].

Migrations and Movements
Canary rockfish are densely aggregating fish [197]. Juveniles descend into deeper water as they mature [197]. Canary rockfish appear to move deeper with age and also are capable of major latitudinal movements.

Reproduction
Canary rockfish are ovoviviparous and have internal fertilization [37, 311]. Off California, canary rockfish spawn from November-March and from January-March off Oregon, Washington, and British Columbia [114, 197, 311]. A wide range in larval sizes

over a broad time span indicates that canary rockfish may have protracted and variable spawning [311].

The age of 50% maturity of canary rockfish is 9 years; nearly all are mature by age 13 (Floyd 2003). Maximum age has been estimated as 60 years [4] to 75 years (Floyd 2003).

Growth and Development
The mean length of newly extruded canary rockfish larvae is 0.14 inch SL [311]. The transformation to pelagic juvenile occurs at sizes greater than 0.5 inch SL. Transformation to benthic juveniles occurs after 2.3 inches, during June-August [311]. Canary rockfish growth does not vary with latitude [37]. The maximum length canary rockfish grow to is 30 inches [37, 114, 197].

Off California, about 50% of the population is mature at 14 inch (5 or 6 years). A 19-inch long female carries approximately 260,000 young and fish 21- to 26-inch long carries about 1,900,000 young [114]. Canary rockfish can live to be 75 years old. A 10-year-old canary rockfish is approximately 20 inch SL [197]. After age 11, females grow faster than males and mature at a larger size, but males live longer [36, 40, 197].

Trophic Interactions
Canary rockfish primarily prey on planktonic creatures, such as krill, and occasionally on fish [197]. Canary rockfish feeding increases during the spring-summer upwelling period when euphausiids are the dominant prey and the frequency of empty stomachs is lower.

Canary Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are associated with the bottom at depths from 328-656 feet all along the west coast,

Composites: rocky shelf, continental slope/basin

Mating Stage
No information.

Large Juvenile Stage:
Insufficient information to define EFH.

Small Juvenile Stage:
Pelagic juveniles occur from near shore to beyond the continental shelf.

Composites: neritic, oceanic, intertidal (draft)

Larval Stage
Larvae occur from 8-190 miles offshore.

Composites: neritic, oceanic

Parturition
Parturition occurs from November through March, probably within adult habitat.

Composites: rocky shelf, continental slope/basin

The small juvenile stage of intertidal EFH for canary rockfish could be affected by the Bridge Program. The adult and parturition life stages of rocky shelf EFH for canary rockfish may be affected by the Bridge Program, although adults are usually found at depths of 328 feet or more.

CHILIPEPPER (*Sebastes goodei*)

Range
Chilipepper are found from Magdalena Bay, Baja California, to as far north as the northwest coast of Vancouver Island, British Columbia [12, 114, 240]. Chilipepper occur in the area covered by this EFH analysis. They are more common from southern Oregon southward. Adults are parademersal and frequent rocky reefs as well as sand and mud bottoms. They are mainly located in the deeper portions of Oregon's territorial sea (164-1,150 feet). Larvae and small juveniles are pelagic and are frequently associated with kelp beds (Love et al. 1990). Larvae and juveniles inhabit shallower, nearshore waters.

Habitat
Allen and Smith [12] define chilipepper as a middle shelf mesobenthal to outer shelf species. Chilipepper have been taken as deep as 1,390 feet, but nearly all in survey catches were taken between 164 and 1,150 feet [12]. They are considered to be a parademersal species.

Adults and older juveniles usually occur over the shelf and slope; larvae and small juveniles are generally found near the surface. In California north of Point Conception, age-0 chilipepper are found from the surface to 26 feet around inshore rocky reefs during the summer [230]. Larvae and juveniles are associated with kelp canopies, but not as frequently as other rockfish species [201]. Juveniles are primarily found in 98-164 feet of water and are pelagic [201]. In California, chilipepper are most commonly found associated with deep, high relief rocky areas and along cliff drop-offs [201], as well as on sand and mud bottoms [230]. They are occasionally found over flat, hard substrates [201]. Juvenile chilipepper have been reported in 26-66 feet in Diablo Canyon [201] Chilipepper are found in water with salinities of 32 to 34l, temperatures of 41° F to 77° F, and at dissolved oxygen levels of 1.0 to 6.8 ppm [230].

Movements and Migrations
Love [196] does not consider this to be a migratory species. However, movements of up to 1.5 miles per day have been recorded [196]. Chilipepper may migrate as far as 148 feet off the bottom during the day to feed [196]. Chilipepper also school by sex just prior to spawning [230].

Reproduction
Chilipeppers are ovoviviparous, and eggs are fertilized internally [308]. In California, fertilization of eggs begins in October. Spawning occurs from September to April [267]; peak spawning is December to January [201]. Chilipepper may spawn multiple broods in a single season [201]. A 12-inch female may give birth to as many as 29,000 larvae [114]. Hart [114] also found that a 20- to 22-inch female may give birth to as many as 538,000 young, but Love, et al. [201] found this number to be significantly too high.

Growth and Development
Eggs develop internally for 40-50 days [308]. Larvae are extruded at 0.18-0.23 inch in length [326]. Larvae are considered to be juveniles typically around 0.9-1.0 inch in length [326]. Females of the species are significantly larger, reaching lengths of up to 22 inches [114]. Males are usually smaller than 16 inches [67].

Males mature at 2 to 6 years of age and 50% are mature at 3 to 4 years. Females mature at 2 to 5 years with 50% mature at 3 to 4 years [230]. Females may attain an age of about 27 years whereas the maximum age for males is about 12 years [230].

Trophic Interactions
Larval and juvenile chilipepper eat all life stages of copepods and euphausiids, and are considered to be somewhat opportunistic feeders [308]. In California, adults prey on large euphausiids, squid, and small fishes such as anchovies, lanternfish and young hake [114, 201]. Chilipepper are found with widow rockfish, greenspotted rockfish, and swordspine rockfish [201]. Juvenile chilipepper compete for food with bocaccio, yellowtail rockfish, and shortbelly rockfish.

Chilipepper Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are parademersal and occur mainly from southern Oregon southward, at depths from 164-1,150 feet.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Mating Stage
Insufficient information to define EFH.

Large Juvenile Stage
Large juveniles are parademersal and usually occur over the shelf and slope, probably in the same habitat as adults.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Small Juvenile Stage
Small juveniles are pelagic and primarily occur at depths of 98-164 feet in inshore areas.

Composites: neritic

Larval Stage
Larvae are pelagic and often are associated with kelp canopies.

Composites: neritic

Parturition
Parturition occurs from September to April, probably within adult habitat.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

The adult, large juvenile, and parturition stages of rocky shelf EFH for chilipepper could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for chilipepper potentially affected by the Bridge Program includes rocky reefs.

The adult, large juvenile, and parturition stages of non-rocky shelf EFH for chilipepper could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for chilipepper potentially affected by the Bridge Program includes sand and mud bottoms.

CHINA ROCKFISH (*Sebastes nebulosus*)

Range
China rockfish occur from southeastern Alaska southward to Redondo Beach (southern California) on the mainland and San Miguel Island offshore [81, 86, 197, 203]. China rockfish is a nearshore species and occur throughout the area covered by this EFH analysis. Larvae are pelagic but all other life stages are demersal, associated with rocky bottoms and reefs from 10- 420 feet (Eschmeyer et al. 1983).

Habitat
China rockfish occur both inshore and along the open coast [81] from 10- 420 feet [81, 114, 197]. They are taken in water less than 302 feet [114]. China rockfish occur among rocks and reefs [81]. They spend virtually all their time sitting on the bottom, often sheltering in crevices [197]. China rockfish are sedentary, probably a territorial species [81, 197].

Off southeastern Alaska, China rockfish occur in semi-protected habitats, but seem to prefer high-energy or more exposed environments and divers frequently observed them around high-relief rocky reefs, submerged wave-cut platforms and boulder fields. Juvenile China rockfish inhabited shallow subtidal waters during summer and early fall [321].

Migrations and Movements
They remain close to home crevices and take shelter when disturbed [114, 197].

Reproduction
Male and female China rockfish mature at the same size: half are mature at 11 inches and all are mature at 12 inches [197]. Spawning occurs from January-July throughout most of its range, with a January peak [197].

Growth and Development
China rockfish grow to 17 inches [81, 197].

Trophic Interactions
Prey taxa of the China rockfish off southeastern Alaska includes brittle stars, rock crabs, decorator crabs, brachyuran crab larvae, caridean shrimps, hermit crabs, and fish remains. Most observed feeding was directed toward the bottom as China rockfish forage on sedentary invertebrates comprising the living turf [322]. Off Oregon they consume crustaceans, particularly decorator or spider crabs, and rock crabs [322]. Off California, China rockfish consume crustaceans (primarily brachyuran crabs), octopi, abalones, chitons, fishes, and brittle stars (Floyd 2003). China rockfish are dietary specialists and have the greatest dietary similarity with quillback rockfish.

China Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur all along the west coast at depths from 10-420 feet, commonly associated with rocky habitat.

Composites: rocky shelf

Mating Stage
No information.

Juvenile Stage
Juveniles can occur in shallow, subtidal waters and probably occur within other adult habitat.

Composites: rocky shelf

Larval Stage
Larvae are pelagic and probably neritic.

Composites: neritic

Parurition:
Young are released from January - June throughout most of its range.

Composites: rocky shelf

The adult, juvenile, and parturition life stages of rocky shelf EFH for China rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for chilipepper potentially affected by the Bridge Program includes high-relief rocky reefs, submerged wave-cut platforms and boulder fields.

COPPER ROCKFISH (*Sebastes caurinus*)

Range

Copper rockfish are found from the Gulf of Alaska southward to central Baja California [81, 197, 226, 352]. Copper rockfish is a nearshore species and occur throughout the area covered by this EFH analysis. Larvae and small juveniles are pelagic but all other life stages are demersal, associated with rocky and rock-sand bottoms from 0 – 600 feet (Eschmeyer et al. 1983). Bays and estuaries are used as nursery areas (Stein and Hassler 1989). Copper rockfish are closely associated with reefs or vegetation (Matthews 1990).

Habitat

Adult copper rockfish occur in nearshore waters, reportedly from the surface to 600 feet [81, 352]. Copper rockfish are somewhat shallower during upwelling [352]. Juvenile copper rockfish tend to live in shallower water, up to about 20 feet [197]. Copper rockfish may use bays as nursery areas [352]. They are relatively abundant in Puget Sound [24] and are common throughout the San Juan Islands and the Strait of Juan de Fuca [225].

Copper rockfish are considered habitat generalists [225]. Young-of-the-year copper rockfish initially occupy a greater diversity of habitats off British Columbia than California; kelp forests are an especially important habitat during this phase [111]. In central California juveniles are closely associated initially with the surface and mid-depth Macrocyctis kelp beds [352]. Off British Columbia, juveniles have been found riding in gooseneck barnacles on floatsam [352]. In Puget Sound, small young-of-the-year copper rockfish are first observed in October, near the base of rockpiles or under pieces of bark or fronds of kelp lying on the bottom [275].

Copper rockfish are common in rocky areas or on rock-sand bottoms in shallow water [81, 111, 352]. Copper rockfish are never observed on an exclusively sand bottom [275, 352]. They are found on natural rocky reefs, artificial reefs, and rock piles; typically found directly on the bottom, closely associated with reefs or vegetation [226]. In a study off British Columbia [253], copper rockfish were observed within 10 feet of quillback rockfish 92% of the time. They have even been sighted sharing caves with giant Pacific octopus [197]. Copper rockfish hide in rock interstices in the winter but not in the summer [275]. Fish within rockpiles are inactive and maintain contact, even curving their bodies around rocks [275]. From July to October, when bull kelp is the most dense, few copper rockfish are seen in the rock interstices, but they are always within 3 feet of the rocks perimeter [275]. On high relief rocky reefs they maintain small home ranges (most within a 323-feet^2 area), yet returned to their home sites when experimentally displaced up to 4 miles in an underwater tag-resighting study. On low relief reefs, they have larger home ranges [226]. These low relief reefs are only inhabited by copper rockfish during

the summer, coincident with the densest kelp cover; in fall and winter when algal cover is reduced, low relief reefs appear quite barren [224]. Copper rockfish do not seem to defend their territories. They assess habitat quality on the presence of structure, protective cover, mates, and food, not on presence of predators [224]. Copper rockfish also avoid warm water by living in deeper depths off southern California (usually below 180 feet) than farther north. Conversely, off British Columbia, they are found in quite shallow water, mostly less than 59 feet [197].

Migrations and Movements

Copper rockfish may move inshore to release their young [224]. Once adults find a good reef, many do not seem to move about much [197, 352]. In northern waters, copper rockfish probably withdraw in winter deep within crevices to avoid storms [197].

Reproduction

Off central California, male copper rockfish may be sexually mature at 3 years of age (12 inches); all are mature by 7 years (16 inches). All females are mature off central California by 8 years (16 inches). In Puget Sound, Washington, sexual maturity occurs at age 4, but occasionally at age 3 [352].

Copper rockfish spawn once per year. In Puget Sound, Washington eggs mature by February. Fertilization occurs from March to May off Washington. Egg production ranges from 15,000 eggs in a 9-inch female to 640,000 in one 18-inch long [114, 352]. Parturition occurs from April to June in Puget Sound [225], from February to April south of British Columbia, and from March to July in southeastern Alaska [197].

Growth and Development

Young are pelagic as larvae and measure 0.19-0.24 inch in length at birth; they remain pelagic until 1.6-2.0 inches SL [352]. Copper rockfish are slow growing and live to 55 years [225]. They can grow to 22 inches in length [81, 352]. In Humboldt Bay, California, fish are 4-6 inches long as underyearlings, 5-8 inches at age one year, 7-9 inches at age two, and 9-12 inches at age three [352]. Growth rates are highest during the summer, coinciding with high feeding rates and upwelling [352].

Trophic Interactions

Copper rockfish are opportunistic carnivores. Crustaceans, followed by fish and molluscs, are the most important food groups of the copper rockfish in terms of volume, number, and frequency of occurrence. In Humboldt Bay, juvenile Dungeness crabs were the most important individual food item in terms of volume and frequency of occurrence [302]. Off British Columbia, they feed on herring, kelp perch, pile perch, squat lobsters, coonstriped shrimp, and to a lesser extent mysids [252]. Demersal crustaceans are important prey throughout all seasons, increasing in occurrence from winter to fall [252].

Generally, copper rockfish rely less on reef associated food organisms as their age (size) increases [352]. Copper rockfish feed during the day and at night [302, 352]. In Humboldt Bay, northern anchovy comprises the largest portion of fish in the copper rockfish diet; shiner perch is also important. Smaller copper rockfish (<1.8 inch SL) in

the kelp canopy eat primarily calanoid copepods, with some harpacticoids and zoea. Fish 4-5 inches eat small crustaceans such as amphipods, shrimp, caprellids, isopods, and pinnixid crabs. Copper rockfish 1-3 years old eat juvenile Dungeness crab and anchovies, with fish increasing and crustaceans decreasing as the fish grow.

Copper Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur in estuaries and all along the west coast at depths from 0-600feet, associated with rocky reefs or vegetation.

Composites: estuarine, rocky shelf

Mating Stage
Mating may occur from late winter through spring. Insufficient information to define EFH.

Large Juveniles
Large juveniles probably occupy adult habitats.

Composites: estuarine, rocky shelf

Small Juveniles
Small juveniles live in estuaries and shallow waters, often associated with the surface and mid-depth kelp beds.

Composites: estuarine, neritic

Larval Stage
Insufficient information to define EFH.

Parturition
Young are released inshore, mainly during winter and spring.

Composites: estuarine, neritic

The adult, large juvenile, small juvenile, and parturition stages of estuarine EFH for copper rockfish could be affected by all ODOT bridge replacement and repair activities. Estuarine EFH for copper rockfish potentially affected by the ODOT Bridge Assessment includes sandy areas in shallow habitats, eelgrass beds, cobble near the base of rockpiles, sand and low rock formations, in rocky areas, and on rock-sand bottoms in shallow water.

The adult and large juvenile stages of rocky shelf EFH for copper rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for copper rockfish potentially affected by the ODOT Bridge Assessment includes rocky and rock-sand bottoms, rocky reefs, and rock piles.

GOPHER ROCKFISH (*Sebastes carnatus*)

Range
Gopher rockfish are common and range from Eureka, California, to San Roque, Baja California [159, 240].

Habitat
Gopher rockfish generally occur in waters <98 feet [55] but have been taken as deep as 180 feet [159]. Gopher rockfish are shallow-water benthic rockfishes that inhabit rocky reefs. They spend the majority of their time during the day in rocky shelters [177] and at night (and to a lesser degree during the day) perching on the bottom in the open [178]. Home ranges of gopher rockfish consist of a primary shelter hole and a larger, feeding area in which they often rest in more exposed positions. The home range size increases with fish size and depth [178]. Both the young-of-the-year and adults rest on the bottom. Young gopher rockfish prefer low rock relief or sand bottoms. They are closely associated with algae and are distributed equally among drift algae and *Macrocystis*. During and after fall storms, they shift to crevices within high relief rock and are less associated with algae [55]. Early gopher rockfish recruits (planktonic larvae) initially occur in the surface canopy in late May and increase in density through July. By July, individuals at mid-depth and on the bottom are larger. As density decreases in the surface canopy, it increases at mid-depth and on the bottom, indicating a gradual movement from surface to bottom in a 1-month period [55]. Adult territories, in rocky reefs dominated by the giant kelp (*Macrocystis pyrifera*), are aggressively defended.

Migrations and Movements
In one study [222], gopher rockfish moving 0.7 mile from a natural reef to an artificial reef in pursuit of a better habitat. However, movements of more than 2 miles are rare [216].

Reproduction
Gopher rockfish are ovoviviparous; eggs are fertilized internally and are carried for 1-2 months and then spawned as pelagic larvae [177]. Gonadal development begins in late November and mating occurs in late January and early February; spawning occurs from March-May [177].

Growth and Development
Larvae are planktonic and they settle in late June [177]. Metamorphosing juveniles first appear inshore during mid- to late June [177]. Gopher rockfish reach sexual maturity in 3 to 4 years at sizes of 5 inches SL or greater [178]. Gopher rockfish can live to be more than 30 years old [216].

Trophic Interactions
The gopher rockfish is a sedentary predator [178] that occupies an intermediate trophic level feeding primarily on crabs and shrimp, with more motile fish and cephalopods comprising most of the remainder of their diet [177]. In deeper waters juvenile gopher

rockfish are the primary prey of adult gopher rockfish, probably because preferred food (crabs and shrimp) is less abundant in the deeper water [112].

Young-of-the-year gopher rockfish consume algal-associated prey [55]. Juveniles living in the surface canopy fall prey to a variety of predators including birds.

Gopher Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are benthic and occur at depths <180 feet off California.

Composites: rocky shelf, non-rocky shelf

Mating Stage
Mating occurs in January and February, probably within the adult habitat.

Composites: rocky shelf, non-rocky shelf

Juveniles
Benthic juveniles probably occur within the adult habitat.

Composites: rocky shelf, non-rocky shelf, intertidal (draft)

Larval Stage
Larvae are pelagic. Insufficient information to define EFH.

Parturition
Parturition occurs from March - May, probably within the adult habitat.

Composites: rocky shelf, non-rocky shelf

The juvenile stage of intertidal EFH for gopher rockfish could be affected by all ODOT bridge replacement and repair activities.

The adult, mating, juvenile, and parturition stages of rocky shelf EFH for gopher rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for gopher rockfish potentially affected by the Bridge Program includes rocky reefs.

The adult, mating, juvenile, and parturition stages of non-rocky shelf EFH for gopher rockfish could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for gopher rockfish potentially affected by the Bridge Program includes sand bottoms.

GRASS ROCKFISH (*Sebastes rastrelliger*)

Range
Grass rockfish are found from Playa Maria Bay, Baja California to Yaquina Bay, Oregon [81, 240, 324]. Grass rockfish is a common shallow-water species (Eschmeyer et al. 1983) that occurs throughout the area covered by this EFH analysis. They occupy nearshore rocky areas, rocky bottom tidepools, areas along jetties, and kelp and eelgrass beds (Miller and Lea 1972). Juveniles use tidepools.

Habitat
The grass rockfish is a common, shallow-water rockfish [81]. They are found from the intertidal zone to 151 feet [240], frequently less than 49 feet [81, 240, 324]. Tide pools usually only contain juveniles [197]. Young-of-the-year grass rockfish appear in shallow water during the spring and summer [197] and recruit to hard substrate [199]. Grass rockfish are common in nearshore rocky areas, rocky bottom tidepools, along jetties, in kelp, and eelgrass [81, 240, 324]. Juvenile grass rockfish are most common in kelp beds off California [150].

Migrations and Movements
No information.

Reproduction
Grass rockfish spawn in winter [197]. Fertilization occurs internally and eggs develop and hatch inside the ovary of the female.

Growth and Development
Adult grass rockfish can grow to a maximum of 22 inches TL [81, 240, 324] and can live to be at least 20 years of age (Floyd 2003).

Trophic Interactions
The grass rockfish is cryptic and nocturnal [126]. Grass rockfish are predators on black surfperch [126]. They also prey upon crabs, shrimps, fishes, and octopi. Midshipmen, which migrate into shallow water in the spring to spawn, are a common part of their diets.

Grass Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults occur from southern Oregon southward, at depths <151 feet, associated with rocky areas and vegetation.

Composites: rocky shelf

Mating Stage
No information.

Juvenile Stage
Juveniles occur from tide pools to adult depths.

Composites: rocky shelf, intertidal (draft)

Larval Stage
No information.

Parturition
Parturtion occurs during the winter, probably within adult habitat.

Composites: rocky shelf

The juvenile stage of intertidal EFH for grass rockfish could be affected by all ODOT bridge replacement and repair activities.

The adult, juvenile, and parturition life stages of rocky shelf EFH for grass rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for grass rockfish potentially affected by the Bridge Program includes intertidal rocky areas and rocky bottom tidepools.

QUILLBACK ROCKFISH (*Sebastes maliger*)

Range
Quillback rockfish are found from the northern Channel Islands in southern California (Floyd 2003), to the Gulf of Alaska [240]. The are common in the Strait of Georgia, San Juan Islands, and Puget Sound and from southeastern Alaska to northern California [60, 114, 197, 224]. Quillback rockfish is a common shallow-water (<902 feet) benthic species that occurs throughout the area covered by this EFH analysis. Like other rockfish, larvae and young juveniles are pelagic while adults and older juveniles are demersal. Young fish are typically found in shallower waters than adults. Quillback rockfish are associated with rocky reef habitats and kelp and eelgrass beds (PFMC 1998bb). Estuaries are used by all life stages.

Habitat
Quillback rockfish are a common, shallow-water benthic species [224]. They are taken from subtidal depths to 902 feet [114, 197], but they occur mainly from 134-197 feet [197, 253]. Young quillback rockfish occur along the shores and adults usually in deeper waters [60]. Quillback rockfish are solitary reef-dwellers, living close to or on the bottom [197, 223, 322]. Occasionally they will rise up 29-39 feet in the water column [197]. In Puget Sound, they occupy a wide variety of habitats, having the highest densities on shallow (<98 feet) reefs [224]. Quillback rockfish live among rocks or sometimes on coarse sand or pebbles next to reefs, particularly in areas with a lot of flat-bladed kelp [197]. They are either found perched on rock or kelp or wedged into crevices and holes, and are rarely seen out in the open or unstructured areas of reefs [223]. Adults tend to associate with high-relief substrate and young-of-the-year tend to associate with low-

relief substrate. Young-of-the-year tend to be on the most complex areas of low-relief reefs [386] and use eelgrass/sand habitat as temporary habitat [225]. Young settle at 0.7-1.0 inch TL to shallow, vegetated habitats such as beds of kelp and eelgrass [386]. Densities on low-relief reefs and sand/eelgrass increased during the summer coincident with peak plant cover [224].

Migrations and Movements

On high-relief rocky reefs in Puget Sound, quillback rockfish maintain small home ranges (within 323 feet^2). Off-reef movement occurs during the summer. During the fall and winter, they remain on artificial reefs. On low-relief rocky reefs, they maintain considerably larger home ranges (4,300-16,150 feet^2). Quillback rockfish only inhabit low relief reefs during the summer and only return from displacements in the summer coincident with peak algal cover. They move from artificial reefs to low relief reefs during the summer and return to artificial reefs in the fall when kelp disappears on low relief reefs. Returns to original reefs when artificially displaced indicates site fidelity. Quillbacks can return to their home sites when experimentally displaced up to 4 miles. Quillback rockfish are not territorial of their home range. They may use navigation or olfactory cues to relocate home sites. They maintain small home ranges during the day, night, and high currents [223, 226]; and [224]. Female quillback rockfish probably move to other habitat to release larvae because no pregnant individuals were observed in these studies [223].

Reproduction

Quillbacks are viviparous. Mating probably occurs in March in Puget Sound and parturition in May [225]. Over their geographic range, they spawn from April-July, with a peak early in the season [197, 223].

Growth and Development

Quillback rockfish can grow to 24 inches [60, 114, 197]. They can live to be 32 years old but almost certainly live longer [197]. Growth rates differ along its range; off southeastern Alaska a 12-year-old is approximately 12 inches, and 50% of quillback rockfish mature at 12 inches; whereas off California a 12-year-old would only be 7 inches, and 50% mature at 9 inches [197].

Trophic Interactions

Quillback rockfish consume a wide range of prey taxa, but are more dietary generalists than other rockfish species [322]. Off British Columbia, quillback rockfish feed on herring and demersal and pelagic crustaceans. They feed primarily during mid-day and are inactive, sheltering in holes and crevices during the night [252]. In Puget Sound quillback rockfish principally prey upon brachyuran crabs; gammarid amphipods; euphausiids, and calanoid copepods.

Quillback Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults occur from in estuaries and along the coast from central California northward, at depths < 902 feet, and mainly associated with rocky habitat.

Composites: estuarine, rocky shelf, continental slope/basin

Mating
Insufficient information to define EFH.

Large Juveniles
Large juveniles probably occupy a somewhat shallower part of the adult habitat.

Composites: estuarine, rocky shelf

Small Juveniles
Small juveniles are pelagic and occur in estuaries and waters over the shelf.

Composites: estuarine, neritic

Larval Stage
Larvae are pelagic and occur in estuaries and waters over the shelf.
Composites: estuarine, neritic

Parturition
Parturition occurs from April through July, probably within adult habitat.
Composites: estuarine, rocky shelf, continental slope/basin

The adult, large juvenile, small juvenile, larval, and parturition stages of estuarine EFH for quillback rockfish could be affected by all ODOT bridge replacement and repair activities. Estuarine EFH for quillback rockfish potentially affected by the Bridge Program includes shallow, vegetated habitats such as beds of eelgrass.

The adult, large juvenile, and parturition stages of rocky shelf EFH for quillback rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for quillback rockfish potentially affected by the Bridge Program includes rocky reefs.

REDSTRIPE ROCKFISH (*Sebastes proriger*)

Range
Redstripe rockfish occur from San Diego, California to the Bering Sea [12, 114, 240]. Redstripe rockfish occur primarily in deeper waters, but can be found within the western portions of the territorial sea boundary, and are most common between 328 and 1,150 feet (Allen and Smith 1988). Young redstripe rockfish can occur in estuaries (Kendall

and Lenarz 1986). Adults are semi-demersal while larvae and juveniles are pelagic to semi-demersal. They are associated with high and low relief rocky areas.

Habitat
Redstripe rockfish inhabits the outer shelf and upper slope [12]. Redstripe rockfish have been reported between 39 and 1,390 feet in depth, but are most common (95%) between 328 and 1,150 feet [12]. Adults are semi-demersal, while larvae and juveniles are pelagic to semi-demersal [94]. Young redstripe rockfish can occur in estuaries [150]. All life stages of this species are found in Puget Sound, but they are relatively uncommon [94]. Redstripe rockfish are generally found slightly off the bottom (one meter or so) over both high and low relief rocky areas [350].

Movements and Migrations
Redstripe rockfish are very sedentary, exhibiting little or no movement from a home habitat or range [228]. In one study off California [228], displaced fish returned to a home range in some but not all cases, suggesting that redstripe rockfish show fidelity to a specific habitat type as opposed to a specific area.

Reproduction
Redstripe rockfish are ovoviviparous [94]. Off Oregon, larvae are released between April and July, but later off northern and central California, during July through September [150]. Larvae are released during July in Puget Sound [94].

Growth and Development
Larvae are extruded between 0.12 and 0.28 inch [150]. The length at 50% maturity of this species is 11 inches for both sexes in Puget Sound, [94]. Redstripe rockfish may grow to reach 24 inches [114].

Trophic Interactions
Larvae and juveniles of this species were found to feed primarily on copepods, their eggs, and copepod nauplii, as well as all stages of euphausiids [150]. Food of adult redstripe rockfish consists of small fish such as anchovies, herring and early stages of other groundfish, as well as squid [350].

Redstripe rockfish may compete for food and habitat resources with widow, squarespot, shortbelly, and canary rockfishes, as well as lingcod and spiny dogfish.

Redstripe Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are parademersal and occur all along the west coast at depths from 328-1,150 feet, associated with rocky substrates.

Composites: rocky shelf, continental slope/basin

Mating Stage
No information.

Juvenile Stage
Insufficient information to define EFH.

Larval Stage
No information.

Parturition
Parturition occurs from April through September, probably within adult habitat.

Composites: rocky shelf, continental slope/basin

The adult and parturition life stages of rocky shelf EFH for redstripe rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for redstripe rockfish potentially affected by the Bridge Program includes rocky areas.

Redstripe rockfish can occur in estuaries and could be affected by ODOT bridge replacement and repair activities. However, estuaries are not designated as EFH for redstripe rockfish.

SHORTBELLY ROCKFISH (*Sebastes jordani*)

Range
Shortbelly rockfish are found from San Benito Islands, Baja California, Mexico to La Perouse Bank, British Columbia [81, 185]. Shortbelly rockfish are a parademersal species and occur in waters from 164 to 1,150 feet deep (Allen and Smith 1988). Small juveniles can occur in shallow waters. Shortbelly rockfish are associated with soft, smooth bottoms.

Habitat
Shortbelly rockfish are considered a middle shelf-mesobenthal species, inhabiting waters from 164-1,150 feet [12]. Shortbelly rockfish are a cold-temperate species occurring on the continental shelf [59] and upper-slope [359]. Larvae are found up to 173 miles offshore, but are generally taken much closer to shore [185], mostly within 12 miles of land [209]. Young-of-the-year shortbelly rockfish have been observed in the surf line off California [186].

The habitat of the shortbelly rockfish is wide ranging [81]. They occur in midwater and away from underwater objects such as reefs or kelp more often than most, if not all, California rockfishes [185]. Adults commonly form very large schools over smooth bottom near the shelf break [186]. Shortbelly rockfish were also observed along the Monterey Canyon ledge [361]. Off California, young shortbelly rockfish recruit to soft substrate and low (<3 feet) relief reefs [199].

Migrations and Movements
During intense upwelling (May-June) relatively small fish stay deep, presumably to avoid advection to shore [184]. During the day shortbelly rockfish are found near the bottom in dense aggregations that often extend 49 feet up in the water column. At night they are more dispersed, 66-230feet above the bottom but still more than 98 feet below the surface of the water [59]. During the summer shortbelly rockfish tend to move into deeper waters and to the north as they grow, but they do not make long return migrations to the south in the winter to spawn [185]. Shortbelly rockfish sometimes are found forming large schools well offshore and off-bottom [81].

Reproduction
Shortbelly rockfish are viviparous, bearing advanced yolk-sac larvae at the time of parturition [307]. Shortbelly rockfish spawn off California during January through April [186]. A 50-g fish produces approximately 115 eggs (larvae) per gram of spawning female, whereas a 275-g fish should produce 139 eggs per gram of body weight [209].

Growth and Development
Shortbelly rockfish larvae is the longest at birth of any eastern Pacific rockfish. Also their larval period is long prior to transformation to the juvenile stage when compared with other eastern Pacific rockfish [185]. On average, developing shortbelly rockfish grow at a rate of 0.02 inch per day [184]. Larvae undergo flexion at 0.31-0.39 inch SL [168]. Larvae metamorphose to juveniles at 1.1 inch and appear to begin forming schools at the surface at that time [168, 185]. Juveniles up to 2.5 inches have been taken by dip nets and benthic individuals have been taken as small as 2.8 inches [185]. The size of shortbelly rockfish tends to increase with depth and the size for a given depth stratum tends to increase in a northerly direction between latitude 34 and 39EN [185].

A few shortbelly rockfish mature at 6 inches, 1 ounce (age 2); 50% are mature at 6.5 inches, 1 ounce (age 3). Nearly all are mature by age 4 [186]. Their maximum size is 12 inches or 9 ounces, and they can live to be about 10 years old [185, 209]. The maximum recorded age is 22 years [186].

Trophic Interactions
Shortbelly rockfish feed primarily on various life stages of euphausiids and calanoid copepods both during the day and night [59, 184]. Shortbelly rockfish play a key role in the food chain, as they are preyed upon by chinook and coho salmon, lingcod, black rockfish, hake, bocaccio, chilipepper, pigeon guillemots, western gull, marine mammals, and others.

Shortbelly Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are parademersal and occur all along the west coast, at depths from 164-1,150 feet.

Composites: rocky shelf, non-rocky shelf, canyon, continental slope/basin

Mating Stage
No information.

Large Juveniles
Insufficient information to define EFH.

Small Juveniles
Small juveniles can occur in shallow waters. Insufficient information to define EFH.

Composites: intertidal (draft).

Larval Stage
Larvae are pelagic and can occur far offshore, but mainly within 12 miles of shore. Insufficient information to define EFH.

Parturition
Spawning occurs during winter and spring, probably within adult habitat.

Composites: rocky shelf, non-rocky shelf, canyon, continental slope/basin

The small juvenile stage of intertidal EFH for shortbelly rockfish could be affected by all ODOT bridge replacement and repair activities.

The adult and parturition stages of rocky shelf EFH for shortbelly rockfish could be affected by the Bridge Program.

The adult and parturition stages of non-rocky shelf EFH for shortbelly rockfish could be affected by ODOT bridge replacement and repair activities.

VERMILION ROCKFISH (*Sebastes miniatus*)

Range
Vermilion rockfish are found from Cape Bartolome, southeastern Alaska (lat. 60 14'N, long. 146 58'W) south to central Baja California, Mexico [197, 264]. Vermillion rockfish is a demersal species associated with rocky substrates (Love et al. 1990). Adults are found in waters up to 784 feet deep, and young fish are most common in waters between 16 and 98 feet deep (Love et al. 1990).

Habitat
Vermilion rockfish occur in shallow water when young and in deeper water as larger adults [81, 216]. Adults occur in water up to 784 feet [201], and were observed in 23 feet in Diablo Canyon [201]. Newly released larvae are pelagic and found near the surface for three to four months, then settle to the bottom [376] in waters between 16 and 98 feet deep [201]. Vermilion rockfish are usually found over rocks, along drop-offs and over

hard bottom, often in aggregations. They occur mostly on or near the bottom, rarely rising more than 10 feet above the reef [197]. Young vermilion rockfish recruited to sand and sand/low rock substrata without algae or kelp [55]. In general, young are recruited to the bottom on soft or hard substrate with low (<3 feet) relief [199]. Juveniles are secretive and often take refuge in dense algae [376].

Migrations and Movements
Vermilion rockfish are usually found aggregating near or slightly above the bottom, often over high relief [201] or artificial structures such as wastewater discharge pipes and oil drilling platforms [230]. They probably move from reef to reef, particularly in deep water, but it is unknown how far they move [197]. It is thought that movements of vermilion rockfish off reefs may be associated with following schools of prey (such as squid) [196].

Reproduction
The length at first maturity for male vermilion rockfish is 12 inches, 50% are mature at 14 inches, and all are mature by 15 inches. Females begin to mature at 12 inches, 50% are mature at 15 inches, and all are mature at 18 inches [201]. Half the population is mature at 8 years [376].

Peak spawning months are September in northern California and November in southern California [376]. An 18-inch SL female spawned 158,915 eggs while a 27-inch SL female spawned 2,683,768 eggs [201]. Vermilion rockfish are single brooders [201].

Growth and Development
Young-of-the-year appear in inshore water beginning in February [197]. Vermilion rockfish can grow to 30 inches and 15 pounds [81]. The oldest individual aged was 25 years old [376].

Trophic Interactions
Vermilion rockfish prey on other fishes (anchovies, lanternfishes, small rockfishes), octopi, squids, and krill [197]. Pelagic young feed primarily upon crustaceans.

Vermilion Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are demersal and occur all along the west coast at depths <784 feet, associated with rocky substrates.

Composites: rocky shelf, canyon, continental slope/basin

Mating Stage
No information.

Juvenile Stage
Juveniles occur over a variety of substrates, and probably occur in the shallower part of the adult range.

Composites: rocky shelf, non-rocky shelf

Larval Stage
No information.

Parturition
Insufficient information to define EFH.

The adult and juvenile stages of rocky shelf EFH for vermilion rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for tiger rockfish potentially affected by the Bridge Program includes rocks, drop-offs, hard bottoms, and rocky reefs.

WIDOW ROCKFISH (*Sebastes entomelas*)

Range
Widow rockfish range from Albatross Bank of Kodiak Island to Todos Santos Bay, Baja California [81, 176, 240, 260]. Widow rockfish is a pelagic species, but older juveniles and adults are often found over hard bottom substrates at depths between 164 and 1,150 feet (NOAA Fisheries 1990). Larvae and small juveniles are found in surface waters from nearshore to 186 miles offshore (Laroche and Richardson 1981).

Habitat
Adults are sublittoral to bathyal over depths of 66-1,200 feet, mostly 328-984 feet [81, 176, 260]. Larvae and small juveniles are neritic and epipelagic, occurring from near surface to 66 feet deep and nearshore to 186 miles offshore [176, 260]. Larger juveniles occur near-bottom, inshore over depths of 29-121 feet [81, 260]. All life stages are pelagic, but older juveniles and adults are often associated with the bottom [260]. All life stages are fairly common from Washington to California [260]. Off Oregon they are reported to be most common on the continental shelf [176]. Pelagic larvae and juveniles co-occur with yellowtail rockfish, chilipepper, shortbelly rockfish, and bocaccio larvae and juveniles off central California [308]. In a study off central California, postpelagic newly settled widow rockfish were first observed at the seaward, sand-rock interface of nearshore reefs in depths of 20-66 feet. They were associated with crevices, sand channels among the rocks, or depressions in the reef [377]. They also recruit to soft substrates and low (<3 feet) relief in association with macrophytes [199]. Juvenile widow rockfish have also been reported from 26-66 feet in Diablo Canyon [201], and adult widow rockfish occur along Monterey Canyon ledge [361]. Widow rockfish occur over hard bottoms along the continental shelf [260]. Substrate preferred by widow rockfish are rocky banks, seamounts, ridges near canyons, headlands, and muddy bottoms near rocks. All life stages occur in euhaline (31-34 ppt) waters [81, 260], and temperatures of 43-60° F and dissolved oxygen levels of 1.0 to 7.0 ppm [230]. Large widow rockfish concentrations occur off head lands such as Cape Blanco, Cape Mendocino, Pt. Reyes,

and Pt. Sur, common characteristics of these areas include extended points of land, offshore canyons, and current circulation eddies inshore of main currents. These oceanographic characteristics appear to be associated in some manner with aggregations of widow rockfish during their reproductive cycle [305].

Migrations and Movements
Adults form dense, irregular, midwater and semi-demersal schools deeper than 328 feet at night and disperse during the day [81, 260, 393].

Reproduction
Widow rockfish are viviparous, have internal fertilization, and brood their eggs until released as larvae [260, 307, 308]. Mating occurs from late fall-early winter, occurring earliest off California, and latest off British Columbia. Off Oregon, mating occurs mostly in December, and in September off California. The mating process occurs in current circulation eddies inshore of main currents, often off extended points of land and in offshore canyons. Parturition of larvae occurs from late winter to early spring with a regional timing sequence similar to mating. Larval release occurs from December-February off California, and from February-March off Oregon, and in April off British Columbia and Alaska. Fecundity increases with size of the female, from 55,000 eggs at 13 inches, to 915,000 eggs at 20 inches [260].

Growth and Development
Larvae are 0.2 inch at parturition and the larval period lasts several weeks. Juveniles are 0.8-1.2 inches at metamorphosis, and they grow to 10 inches over 3 years. Age and size at sexual maturity varies by region and sex, generally increasing northward and at older ages and larger sizes for females. Some mature in 3 years (10 inches), 50% are mature by 4-5 years (10-14 inches), and most are mature in 8 years (15-16 inches) [28, 260]. The maximum age of widow rockfish is 28 years, but rarely over 20 years for females and 15 years for males [260]. The largest size is 21 inches, about 5 pounds [81, 260].

Trophic Interactions
Widow rockfish are carnivorous. Adults feed on small pelagic crustaceans, midwater fishes (such as age-1 or younger Pacific hake), salps, caridean shrimp, and small squids [3, 260]. They pursue nektonic prey in the water column probably hunting by sight, feeding in upper levels at night and in deeper water during the daytime. During spring, the most important prey item is salps, during the fall fish are more important, and during the winter widow rockfish primarily eat sergestid shrimp [3]. Feeding is most intense in the spring after spawning [260]. Pelagic juveniles are opportunistic feeders and their prey consists of various life stages of calanoid copepods, and sub-adult euphausiids (including eggs).

Widow Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are pelagic, but associated with the bottom along the continental shelf and slope and in submarine canyons at depths between 164 and 1,150 feet, primarily over hard bottoms, such as rocky banks, ridges and headlands.

Composites: rocky shelf, non-rocky shelf, canyon, continental slope/basin

Mating Adult Stage
During late fall and early winter, mating occurs in current circulation eddies inshore of main currents, often off extended points of land and in offshore canyons.

Composites: rocky shelf, non-rocky shelf, canyon, continental slope/basin

Large Juvenile Stage
Large juveniles are pelagic, but associated with the bottom along the inner continental shelf at depths between 30 and 121 feet, probably over hard, rocky bottoms.

Composites: rocky shelf, non-rocky shelf, canyon

Small Juvenile Stage
Small juveniles occur in surface waters up to 66 feet deep from near shore to 186 miles offshore.

Composites: neritic, oceanic

Larval Stage
Larvae occur in the same areas as small juveniles: in surface waters up to 66 feet deep from near shore to 186 miles offshore.

Composites: neritic, oceanic

Parturition
From late winter through early spring, parturition occurs along the coast in adult areas.

Composites: rocky shelf, non-rocky shelf, canyon, continental slope/basin

The adult, mating, large juvenile, and parturition stages of rocky shelf EFH for widow rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for widow rockfish potentially affected by the Bridge Program includes sand-rock interfaces of nearshore reefs, crevices, or depressions in the reef, hard bottoms, rocky banks, seamounts, ridges near canyons, headlands, rock outcrops surrounded by mud, high relief outcroppings, and low relief cobble outcroppings.

The adult, mating, large juvenile, and parturition stages of non-rocky shelf EFH for widow rockfish could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for widow rockfish potentially affected by the Bridge Program includes soft substrates and low relief, sand-rock interfaces of nearshore reefs, sand channels among the rocks, muddy bottoms near rocks, and sand.

YELLOWTAIL ROCKFISH (*Sebastes flavidus*)

Range

Yellowtail rockfish range from San Diego, California, to Kodiak Island, Alaska [89, 98, 191, 197, 240, 262]. The center of yellowtail rockfish abundance is from Oregon to British Columbia [89]. Yellowtail rockfish is a paradmersal species and occurs over sloping shores, rocky reefs, mud with cobble, rocky ridges, and sand habitats (Hart 1973). Adults are pelagic and occur near, but not on, the bottom. Pelagic juveniles occur in areas outside the territorial sea, but benthic juveniles occur nearshore, at depths of 66 to 121 feet.

Habitat

Yellowtail rockfish are a common, demersal species that is most abundant over the middle shelf [54, 89, 366, 384]. In the North Pacific, they are considered a middle shelf-mesobenthal species, and have been reported at depths of 0-1,800 feet, although nearly all were taken between 164-984 feet in survey catches [12]. Off Heceta Bank, Oregon, they usually remain at midwater depths of 82-115 feet, well above seafloor depths of approximately 246 feet [197, 280]. Yellowtail adults are considered as being semi-pelagic [349, 355] or pelagic which allows them to range over wider areas than benthic rockfish [280]. Yellowtail rockfish are most common near the bottom, but not on the bottom [197, 349]. Pelagic juveniles occur 15-165 miles offshore, benthic juveniles occur nearshore, in 66-121 feet deep water [366].

Yellowtail rockfish are part of the shelf rockfish assemblage which includes Pacific ocean perch, bocaccio, chilipepper, and canary, silvergray, black, and widow rockfishes [2, 89, 119, 197, 355]. Based on research trawl surveys, the area from Cape Flattery to Cape Blanco is characterized by a canary-yellowtail-silvergray assemblage in 300-594 feet of water. The Cape Blanco to Cape Mendocino region is dominated by yellowtail and stripetail rockfishes in the 300-594 feet zone. Yellowtail rockfish are not as common in survey catches from Cape Mendocino to Point Hueneme [107], although yellowtail rockfish are relatively common in recreational catches off central California (Floyd 2003). In Puget Sound, Washington, yellowtail rockfish are more abundant in northern, than in central areas [366]. Adult yellowtail rockfish occur along steeply sloping shores or above rocky reefs [114]. They can be found above mud with cobble, boulder and rock ridges, and sand habitats; they are not; however, found on mud, mud with boulder, or flat rock [197, 355].

Migrations and Movements

Yellowtail rockfish form large (sometimes greater than 1,000 fish) schools and can be found alone or in association with other rockfishes [197, 280, 321, 355, 366]. These

schools may persist at the same location for many years [280]. In one study, yellowtail rockfish made rapid descents to near bottom depths, but no obvious diel vertical or horizontal migrations were detected [280]. However, others [191, 366] report that yellowtail rockfish exhibit diurnal vertical migrations in behavior associated with feeding on vertically migrating prey.

Yellowtail rockfish can make long distance movements [349]. Young-of-the-year come into shallow water, often into kelp beds, and usually migrate to deeper water as they mature [53, 197, 349]. Adult yellowtail rockfish show strong site fidelity and homing abilities [53, 54, 98, 280].

Reproduction
Yellowtail rockfish are viviparous [262]. Along the west coast yellowtail rockfish mate from October to December, parturition peaks in February and March (ranges from November to June) off Oregon-British Columbia [197, 366, 389] and from November-March off California [389]. Fecundity varies with length, 66,000 eggs at 12 inches to 1.15 million eggs at 21 inches in length [297, 366].

Growth and Development
Larvae are approximately 0.2 inch in length when extruded [366]. Larvae transform to pelagic juveniles at 0.9-1.1 inches in length. They transform to benthic juveniles at 1.6-2.0 inches in length. Young-of-the-year pelagic juveniles often appear in kelp beds beginning in April and live in and around kelp, in midwater during the day, descending to the bottom at night [197, 366]. Benthic juveniles begin to settle from June-November [366]. Male yellowtail rockfish are 13-16 inches in length (5-9 years) at 50% maturity, females are 15-18 inches (6-10 years) [366].

Yellowtail rockfish are long-lived and slow-growing; the oldest recorded was 64 years old [90, 366]. Even though they are slow growing, like other rockfish, they have a high growth rate when compared to other rockfish [366]. They reach a maximum size of about 22 inches in approximately 15 years [366].

Trophic Interactions
Yellowtails feed mainly on pelagic animals, but are opportunistic, occasionally eating benthic animals as well [191]. Large juveniles and adults eat fish (small hake, Pacific herring, smelt, anchovies, lanternfishes, and others), along with squid, krill, and other planktonic organisms (euphausiids, salps, and pyrosomes) [197, 297, 321, 366]. Yellowtail rockfish caught in bottom trawls off Washington fed almost exclusively on euphausiids, while those caught in midwater trawls off Queen Charlotte Sound fed on euphausiids as well as pelagic and benthic fishes [191]. Feeding primarily occurs during night or early morning hours, although some feeding probably occurs during the daytime as well.

Yellowtail Rockfish Life Stages and EFH Potentially Affected by the Bridge Program

Adult Stage
Adults are parademersal and occur all along the west coast, at depths from 164-1,150 feet.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Mating Stage
Mating occurs from October to December, probably within adult habitat.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

Large Juveniles
Large juveniles occur at depths from 66-121 feet.

Composites: rocky shelf, non-rocky shelf

Small Juveniles
Small juveniles are pelagic and occur from 15-165 miles offshore.

Composites: neritic, oceanic, intertidal (draft)

Larval Stage
Insufficient information to define EFH.

Parturition
Parturition occurs from November to late spring, probably within adult habitat.

Composites: rocky shelf, non-rocky shelf, continental slope/basin

The small juvenile stage of intertidal EFH for yellowtail rockfish could be affected by all ODOT bridge replacement and repair activities.

The adult, mating, large juvenile, and parturition stages of rocky shelf EFH for yellowtail rockfish could be affected by ODOT bridge replacement and repair activities. Rocky shelf EFH for yellowtail rockfish potentially affected by the Bridge Program includes rocky areas, steeply sloping shores with walls and cliffs, ridges and boulders.

The adult, mating, large juvenile, and parturition stages of non-rocky shelf EFH for yellowtail rockfish could be affected by ODOT bridge replacement and repair activities. Non-rocky shelf EFH for yellowtail rockfish potentially affected by the Bridge Program includes mud with cobble, boulder and rock ridges, and sand habitats.

7.3.2 Description of Essential Fish Habitat for Pacific Salmon

EFH is the aquatic habitat necessary to allow for salmon production needed to support a long-term sustainable salmon fishery and salmon contributions to a healthy ecosystem. The salmon fishery EFH includes all those streams, lakes, ponds, wetlands, and other water bodies currently or historically accessible to salmon in Washington, Oregon, Idaho and California. In the estuarine and marine areas, salmon EFH extends from the nearshore and tidal submerged environments to 37 miles offshore of Washington, Oregon and California north of Point Conception. Foreign waters (i.e., off Canada) are not included in salmon EFH because they are outside U.S. jurisdiction. The Pacific coast salmon fishery EFH also includes the marine areas off Alaska designated as salmon EFH by the North Pacific Fishery Management Council. The geographic extent of freshwater EFH is specifically defined as all waters currently or historically accessible to salmon within the United States Geological Survey (USGS) hydrologic units identified in Table 7.3.2-1. Salmon EFH excludes areas upstream of longstanding naturally impassible barriers (i.e., natural waterfalls in existence for several hundred years). Salmon EFH includes aquatic areas above all artificial barriers except those listed in Table 7.3.2-2. In the future, should salmon access or reintroduction above any of the dams listed in Table 7.3.2-2 become technologically and economically feasible, these areas would be designated as salmon EFH.

Table 7.3.2-1. Pacific salmon freshwater EFH identified by USGS hydrologic unit number.

USGS Hydr. Unit	State(s)	Hydrologic Unit Name	Salmon species
17080001	OR/WA	L. Columbia-Sandy	chinook and coho salmon
17080003	OR/WA	L. Columbia - Clatskanie	chinook and coho salmon
17080006	OR/WA	Lower Columbia	chinook and coho salmon
17090001	OR	M.F. Willamette River	chinook salmon
17090002	OR	Coast F. Willamette R.	chinook salmon
17090003	OR	U. Willamette River	chinook and coho salmon
17090004	OR	McKenzie River	chinook and coho salmon
17090005	OR	N. Santiam River	chinook and coho salmon
17090006	OR	S. Santiam River	chinook and coho salmon
17090007	OR	Mid. Willamette River	chinook and coho salmon

Table 7.3.2-1. (continued).

USGS Hydr. Unit	State(s)	Hydrologic Unit Name	Salmon species
17090008	OR	Yamhill River	chinook and coho salmon
17090009	OR	Molalla - Pudding River	chinook and coho salmon
17090010	OR	Tualatin River	chinook and coho salmon
17090011	OR	Clackamas River	chinook and coho salmon
17090012	OR	L. Willamette River	chinook and coho salmon
17070101	OR/WA	Mid. Columbia - Lake Wallula	chinook salmon
17070102	OR/WA	Walla Walla River	chinook salmon
17070103	OR	Umatilla River	chinook salmon
1707104	OR	Willow	chinook salmon
17070105	OR/WA	Mid. Columbia - Hood	chinook and coho salmon
17070301	OR	Upper Deschutes River	chinook salmon
17070303	OR	Beaver - South Fork	chinook salmon
17070304	OR	Upper Crooked River	chinook salmon
17070305	OR	Lower Crooked River	chinook salmon
17070306	OR	Lower Deschutes River	chinook and coho salmon
17070307	OR	Trout Creek	chinook and coho salmon
17070201	OR	Upper John Day River	chinook salmon
17070202	OR	N.F. John Day River	chinook salmon
17070203	OR	Middle F. John Day River	chinook salmon
17070204	OR	Lower John Day River	chinook salmon
17060101	OR/ID	Hells Canyon	chinook salmon
17060102	OR	Imnaha River	chinook salmon
17060103	OR/WA/ID	Lower Snake - Asotin Creek	chinook and coho salmon
17060104	OR	Upper Grande Ronde	chinook and coho salmon

Table 7.3.2-1. (continued).

USGS Hydr. Unit	State(s)	Hydrologic Unit Name	Salmon species
17060105	OR	Wallowa River	chinook and coho salmon
17060106	OR/WA	Lower Grande Ronde	chinook and coho salmon
17100201	OR	Necanicum River	chinook and coho salmon
17100202	OR	Nehalem River	chinook and coho salmon
17100203	OR	Wilson - Trask - Nestucca	chinook and coho salmon
17100204	OR	Siletz - Yaquina River	chinook and coho salmon
17100205	OR	Alsea River	chinook and coho salmon
17100206	OR	Siuslaw River	chinook and coho salmon
17100207	OR	Siltcoos River	chinook and coho salmon
17100301	OR	N. Umpqua River	chinook and coho salmon
17100302	OR	S. Umpqua River	chinook and coho salmon
17100303	OR	Umpqua River	chinook and coho salmon
17100304	OR	Coos River	chinook and coho salmon
17100305	OR	Coquille River	chinook and coho salmon
17100306	OR	Sixes River	chinook and coho salmon
17100307	OR	Upper Rogue River	chinook and coho salmon
17100308	OR	Middle Rogue River	chinook and coho salmon
17100309	CA/OR	Applegate River	chinook and coho salmon
17100310	OR	Lower Rogue River	chinook and coho salmon
17100311	CA/OR	Illinois River	chinook and coho salmon
17100312	CA/OR	Chetco River	chinook and coho salmon
18010101	CA/OR	Smith River	chinook and coho salmon
18010206	CA/OR	Upper Klamath River	chinook and coho salmon
18010209	CA/OR	Lower Klamath River	chinook and coho salmon

Table 7.3.2-2. Tentative list of man-made barriers under consideration for exclusion of EFH above such barriers. The salmon fishery EFH will exclude historic habitat above barriers that are considered to not be technologically and economically feasible for salmonid passage and/or re-establishment of self-sustaining runs above such barriers.

Name of Barrier	State	USGS Hydro. Unit	Basin	Comments
Pelton Dam Round Butte Dam	OR	17070306	Deschutes River	A passage project is pending - proposed delete from this list. Next upstream dam is Round Butte. Dams represent the upstream extent of proposed critical habitat for chinook.
Big Cliff Dam	OR	17090005	N. Santiam River	Passage under consideration. Adult passage feasible. Juvenile passage may be feasible. Proposed delete from this list.
Foster Dam Green Peter Dam	OR	17090006	S. Santiam River	This dam has passage facilities - proposed delete from this list. Next upstream dam is Green Peter. Dams represent the upstream extent of proposed critical habitat for chinook.
Cougar Dam	OR	17090004	McKenzie River	Passage under consideration - proposed delete from this list. Dam represents the upstream extent of proposed critical habitat for chinook.
Dexter Dam	OR	17090001	Middle Fork Willamette River	Passage under consideration. Adult passage feasible. Juvenile passage may be feasible. Proposed delete from this list. Dam represents the upstream extent of proposed critical habitat for chinook.
Dorena Dam	OR	17090002	Coast Fork Willamette River	Passage under consideration. Adult passage feasible. Juvenile passage may be feasible. Proposed delete from this list.
Soda Springs Dam	OR	17100301	N. Umpqua River	Passage under consideration - proposed delete from this list.
Lost Creek Dam	OR	17100307	Rogue River	Habitat is flooded. Dam represents the upstream extent of critical habitat for coho and proposed critical habitat for chinook.
Applegate Dam	OR	17100309	Applegate River	Dam represents the upstream extent of critical habitat for coho and proposed critical habitat for chinook.
Bull Run Dam	OR	17080001	Sandy River	Dam represents the upstream extent of proposed critical habitat for chinook.
Oak Grove Dam	OR	17090011	Clackamas River	Dam represents the upstream extent of proposed critical habitat for chinook.

Listed Salmonid ESUs with EFH in Oregon:

CHINOOK SALMON:

SNAKE RIVER FALL-RUN ESU
SNAKE RIVER SPRING / SUMMER-RUN ESU
LOWER COLUMBIA RIVER ESU
UPPER COLUMBIA RIVER SPRING-RUN ESU
UPPER WILLAMETTE RIVER ESU

COHO SALMON:

SOUTHERN OREGON / NORTHERN CALIFORNIA ESU
OREGON COAST ESU

Salmon ESUs with EFH in Oregon that are not listed under ESA:

Deschutes River Summer/Fall Run Chinook
SONC Chinook
Oregon Coast Chinook
Mid-Columbia River Spring Chinook
Upper Columbia Summer/Fall Chinook
Lower Columbia River/Southwest Washington Coho

7.3.2.1 Deschutes River Summer/Fall Run Chinook Salmon

This ESU includes all naturally-spawned populations of chinook salmon from the Deschutes River. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 2,687 square miles in Oregon. The following counties lie partially or wholly within these basins: Oregon - Crook, Hood River, Jefferson, Sherman, and Wasco.

Among ocean-type Columbia River populations above Celilo Falls, summer-run chinook salmon spawn in the mid- and lower reaches of tributaries with peak spawning occurring in October, whereas fall-run chinook salmon spawn in the mainstem Columbia and Snake Rivers and the lower reaches of the Deschutes and Yakima Rivers with peak spawning occurring in November ([Garcia et al. 1996] [Marshall et al. 1995] [Mullan 1987] [Howell et al. 1985]). The Deschutes River and Marion Drain systems support fall-runs with very high incidences of 2-year-old "jack" chinook salmon ([ODFW 1995b] [Hymer et al. 1992]). A significant number of tagged fall-run chinook salmon from the Snake and Deschutes Rivers are recovered in southerly waters off the Oregon and California Coast, and recovery of CWT-marked Snake and Deschutes River fall-run chinook salmon off Alaska is not large ([Waples et al. 1991] [Howell et al. 1985]). A summer run may have existed on the Deschutes River. Recoveries of returning adults tagged at Bonneville Dam in June and July (a migration timing that is generally associated with summer runs) were made in the Deschutes and Metolius (a tributary to the upper Deschutes River) Rivers (Galbreath 1966). Jonasson and Lindsay (1988) speculated that a distinct summer run spawned in the upper Deschutes River prior to the construction of Pelton Dam (river mile 103) in 1958 and Round Butte Dam (river mile 110) in 1964, and that subsequently the run was eliminated or assimilated into the fall-run. Presently, fall-run chinook salmon on the Deschutes River return much earlier than any other fall-run stock on the Columbia River (Olsen et al. 1992), suggesting

that some assimilation may have taken place. Deschutes River fall-run chinook salmon are described as having a small size for their age (Kostow 1995).

The Deschutes River contains "native" stream-type chinook salmon. Even prior to the construction of Pelton Dam, spawning areas for spring-run chinook salmon on the Deschutes River lay below 3,280 feet (Nehlsen 1995).

The Deschutes River population continues to increase. Most recent data shows annual returns to be at a five-year average of about 16,000 fish, increasing at about 18% a year

Concerns remain over the possible extinction of the summer-run life history type in the Deschutes Basin, and the loss of fall-run fish from adjacent river basins (Umatilla, John Day, Walla Walla) that may have shared a common ESU with Deschutes chinook.

Pathogens have the largest effect on chinook survival in the lower Deschutes River (Mobrand 1999 *in* Floyd 2003). Data indicate that habitat diversity, oxygen, pathogens, predation, sediment load, and temperature had the largest effect on salmon productivity.

7.3.2.2 Southern Oregon/Northern California Chinook Salmon

The Southern Oregon/Northern California chinook ESU includes all naturally spawned populations of chinook salmon from rivers and streams between Cape Blanco, Oregon (excluding the Elk River), and the lower Klamath River, California, excluding populations in the Klamath River Basin upstream from the confluence of the Klamath and Trinity Rivers. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 6,528 square miles in California and Oregon. The following counties lie partially or wholly within these basins: California - Del Norte, Humboldt, and Siskiyou; Oregon - Coos, Curry, Douglas, Jackson, Josephine, and Klamath.

Chinook salmon in this ESU exhibit an ocean-type life-history; ocean distribution (based on marine CWT recoveries) is predominantly off of the California and Oregon coasts. Ecologically, the majority of river systems in this ESU are relatively small and heavily influenced by a maritime climate. Low summer flows and high temperatures in many rivers result in seasonal physical and thermal barrier bars that block movement by anadromous fish.
8.3.2.3 Oregon Coast Chinook Salmon

The Oregon Coast chinook ESU includes all naturally spawned populations of chinook salmon in Oregon coastal basins north of, and including, the Elk River. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 10,604 square miles in Oregon. The following counties lie partially or wholly within these basins: Benton, Clatsop, Columbia, Coos, Curry, Douglas, Jackson, Josephine, Lane, Lincoln, Polk, Tillamook, Washington, and Yamhill.

These populations exhibit an ocean-type life-history and mature at ages 3, 4, and 5. In contrast to the more southerly ocean distribution pattern shown by populations from the lower Columbia

River and farther south, CWT recoveries from populations within this ESU are predominantly from British Columbia and Alaska coastal fisheries.

7.3.2.4 Mid-Columbia River Spring Chinook Salmon

This ESU includes all naturally spawned populations of spring-run chinook salmon in Columbia River tributaries from the Klickitat River upstream to include the Yakima River (excluding the Snake River Basin). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 26,739 square miles in Oregon and Washington. The following counties lie partially or wholly within these basins: Oregon - Baker, Clackamas, Crook, Gilliam, Grant, Harney, Hood River, Jefferson, Morrow, Sherman, Umatilla, Union, Wallowa, Wasco, and Wheeler.

Chinook salmon from this ESU emigrate to the ocean as yearlings and apparently migrate far off-shore, as they do not appear in appreciable numbers in any ocean fisheries. The majority of adults spawn as 4-year-olds.

7.3.2.5 Upper Columbia Summer/Fall Chinook Salmon

The ESU includes all naturally spawned populations of summer- and fall-run chinook salmon in the Columbia River and tributaries upstream of the confluence of the Snake and Columbia Rivers to Chief Joseph Dam (with the exception of chinook salmon which spawn in the Marion Drain). Major river basins containing spawning and rearing habitat for this ESU comprise approximately 8,795 square miles in Washington. The following counties lie partially or wholly within these basins: Adams, Benton, Chelan, Douglas, Franklin, Grant, King, Kittitas, Klickitat, and Yakima. These chinook salmon migrate up the Columbia River past Oregon as adults and outmigrate past Oregon as rearing subyearlings and smolts.

Chinook salmon from this ESU primarily emigrate to the ocean as subyearlings but mature at an older age than ocean-type chinook salmon in the Lower Columbia and Snake Rivers.

7.3.2.6 Lower Columbia River Coho Salmon

The ESU includes all naturally spawned populations of coho salmon from Columbia River tributaries below the Klickitat River on the Washington side and below the Deschutes River on the Oregon side (including the Willamette River as far upriver as Willamette Falls), as well as coastal drainages in southwest Washington between the Columbia River and Point Grenville. Major river basins containing spawning and rearing habitat for this ESU comprise approximately 10,418 square miles in Oregon and Washington. The following counties lie partially or wholly within these basins: Oregon - Clackamas, Clatsop, Columbia, Hood River, Marion, Multnomah, Wasco, and Washington.

7.3.3 Salmon Life History Information

Chinook Salmon

Juveniles (freshwater)
Chinook salmon fry are typically 1.3-1.4 inches in length when they emerge, though there is considerable variation among populations and size at emergence is determined in part by egg size. The length of freshwater residence before seaward migration is as variable as size; ocean-type fish can migrate seaward immediately after yolk absorption, but most migrate 30-90 days after emergence. Others move seaward as fingerlings in the late summer of their first year, while still others, particularly in less productive or cold water systems, overwinter and migrate as yearling fish (Taylor 1990a, 1990b). The proportion of fingerling and yearling migrants within a population may vary significantly from one year to the next ([Myers et al. 1998] [Roni 1992]).

In contrast, stream-type fish generally spend at least one year in freshwater before emigrating to sea. Alaskan fish are predominantly stream-type, while chinook salmon from northern British Columbia are approximately half stream-type and half ocean-type (Taylor 1990a, Healey 1991). Ocean-type life histories are most common in central and southern British Columbia, the Pacific Northwest, and California, with the exception of populations inhabiting the upper reaches of large river basins such as the Fraser, Columbia, Snake, and to a lesser extent the Klamath and Sacramento.

Water and habitat quality and quantity determine the productivity of a watershed for chinook salmon. Both stream- and ocean-type fish utilize a variety of habitats during their freshwater residency, and are dependent on the quality of the entire watershed, from headwater to estuary. Juvenile chinook inhabit primarily pools and stream margins, particularly undercut banks, behind woody debris accumulations, and other areas with cover and reduced water velocity ([Bjornn and Reiser 1991] [Lister and Genoe 1970]). While chinook salmon habitat preferences are similar to those for coho salmon, chinook inhabit slightly deeper (2-47 inches) and higher velocity (0-15 inches/second) areas than coho (Bjornn and Reiser 1991, Healey 1991). The stream or river must provide adequate summer and winter rearing habitat, as well as migration corridors from spawning and rearing areas to the sea. Stream-type juveniles are more dependent on freshwater ecosystems because of their extended residence in these areas. The length of freshwater residence and growth is determined partially by water temperature and food resources. The principal foods in freshwater are larval and adult insects, while those in estuarine areas include epibenthic organisms, insects, and zooplankton.

Growth rates during the period of initial freshwater residency depend on the quality of habitats occupied by the fish. Growth rates between 0.008 inch/day and 0.024 inch/day have been reported for ocean-type fish and between 0.004 inch/day and 0.013 inch/day for stream-type fish ([Healey 1991] [Kjelson et al. 1982] [Loftus and Lenon 1977] [Mains and Smith 1964] [Meehand and Siniff 1962] [Rich 1920]). For ocean-type fish, growth rates in estuarine habitats are generally much higher than in riverine or stream habitats, which is most likely due to a higher abundance of prey.

Juveniles (estuarine)

Although both stream- and ocean-type chinook salmon may reside in estuaries, stream-type chinook salmon generally spend a very brief period in the lower estuary before moving into coastal waters and the open ocean (Healey 1983, Healey 1982, Healey 1980; Levy and Northcote 1981). In contrast, ocean-type chinook salmon typically reside in estuaries for several months before entering coastal waters of higher salinity (Healey 1980, 1982; Congleton et al. 1981, Levy and Northcote 1981, Kjelson et al. 1982).

Ocean-type chinook salmon typically begin their estuarine residence as fry (immediately after emergence) or as fingerling (after spending several months in freshwater). Fry generally enter the upper reaches of estuaries in late winter or early spring, beginning in January at the southern end of their range in the Sacramento-San Joaquin Delta, and as late as April farther north, such as in the Fraser River Delta (Sasaki 1966; Dunford 1975, Levy et al. 1979; Healey 1980, 1982; Gordon and Levings 1984). In contrast, chinook salmon fingerling typically enter estuarine habitats in June and July (April to June in the Sacramento Delta), or approximately when the chinook salmon who arrived in the estuary as fry are emigrating to higher salinity marine waters. Regardless of time of entrance, juvenile ocean-type chinook salmon spend from 1 to 3 months in estuarine habitats (Rich 1920, Reimers 1973, Myers 1980 *in* Floyd 2003; Kjelson et al. 1982, Levy and Northcote 1981, Healey 1980, 1982; Levings 1982).

Chinook salmon fry prefer protected estuarine habitats with lower salinity, moving from the edges of marshes during high tide to protected tidal channels and creeks during low tide; they venture into less protected areas at night (Healey 1980, 1982; Levy and Northcote 1981, 1982; Kjelson et al. 1982, Levings 1982). As the fish grow larger, they increasingly enter higher-salinity waters and less protected habitats, including delta fronts the estuary edge, before finally dispersing into strictly marine habitats. In contrast to fry, chinook fingerling, with their larger size, immediately take up residence in deeper-water estuarine habitats (Everest and Chapman 1972, Healey 1991).

The chinook diet during estuarine residence is highly variable, and is dependent upon the particular estuary, year, and season, as well as prey abundance. In general, chinook are opportunistic feeders, consuming larval and adult insects and amphipods when they first enter estuaries, and increasingly depending on larval and juvenile fish as they grow larger. Preferred diet items for chinook salmon include aquatic and terrestrial insects such as chironomid larvae, dipterans, cladocerans such as *Daphnia*, amphipods including *Eogammarus* and *Corophium*, and other crustaceans such as *Neomysis*, crab larvae, and cumaceans (Sasaki 1966, Dunford 1975, Birtwell 1978 *in* Floyd 2003, Levy et al. 1979, Northcote et al. 1979 *in* Floyd 2003, Healey 1980, 1982; Kjelson et al. 1982, Levy and Northcote 1981, Levings 1982, Gordon and Levings 1984, Myers 1980 *in* Floyd 2003; Reimers 1973). Larger juvenile chinook consume juvenile fishes such as anchovy *(Engraulidae)*, smelt *(Osmeridae)*, herring *(Clupeidae)*, and stickleback *(Gasterosteidae)*.

Growth in estuaries is quite rapid, and chinook may enter the upper reaches of estuarine environments as 1.4-1.6-inch fry, and leave as 2.8-4.3-inch smolts (Rich 1920, Levy and

Northcote 1981, 1982; Reimers 1973, Healey 1980). Growth rates during this period are difficult to estimate because small individuals are continually entering the estuary from upstream, while larger individual depart for marine waters. Reported growth for populations range from 0.008 inch/day to 0.034 inch/day, and are as high as 0.052 inch/day for groups of marked fish (Rich 1920, Levy and Northcote 1981, 1982; Reimers 1973, Healey 1980, Kjelson et al. 1982, Healey 1991, Levings et al. 1986).

Juveniles (marine)
After leaving the freshwater and estuarine environment, juvenile chinook disperse to marine feeding areas. Ocean-type fish which have a longer estuarine residence tend to be coast-oriented, preferring protected waters and waters along the continental shelf (Healey 1983). In contrast, stream-type fish pass quickly through estuaries, are highly migratory, and may migrate great distances into the open ocean.

Chinook salmon typically remain at sea for 1 to 6 years. They have been found in oceanic waters at temperatures ranging from 34-50°F, although few are found in waters below 41^0F (Major et al. 1978). They do not concentrate at the surface as do other Pacific salmon, but are most abundant at depths of 98-230 feet and are often associated with bottom topography (Taylor 1969, Argue 1970 *in* Floyd 2003). However, during their first several months at sea, juvenile chinook salmon of less than 5 inches are predominantly found at depths of less than 121 feet (Fisher and Pearcy 1995). Because of their distribution in the water column, the majority of chinook salmon harvested in commercial troll fisheries are caught at depths of 98 feet or greater.

Chinook salmon range widely in the North Pacific Ocean and the Bering Sea, as far south as the U.S./Mexico border (Godfrey 1968, Major et al. 1978). Chinook salmon from California, Oregon, Washington, and Idaho have been recovered in coastal areas throughout the Straight of Georgia and Inland Passage, along the Alaskan Coast into Cook Inlet and waters surrounding Kodiak Island, extending out into the Aleutian/Rat Island chains to 180ºW, and northward in the Bering Sea to the Priblof Islands (Hart and Dell 1986, Meyers et al. 1996).

Chinook salmon may stay in coastal waters or may migrate into offshore oceanic habitats. Migration from coastal to oceanic waters may begin off the coast of Vancouver Island, or may be delayed until reaching as far as Kodiak Island (Hartt and Dell 1986). Limited tag release and recovery data have found Washington origin chinook salmon in the Emperor Sea Mounts area, at approximately 44ºN and 175ºW (Meyers et al. 1996). Based on high seas tagging data presented in Meyers et al. (1996) and Hartt and Dell (1986), the oceanic distribution of Pacific Northwest chinook salmon appears to include the Pacific Ocean and Gulf of Alaska north of approximately 44ºN and east of 180ºW, including some areas of the Bering Sea.

The coastal distribution of chinook salmon is similar to coho salmon (Hartt and Dell 1986), with high concentrations in areas of pronounced coastal upwelling. Juvenile chinook are generally found within 34 miles of the Washington, Oregon, and California coast, with the vast majority of fish found less than 17 miles offshore (Pearcy and Fisher

1990, Fisher and Pearcy 1995). Historically, juvenile chinook salmon have been reported in coastal streams as far south as San Luis Obisbo (Jordan 1894) and the Ventura River (Jordan and Gilbert 1881), so it can be presumed that their historical ocean distribution occasionally included coastal upwelling areas off southern California. Point Conception (34º30'N), California, is considered the faunal break for marine fishes, with salmon and other temperate water fishes found north and subtropical fishes found south of this point (Allen and Smith 1988). Therefore, the historic southern edge of the marine distribution appears to be near Point Conception, California, and this expands and contracts seasonally and annually depending on ocean temperature patterns and upwelling.

It has been shown that ocean-migration patterns are influenced by both genetics and environmental factors (Healey 1991). Migratory patterns may have evolved as a balance between the benefits of accessing specific feeding grounds and the energy expenditure and dispersion risks necessary to reach them. Along the eastern Pacific rim, chinook salmon originating north of Cape Blanco on the Oregon coast tend to migrate north towards and into the Gulf of Alaska, while those originating south of Cape Blanco migrate south and west into waters off Oregon and California (Godfrey 1968, Major et al. 1978, Cleaver 1969 *in* Floyd 2003, Wahle and Vreeland 1977 *in* Floyd 2003, Wahle et al. 1981 *in* Floyd 2003, Healey and Groot 1987).

While the marine distribution of chinook salmon can be highly variable within and among populations, migration and ocean distribution do show some consistent patterns. For example, chinook salmon that spawn in rivers south of the Rogue River in Oregon disperse and rear in marine waters off the Oregon and California Coast, while those spawning north of the Rogue River migrate north and west along the Pacific coast (Godfrey 1968, Major et al. 1978, Cleaver 1969 *in* Floyd 2003, Wahle and Vreeland 1977 *in* Floyd 2003, Wahle et al. 1981 *in* Floyd 2003, Healey and Groot 1987). These patterns result in the harvest of fish from Oregon, Washington, and British Columbia within the Alaskan exclusive economic zone (EEZ).

Chinook salmon are the most piscivorous of the Pacific salmon. Accordingly, fishes make up the largest component of their diet at sea, although squids, pelagic amphipods, copepods, and euphausiids are also important at times (Merkel 1957, Prakash 1962, Ito 1964, Hart 1973, Healey 1991).

Adults

Throughout their range, adult chinook salmon may enter freshwater during almost any month of the year, although there are generally one to three peaks of migratory activity. In northern areas, chinook salmon river entry peaks in June, while in rivers such as the Fraser and Columbia, entry occurs between March and November, and peaks in spring (March-May), summer (May-July), and fall (August-September). The Sacramento also has a winter-run population, which enters freshwater between December and July.

Chinook salmon become sexually mature at anywhere between 2 and 8 years of age, with "jacks" (precocious males) maturing after only 1-2 years. Overall, the most common age for the sexual maturity of ocean- and stream-type fish is 3-5 years, with males tending to

mature slightly younger than females. In general, stream-type fish have a longer generation time than do ocean-type fish, presumably owning to their longer freshwater residence, and chinook salmon from Alaska and more northern latitudes typically mature a year or more later than their southern counterparts (Roni and Quinn 1995, Myers et al. 1998).

The size and age of adults at sexual maturity varies considerably among populations and years, and is influenced by both genetic and environmental factors. Size at maturity is thought to represent adaptation to local spawning environment (Ricker 1980, Healey 1991, Roni and Quinn 1995). Most adult chinook salmon females are 26-33 inches in length, while the slightly younger males are 20-33 inches. However, male and female fish larger than 39 inches in length at maturity are not uncommon in many populations.

Prior to sexual maturation and spawning, adult chinook salmon often rest, or hold, in large deep, low velocity pools, with abundant large woody material or other cover features. These areas may serve as a refuge from high river temperatures or predators, where they can reduce metabolic demands and reserve energy prior to spawning (Berman and Quinn 1991). The spawning densities of chinook and coho salmon have been correlated with large woody material and pool frequency (Montgomery et al. In prep. *in* Floyd 2003).

The survival of chinook salmon is affected by factors including run type (i.e., spring, summer, fall), freshwater migration length, and year. Hatchery spring and summer chinook salmon have smolt-to-adult survival rates that average one percent, although survival of many upper Columbia and Snake River basin hatchery stocks is typically less than 0.2% (Coronado-Hernandez 1995). Wild stocks from these areas are thought to have ocean survival are rates 2 to 10 times greater than hatchery fish (Coronado-Hernandez 1995). Fall chinook hatchery stocks also survive from smolt to adult at approximately one percent; fish from some areas, such as the Oregon coast, are consistently higher, though typically less than five percent (Coronado-Hernandez 1995).

Habitat Areas of Particular Concern

While lack of information at a sufficiently fine scale precludes identification of specific stream reaches and habitats as Habitat Areas of Particular Concern (HAPCs), information exists on the type of stream reaches preferred by chinook salmon for spawning and rearing. It is generally accepted that salmon spawn and rear primarily in stream reaches with a slope less than four to five percent (Lunetta et al. 1997), though they migrate through much steeper stream reaches. Furthermore, recent research has indicated that chinook and other fall-spawning anadromous salmonids are found primarily in plane-bed, pool-riffle, and forced-pool riffle stream channels, with slopes of less than four percent (Montgomery and Buffington 1997, Montgomery et al. In prep. *in* Floyd 2003). Stream reaches with a slope of greater than four percent are not frequently utilized by chinook salmon for spawning and rearing because of their high bed load transport rate, deep scour, and coarse substrate (Montgomery et al. In prep. *in* Floyd 2003).

The delineation of channel types allows the identification of potentially important and vulnerable habitats in the absence of accurate distribution or habitat data. Moreover, degraded stream reaches, those lacking key roughness elements (e.g., large woody material), and stream reaches with a high potential for restoration will still be identified as potential habitat. Therefore, the protection and restoration of chinook salmon habitat should focus on pool-riffle, plane bed, and forced-pool-riffle channels. Furthermore, any activity adjacent to or upstream of activity that could influence the quality of these important reaches or channels should be evaluated. Other vulnerable habitats that are in need of protection and restoration are off-channel rearing areas (e.g., wetlands, oxbows, side channels, sloughs) and estuarine and other near-shore marine areas. Submarine canyons and other regions of pronounced upwelling are also thought to be particular important during El Nino events (N. Bingham, Pacific Coast Federation of Fishermen Association, P.O. Box 783, Mendocino, CA 985460 pers. comm.) and may need additional consideration for protection.

Freshwater Essential Habitat

Freshwater Essential Fish Habitat (EFH) for chinook salmon consists of habitat suitable for 4 critical stages: (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration; (4) adult migration and holding. Important features of essential habitat for spawning, rearing, and migration include adequate: (1) substrate composition; (2) water quality (e.g., dissolved oxygen, nutrients, temperature, etc.); (3) water quantity, depth and velocity; (4) channel gradient and stability; (5) food; (6) cover and habitat complexity (e.g., large woody material, pools, channel complexity, aquatic vegetation, etc.); (7) space; (8) access and passage; and (9) flood plain and habitat connectivity. This incorporates but is not limited to life-stage specific habitat criteria summarized in Table 7.3.3-1. Chinook salmon EFH includes all those streams, lakes, ponds, wetlands, distributaries, and other waterbodies currently and historically utilized by chinook salmon in Washington, Oregon, Idaho, and California. The geographic extent of chinook essential habitat includes all waters currently and historically used by chinook salmon within the United States Geological Survey (USGS) hydrologic units identified in Table II.E-1.

Marine Essential Habitat

The important stages with regard to chinook salmon marine EFH are 1) estuarine rearing; 2) early ocean rearing; and 3) juvenile and adult migration. Important features of this estuarine and marine habitat are 1) adequate water quality; 2) adequate temperature; 3) adequate prey species and forage base (food); and 4) adequate depth, cover, marine vegetation, and algae in estuarine and near-shore habitats. The available information for each life-history stage is summarized below (Table 7.3.3-1). Overall, chinook salmon marine distribution is extensive, varies seasonally and interannually, and can only be defined generally. While limited information exists on chinook habitat use in marine waters, it is clear that those habitats utilized during early-ocean entry are the most

Table 7.3.3-1. Chinook salmon habitat use by life history stage. (Please see notes on next page).

Stage - EFH Level	Duration or Age	Diet/Prey	Season/Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs, 0-4 - Not all habitats have been sampled	50-130 d	Non-feeding stage; eggs consumed by birds, fish and mammals	late summer, fall, and winter	intragravel in stream beds	8 to 31 inches gravel depth; 6 inches to 23 feet water depth	medium to coarse gravel	NA	**DO** < 2 mg/l lethal, optimum > 8 mg/l; **Temperature** 32-67ºF, optimum 41-57ºF; **Water velocity** 6-75 inches/second
Larvae, 0-4 - (alevins) Not all habitats have been sampled	50-125 d until fry emerge from gravel	Non-feeding stage; Alevins consumed by birds, fish and mammals	fall, winter, and early spring	intragravel until fry emergence	8 to 31 inches in gravel depth; 6-275 inches water depth	medium to coarse gravel	NA	**DO** < 2 mg/l lethal, optimum > 8 mg/l; **Temperature** 32-67ºF, optimum 41-57ºF; **Water velocity** 6-75 inches/second
Juveniles, 0-4 (freshwater) - Not all habitats have been sampled	days-years	Insect larvae, adults, plankton	year-round, depending on race	streams, sloughs, rivers	0-47 inches	varied	NA	**DO** lethal at <2 mg/l, optimum at saturation; **Temperature** 32-79ºF, optimum 54-57ºF; **Salinity** < 29 ppt
Juveniles, 0-3 (Estuary and oceanic) - Not all habitats have been sampled	6-months to two years	Estuary: copepods, euphausiids, amphipods Ocean: Fish, squid, euphausiids	Estuary: Spring, summer, fall Ocean: year-round	BCH BAY, IP, ICS, OCS	P, N, SD/SP 30-80 m preferred depth	All bottom types	estuarine, littoral then more open water, UP, F, CL, G	**DO** lethal at <2 mg/l, optimum at saturation; **Temperature** 32-79ºF, optimum 54-57ºF; **Salinity** sea water
Adults, 0-2 - Not all habitats have been sampled	2-8 yrs of age from egg to mature adult	Fish, squid, euphausiids, amphipods, and copepods	Spawning: (July-Feb) Non-spawning: Year round	Oceanic to nearshore migrations Spawn in freshwater	P, N, SD/SP	NA	Different stock groups have specific oceanic migratory patterns	**DO** Preferred >5 mg/l, optimum at saturation; **Temperature** 32-79ºF; optimum <57ºF

Major sources: Healey 1991, Bjorrn and Reiser 1991, Myers et al. 1998, NOAA 1990, Fisher and Pearcy 1995, Spence et al. 1996

NOTES for Table 7.3.3-1:

EFH Data Level
0: No systematic sampling has been conducted for this species and life stage; may have been caught opportunistically in small numbers during other surveys.
1: Presence/absence distribution data are available for some or all portions of the geographic range.
2: Habitat-related densities are available. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value.
3: Habitat-related growth, reproduction, or survival rates are available. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).
4: Habitat-related production rates are available. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and a healthy ecosystem.
Location where found (in waters of these depths)
BCH - beach (intertidal)
ICS - inner continental shelf (3-160 feet)
MCS - middle continental shelf (160-330 feet)
OCS - outer continental shelf (330-660 feet)
USP - upper slope (660-3,300 feet)
LSP - lower slope (3,300-9,800 feet)
BSN - basin (>9,800 feet)
BAY - nearshore bays, give depth if appropriate (e.g., fjords)
IP - island passes (areas of high current), give depth if appropriate
Where found in water column
D - demersal (found on bottom)
SD/SP - semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom
P - pelagic (found off bottom, not necessarily associated with a particular bottom type)
N - neustonic (found near surface)
Bottom Types
M - mud
S - sand
R - rock
SM - sandy mud
CB - cobble
C - coral
MS - muddy sand
G - gravel
K - kelp
SAV - subaquatic vegetation other than kelp (e.g., eelgrass).
Oceanographic Features
UP - upwelling
G - gyres
F - fronts
CL - thermo-or pycnocline
E - edges
Other
U=Unknown
NA=not applicable

important. Furthermore, available research (Pearcy and Fisher 1990, Fisher and Pearcy 1995), catch data, and interviews with commercial fisherman all indicate and confirm that juvenile and maturing chinook salmon are found in highest concentrations along the continental shelf within 35 miles of the Washington, Oregon, and California coastlines. Therefore, the geographic extent of essential marine habitat for chinook salmon includes all waters from mean high water to 35 miles offshore north of Point Conception, California.

Coho Salmon

Juveniles (freshwater)

The vast majority of juvenile coho salmon from California to central British Columbia spend 1 year in fresh water before migrating to sea as 3.3-4.5-inch smolts (Pritchard 1940, Sumner 1953, Drucker 1972, Blankenship and Tivel 1980; Seiler et al. 1981, 1984; Blankenship et al. 1983; Lenzi 1983, 1985, 1987; Irvine and Ward 1989; Lestelle and Weller 1994). Because growth rates are lower in colder water, juveniles from northerly areas require 2 years in fresh water to attain this size, and some populations may need as many as 4-5 years to reach this size (Gribanov 1948, Drucker 1972, Crone and Bond 1976).

Coho smolt production is most often limited by the availability of summer and winter freshwater rearing habitats (Williams et al. 1975, Reeves et al. 1989, Nickelson et al. 1992). The lack of winter rearing habitats, such as backwater pools, beaver ponds, wetlands, and other off-channel rearing areas, is considered the primary factor limiting coho salmon production in many coastal streams (Cederholm and Scarlett 1981, Swales et al. 1988, Nickelson et al. 1992). If spawning escapement is adequate, sufficient fry are usually produced to exceed the carrying capacity of rearing habitat. In such cases, carrying capacity of summer habitats set a density-dependent limit on the juvenile population, which then may suffer density-independent mortality during winter depending on the severity of conditions, fish size, and quality of winter habitat.

Coastal streams, wetlands, lakes, sloughs, distributaries, estuaries, and tributaries to large rivers can all provide coho rearing habitat. The most productive habitats exist in smaller streams (less than fourth order) having low-gradient alluvial channels with abundant pools formed by large woody material (Foerster and Ricker 1953, Chapman 1965). Beaver ponds and large slackwater areas can provide some of the best rearing areas for juvenile coho (Bustard and Narver 1975, Nickelson et al. 1992). Coho juveniles may also use brackish-water estuarine areas in summer and migrate upstream to fresh water to overwinter (Crone and Bond 1976).

During summer rearing, the highest juvenile coho densities tend to occur in areas with abundant prey (e.g., drifting aquatic invertebrates and terrestrial insects that fall into the water) and structural habitat elements (e.g., large woody material and associated pools). Their preferred habitats include a mixture of different types of pools, glides, and riffles with large woody material, undercut banks, and overhanging vegetation to provide advantageous positions for feeding (Foerster and Ricker 1953, Chapman 1965, Reeves et

al. 1989, Bjornn and Reiser 1991). Coho grow best where water temperature is between 50ºF and 59ºF, and dissolved oxygen (DO) is near saturation. Juvenile coho can tolerate temperatures between 32ºF and 79ºF if changes are not abrupt (Brett 1952, Konecki et al. 1995). Their growth and stamina decline significantly when DO levels drop below 4 mg/l, and a sustained concentration of less than 2 mg/l is lethal (Reeves et al. 1989). Summer populations are usually constrained by density-dependant effects mediated by territorial behavior. In flowing water, juvenile coho usually establish individual feeding territories, whereas in lakes, large pools, and estuaries they are less likely to establish territories and may aggregate where food is abundant (Chapman 1962, McMahon 1983). Because growth in summer is often density-dependent, the size of juveniles in late summer is often inversely related to population density.

In winter, territorial behavior is diminished, and juveniles aggregate in freshwater habitats that provide cover and relatively stable depth, velocity, and water quality. Winter mortality factors include hazardous conditions during winter peak stream flow (e.g., scour, high velocities), stranding of fish during floods or by ice damming, physiological stress from low temperature, and progressive starvation (Hartman et al. 1984). In winter, juveniles prefer a narrower range of habitats than in summer, especially large mainstream pools, backwaters, beaver ponds, off-channel ponds, sloughs, and secondary channel pools with abundant large woody material, and undercut banks and debris along riffle margins (Skeesick 1970, Nickelson et al. 1992). Survival in winter, in contrast to summer, is generally density-independent, and varies directly with fish size and the amount of available cover and ponded water, and inversely with the magnitude of the peak stream flow. Survival from eggs to smolts is usually less than two percent (Neave and Wickett 1953).

The habitat requirements of coho during seaward migration are similar to those of coho juveniles. A high streamflow aids their migration by flushing them downstream and reducing their vulnerability to predators. Migrating smolts are particularly vulnerable to predation because they are concentrated, and moving through areas of reduced cover. Mortality during seaward migration can be quite high (Tytler et al. 1978, Dawley et al. 1986 *in* Floyd 2003, Seiler 1989). The seaward migration of smolts in native stocks is thought to be timed so that the smolts arrive in the estuary and nearshore ocean when food is plentiful (Foerster and Ricker 1953, Shapovalov and Taft 1954, Drucker 1972). In California the seaward migration is also timed to occur prior to the closing of some estuaries and tidal reaches by the formation of impassible sand bars (Bryant 1994). Rapid growth during the early period in the estuary and nearshore ocean is critical to survival, because mortality from predation appears to be size dependent (Myers and Horton 1982, Dawley et al. 1986 *in* Floyd 2003, Pearcy and Fisher 1988, Holtby et al. 1990, Pearcy 1992).

Juveniles (Estuarine)

The amount of time juvenile coho salmon rear in estuaries appears to be highly variable, with northern populations generally dwelling longer in estuaries than southern populations (Pearce et al. 1982, Simenstad et al. 1982, Tschaplinksi 1982). For example, Oregon coast, Columbia River, and Puget Sound coho salmon are thought to remain in

estuarine areas for several days to several weeks, while many British Columbian and Alaskan populations remain in estuaries for several months (Myers and Horton 1982, Pearce et al. 1982, Simenstad et al. 1982, Tschaplinksi 1982, Levings et al. 1995). As in the stream environment, large woody material is an important element of juvenile coho salmon habitat in estuaries (McMahon and Holtby 1992). In estuarine environments, coho salmon consume large planktonic or small nektonic animals, such as amphipods (*Corophium* spp., *Eogammarus* spp.), insects, mysids, decapod larvae, and larval and juvenile fishes (Myers and Horton 1982, Simenstad et al. 1982, Dawley et al. 1986 *in* Floyd 2003, McDonald et al. 1987 *in* Floyd 2003). They are in turn preyed upon by marine fishes, birds, and mammals. In estuaries, smolts appear in intertidal and pelagic habitats, with deep, marine-influenced habitats often preferred (Pearce et al. 1982, Dawley et al. 1986 *in* Floyd 2003, McDonald et al. 1987 *in* Floyd 2003).

Juveniles (Marine)

Two primary dispersal patterns have been observed in coho salmon after the emigration from freshwater. Some juveniles spend several weeks in coastal waters before migrating northwards into the offshore waters of the Pacific Ocean (Hartt 1980, Hartt and Dell 1986, Pearcy and Fisher 1988, Pearcy 1992), while others remain in coastal waters near their natal stream for at least the first summer before migrating north. The latter dispersal pattern is commonly seen in coho salmon from California, Oregon, and Washington (Shapovalov and Taft 1954, Godfrey 1965, Miller et al. 1983). It is not clear whether these less migratory fish, particularly those from coastal areas, make extensive migrations after the first summer. However, it is known that some Puget Sound/Strait of Georgia-origin coho salmon spend their entire ocean residence in the Sound and Strait, while others migrate to the open ocean in late summer (Healey 1980, Godfrey et al. 1975, Hartt and Dell 1986). The spatial distribution of suitable habitat conditions is affected by annual and seasonal changes in oceanographic conditions, and may affect the tendency of fish to migrate from, or reside in, coastal areas after ocean entry.

Coho from the Pacific Northwest generally stay in nearshore coastal and inland waters well into October (Hartt and Dell 1986). Juvenile coho from Oregon and presumably other areas will initially be found south of their natal streams, moved by strong southerly currents (Pearcy 1992). When these currents weaken in the winter months, juvenile coho migrate northward. In strong upwelling years, when the band of favorable temperatures and available prey is more extensive, coho salmon appear to disperse further from shore. In weak upwelling years, coho salmon concentrate in upwelling zones closer to the shore (Pearcy 1992), often near submarine canyons and other areas of consistent upwelling (Nat Bingham, Pacific Coast Federation of Fishermen's Associations, P.O. Box 783, Mendocino, CA, 95460 pers. com., February 1998). Generally, juvenile coho are found within 37 miles of the California, Oregon, and Washington coast, with the majority found within 23 miles of the coast (Pearcy and Fisher 1990, Pearcy 1992). Puget Sound-origin coho salmon are typically found in coastal waters of the Straight of Juan de Fuca and Vancouver Island throughout summer months (Hartt and Dell 1986).

Coho leaving Puget Sound and other inland waters are found to migrate north along the east or west coast of Vancouver Island and out into the Pacific Ocean (Williams et al.

1975, Hart and Dell 1986). Tag, release, and recovery studies suggest that immature coho salmon from Washington and Oregon are found as far as 60ºN along the Pacific Coast, and California-origin coho salmon as far as 58ºN in SE Alaska (Meyers et al. 1996). Coho salmon from Oregon streams have been taken in offshore waters near Kodiak Island in the northern Gulf of Alaska (Hart and Dell 1986, Meyers et al. 1996). Westward migration of coho salmon into offshore oceanic waters appears to extend beyond the U.S. Exclusive Economic Zone (EEZ) beginning around 45ºN latitude off the Oregon coast (Meyers et al. 1996). Coded-wire and high-seas tag data for Washington and Oregon suggest that oceanic migration for these coho stocks can extend as far south and west as 43ºN and 175ºE around the Emperor Sea Mounts (Meyers et al. 1996), believed to be an area of high prey abundance. Thus it appears that coho salmon stocks from Washington, Oregon, and California are found at least occasionally in the Pacific Ocean and Gulf of Alaska north of 44ºN to 57ºN, extending westward and southward along the Aleutian chain to the Emperor Sea Mounts area near 43ºN and 175ºE.

While juvenile and maturing coho are found in the open north Pacific, the highest concentrations are found in the more productive waters of the continental shelf, within 37 miles of the coast. Coho salmon have been occasionally reported off the coast of southern California near the Mexican border (Bryant 1994). However, Point Conception (34º30'N), California, is considered the faunal break for marine fishes, with salmon and other temperate water fishes primarily found north and subtropical fishes to the south (Allen and Smith 1988), although the southern limit expands and contracts seasonally and annually depending on ocean temperature patterns and upwelling.

Coho salmon in coastal and oceanic waters originate in stocks from a wide variety of streams in Washington, Oregon, and California (Godfrey et al. 1975, French et al. 1975, Burgner 1980, Hartt 1980, Hartt and Dell 1986, Weitkamp et al. 1995). Analysis of coded wire tag (CWT) data indicates distinct migration patterns for various basins, provinces, and states. For example, coho salmon from the Columbia River make up a high proportion of fish captured in Oregon waters, whereas coho from the Washington coast are rarely recovered in Oregon waters but frequently recovered in British Columbia (Weitkamp et al. 1995). The vast majority of CWT coho salmon are recovered in coastal waters where coho salmon fisheries occur.

Marine invertebrates, such as copepods, euphausiids, amphipods, and crab larvae are the primary food when coho first enter salt water. Fish represent an increasing proportion of the diet as coho salmon grow and mature (Shapovalov and Taft 1954, Healey 1978, Myers and Horton 1982, Pearcy 1992). Growth is controlled mainly by food quantity, food quality, and temperature. Growth is best in pelagic habitats where forage is abundant and sea surface temperature is between 54ºF and 59ºF (Godfrey et al. 1975, Hartt 1980, Healey 1980). Coho salmon rarely use areas where sea surface temperature exceeds 59ºF and are generally found in the uppermost 33 feet of the water column. Coho salmon do not aggregate in offshore waters and prefer slightly warmer ocean temperatures than do other Pacific salmon (Godfrey 1965, Manzer et al. 1965, Welch 1995 *in* Floyd 2003). Before entering fresh water, most coho slow their feeding and begin to lose weight as they develop secondary sexual characteristics and large gonads.

Precocious males return to spawn after approximately 6 months at sea, but most coho remain at sea for about 16 months before returning to coastal areas and entering fresh water to spawn (Godfrey 1965; Wright 1968, 1970; Sandercock 1991).

Adults

Adult coho enter fresh water from early July through December, often after the onset of fall freshets, with peak river entry occurring as early as September in Alaska; October and November in British Columbia, Washington, and Oregon; and December and even January in California (Briggs 1953, Godfrey 1965, Ricker 1972, Fraser et al. 1983, Bryant 1994). Some populations, often referred to as the "summer-run" coho salmon, are exceptionally early, entering rivers in late spring and early summer (Aro and Shepard 1967, Houston 1983, WDF et al. 1993). In general, larger river basins have a wider range of river entry times than do smaller systems, and river entry occurs later the farther south a river is situated (Godfrey 1965, Sandercock 1991). The fish feed little and migrate upstream to their natal stream using olfactory cues imprinted in early development (Harden Jones 1968, Quinn and Tolson 1986, Sandercock 1991). The fidelity of mature fish to their natal streams is high, and straying rates are generally less than five percent (Shapovalov and Taft 1954, Lister et al. 1981, Labelle 1992). Adult coho may travel for a short time and distance upstream to spawn in small streams or may enter large river systems and travel for weeks to reach spawning areas more than 1,240 miles upstream (Godfrey 1965, Aro and Shepard 1967, McPhail and Lindsay 1970 *in* Floyd 2003, Sandercock 1991, WDF et al. 1993).

Most coho salmon spawn at approximately the same time regardless of when they entered fresh water (Foerster and Ricker 1953, Shapovalov and Taft 1954, Sandercock 1991). Consequently, populations that enter fresh water in late summer and early fall may reside in fresh water 3-4 months before spawning, while fish entering fresh water in late fall may spawn within weeks of entry. At the extreme southern end of their range in central California, most coho salmon enter fresh water in late December or January and spawn shortly thereafter (Briggs 1953, Shapovalov and Taft 1954, Bryant 1994).

The survival of coho salmon is generally affected by numerous factors in both salt and fresh water, including ocean conditions, location of natal stream, freshwater migration length, stream flow, and other environmental factors. Hatchery coho salmon have smolt-to-adult survival rates that average between three to five percent, but can be much higher in areas such as Puget Sound, as well as lower during unfavorable years (Coronado-Hernandez 1996 *in* Floyd 2003). Wild stocks typically show marine survival rates 2-3 times greater than hatchery fish (Seiler 1989, Pearcy 1992, Coronado-Hernandez 1996 *in* Floyd 2003).

Freshwater Essential Habitat (Freshwater)

Freshwater Essential Fish Habitat (EFH) for coho salmon consists of habitat suitable for four critical stages: 1) spawning and incubation; 2) juvenile rearing; 3) juvenile migration; and 4) adult migration. Important features of essential habitat for spawning, rearing, and migration include adequate: 1) substrate composition; 2) water quality (e.g., dissolved oxygen, nutrients, temperature, etc.); 3) water quantity, depth and velocity; 4)

channel gradient and stability; 5) food; 6) cover and habitat complexity (e.g., large woody material, channel complexity, aquatic vegetation, etc.); 7) space; 8) access and passage; and 9) habitat and flood plain connectivity. This incorporates but is not limited to the life-stage-specific habitat criteria summarized in Table II.B-1. Coho salmon freshwater essential habitat includes all those streams, lakes, ponds, wetlands, and other waterbodies currently and historically utilized by coho salmon within Washington, Oregon, Idaho, and California. The geographic extent of coho salmon essential habitat includes all waters currently and historically used by coho salmon within the United States Geological Survey (USGS) hydrologic units identified in Table 7.3.3-2.

The diversity of habitats utilized by coho salmon, coupled with the inadequacy of existing species distribution maps, makes it extremely difficult to identify all stream reaches, wetlands, and waterbodies essential for the species at this time. Designating each specific river reach would invariably exclude small, important tributaries from designation as EFH.

Defining specific river reaches is also complicated because of the current low population of the species and our imperfect understanding of its freshwater distribution, both current and historical. Adopting a more inclusive, watershed-based description of EFH is appropriate because it 1) recognizes the species' use of diverse habitats and underscores the need to account for all of the habitat types supporting the species' freshwater and estuarine life stages, from small headwater streams to migration corridors and estuarine rearing areas; 2) takes into account the natural variability in habitat quality and use (e.g., some streams may have fish present only in years with plentiful rainfall) that makes precise mapping difficult; and 3) reinforces the important linkage between aquatic areas and adjacent upslope areas. Moreover, this watershed-based approach is consistent with other Pacific salmon habitat protection and recovery efforts such as the ESA, Northwest Forest Plan, and the Oregon Coastal Salmon Restoration Initiative. Therefore, the geographic extent of coho salmon essential habitat was delineated using hydrologic units defined in the U.S. Geological Survey's 1:500,000 scale hydrologic unit maps for Washington, Idaho, Oregon, and California (USGS 1975, 1976, 1978, 1989 *in* Floyd 2003, Seaber et al. 1986 *in* Floyd 2003).

Marine Essential Habitat

The important stages with regard to coho salmon marine EFH are 1) estuarine rearing; 2) early ocean-rearing; and 3) juvenile and adult migration. Important features of this estuarine and marine habitat are 1) adequate water quality; 2) adequate temperature; 3) adequate prey species and forage base (food); and 4) adequate depth, cover, and marine vegetation in estuarine and nearshore habitats. Overall, coho salmon marine distribution is extensive, varies seasonally and by year, and can only be defined generally. While limited information exists on coho salmon habitat use in marine waters, it is clear that those habitats utilized during early ocean entry are the most important. Furthermore, available research, catch data, and interviews with commercial fishermen indicate and

Table 7.3.3-2. Coho salmon habitat use by life history stage. (See notes on following page.)

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Eggs, 0-4 - Not all habitats have been sampled	50 days at optimum temperatures	Non-feeding stage; eggs consumed by birds, fish and mammals	fall/winter	streambeds	intragravel; water depth 1.5-14 inches	NA	NA	**DO** < 2 mg/l lethal, optimum > 8 mg/l; **Temperature** 32-63ºF; optimum 40-56ºF; **substrate** 1-4 inches with < 15% fines (<0.13 inch), optimum <5% fines; **Water velocity** 10-35 inches/second
Larvae, 0-4 - (alevins) Not all habitats have been sampled	100 days at optimum temperatures	Non-feeding stage; Alevins consumed by birds, fish and mammals	winter/spring	streambeds	intragravel; water depth 1.5-14 inches	NA	NA	**DO** < 3 mg/l lethal, optimum > 8 mg/l; **Temperature** 32-63ºF; optimum 40-56ºF; **Substrate** 1-4 inches with < 15% fines (<0.13 inch), optimum <5% fines; **Water velocity** 10-35 inches/second
Juveniles, 0-4 (freshwater) - Not all habitats have been sampled	1-5 yrs, most (>90%) 1 yrs	Aquatic, terrestrial, and estuarine invertebrates, fish; Predators include birds, fish, mammals	rearing -all year migration- spring and fall	streams, lakes, BAY (estuaries)	Water depth 0-48 inches in streams	NA	NA	**DO** lethal at <2 mg/l, optimum at saturation; **Temperature** 32-79ºF; optimum 54-57ºF; **Salinity** < 29 ppt; **Water velocity** 2-12 inches/second
Juveniles, 0-3 (marine) - Not all habitats have been sampled	16 months (except precocious males)	epipelagic fish (herring, sand lance) and marine invertebrates (copepods, euphausiids, amphipods, crab larvae)	rearing- all year migration - all year	BCH, ICS, MCS, OCS, USP, BAY, IP	pelagic	NA	UP, CL, F; migration influenced by currents, salinity and temperature	**Temperature** <49ºF; **Depth** <110 feet

Table 7.3.3-2. (continued).

Stage - EFH Level	Duration or Age	Diet/Prey	Season/ Time	Location	Water Column	Bottom Type	Oceanographic Features	Other
Adults, 1-2 - Not all habitats have been sampled	up to 2 months	little or none	migration - fall spawning - fall, winter	rivers, streams, lakes		NA		**DO** Preferred >5 mg/l, optimum at saturation; **Temperature** 32-79ºF; optimum <57ºF

Primary Sources: Shapovalov and Taft 1954, Sandercock 1991, Bjorrn and Reiser 1991, Weitkamp et al. 1995, Spence et al. 1996.

NOTES for Table 7.3.3-1:

EFH Data Level
0: No systematic sampling has been conducted for this species and life stage; may have been caught opportunistically in small numbers during other surveys.
1: Presence/absence distribution data are available for some or all portions of the geographic range.
2: Habitat-related densities are available. Density data should reflect habitat utilization, and the degree that a habitat is utilized is assumed to be indicative of habitat value.
3: Habitat-related growth, reproduction, or survival rates are available. The habitats contributing the most to productivity should be those that support the highest growth, reproduction, and survival of the species (or life history stage).
4: Habitat-related production rates are available. Essential habitats are those necessary to maintain fish production consistent with a sustainable fishery and a healthy ecosystem.
Location where found (in waters of these depths)
BCH - beach (intertidal)
ICS - inner continental shelf (1-160 feet)
MCS - middle continental shelf (160-330 feet)
OCS - outer continental shelf (330-660 feet)
USP - upper slope (660-3,280 feet)
LSP - lower slope (3,280-9,840 feet)
BSN - basin (>9,840 feet)
BAY - nearshore bays, give depth if appropriate (e.g., fjords)
IP - island passes (areas of high current), give depth if appropriate
Where found in water column
D - demersal (found on bottom)
SD/SP - semi-demersal or semi-pelagic if slightly greater or less than 50% on or off bottom
P - pelagic (found off bottom, not necessarily associated with a particular bottom type)
N - neustonic (found near surface)
Bottom Types
M - mud
S - sand
R - rock
SM - sandy mud
CB - cobble
C - coral
MS - muddy sand
G - gravel
K - kelp
SAV - subaquatic vegetation other than kelp (e.g., eelgrass).
Oceanographic Features
UP - upwelling
G - gyres
F - fronts
CL - thermo-or pycnocline
E - edges
Other
U=Unknown
NA=not applicable

confirm that the highest concentrations of juvenile and maturing coho salmon are found within 37 miles of the Washington, Oregon, and California coasts (Pearcy and Fisher 1990, Pearcy 1992). Therefore, the geographic extent of essential marine habitat for coho salmon is defined as all waters between mean high water and 37 miles offshore north of Point Conception, California.

7.4 Analysis of Effects on Groundfish and Pacific Salmon Essential Fish Habitat

The Bridge Program may have effects on the Pacific salmon and groundfish EFH as a result of bridge repair or replacement activities within or upstream of designated EFH. These effects will be either water-borne (turbidity, chemicals) or habitat-related (stream channel and riparian effects). Bridge repair or replacement activities in an EFH or upstream of a natural barrier upstream of an EFH may adversely affect that EFH.

7.4.1 Screening Criteria

A screening of the geographic extent and concentration of potential effects on groundfish and Pacific salmon EFH was completed by preparing a GIS data layer that provided the spatial extent of EFH for both groups and then comparing the location of EFH with the known bridge replacement or repair locations. For Pacific salmon, the 4th field HUCs were selected from the list provided in Amendment 14 to the Pacific Coast Salmon Plan: Appendix A (PFMC 1999). The 4th field HUCs with barriers to fish passage were included in the GIS analysis, under the assumption that partial or future access of these areas to salmonids is or will be available during the span of the proposed action. Furthermore, activities occurring above impassible barriers that are likely to adversely affect EFH below impassible barriers are subject to the consultation provisions of the MSA.

For groundfish, “head of tide” data collected by the Oregon Division of State Lands (DSL 1989) were used as a proxy for the extent of saltwater incursion into coastal streams. A GIS data layer was created for this information, in conjunction with a hydrography layer of Oregon rivers. The assumptions used in the analysis of potential effects of the Bridge Program on EFH are documented in Appendix 2-A (Effects Screening Layer Memos) and 2-B (Evaluation of Effects Memos).

7.4.2 Potential Adverse Effects on Groundfish EFH and Associated Mitigation/Avoidance Measures

Non-fishing activities associated with the proposed action that may adversely affect groundfish EFH include filling, excavation, impoundment, discharge, water diversions, thermal additions, actions that contribute to non-point source pollution and sedimentation, the introduction of potentially hazardous materials, the introduction of exotic species, and the conversion of aquatic habitat that may eliminate, diminish, or disrupt the functions of EFH. The environmental performance standards detailed in Section 3 have been developed to minimize or avoid adverse effects on designated EFH.

7.4.2.1 Groundfish Estuarine EFH

This document provides an analysis of the potential effects of the proposed action on the estuarine EFH for groundfish. EFH can be affected when one or more physical, chemical, or biological parameters are altered. Pathways through which potential effects may be delivered to groundfish EFH are summarized below.

Riparian Vegetation

Bridge replacement or repair activities along banks with riparian vegetation may degrade the function of the existing riparian habitat by removing vegetation and destabilizing the banks. Potential impacts include the loss of riparian shade and cover, loss of organic inputs, and loss of habitat complexity. Allochthonous detritus probably constitutes the dominant pathway of trophic carbon into estuarine food webs, and riparian vegetation is often the dominant source of organic matter contributing to the estuarine detritus pool, such as in the Columbia River estuary (Simenstad and Wissmar 1996 *in* Floyd 2003).

Riparian vegetation removal will likely be required by the proposed action. However, the amount of riparian vegetation cleared at individual bridge sites is small relative to the available riparian vegetation for estuarine systems within the range of the project. Riparian vegetation clearing will rarely extend more than 75 feet on either side of a replaced bridge. For most systems, temperature increases due to riparian vegetation removal on this small scale will not be measurable. The environmental performance standards in Section 3 will minimize vegetation removal, and ensure that removed vegetation that is not part of the new permanent bridge footprint is replaced with a functional equivalent; monitoring will be conducted to ensure the long-term survival of replacement plantings. Some temporary minor effects on water temperature in some stream systems may be expected while the replaced riparian vegetation matures. Over time, the new growth will be functionally equivalent to the vegetation removed by the project. Therefore, riparian vegetation removal effects on stream temperature are considered to be temporary, and in most cases minor.

Wetlands

Bridge replacement or repair activities may take place in estuarine wetlands. Wetland size may be reduced by the placement of fill, reducing or eliminating habitat for submerged aquatic or emergent vegetation, and reducing food web support.

Fill may cause direct harm to EFH or estuarine habitat by burying plants; fish; or invertebrate eggs, larvae, or adults; or by displacing mobile animals. The removal of material from wetlands for the purpose of creating open and/or deeper water, the excavation of exotic plants, or drainage of adjacent lands may modify hydrologic regimes to the detriment of wetland plant species.

The addition of fill to estuarine wetlands may reduce water quality by eliminating the normal settling, filtration, adsorption of contaminants and nutrients, and denitrification of surface runoff formerly entering the estuarine system through that wetland. As a result, excess nutrients in surface water may lead to algae blooms and subsequently to reduced dissolved oxygen content in streams. During the construction or repair activity and until revegetation is complete, adjacent waters are likely to have increased turbidity from surface runoff and the erosion of fill materials.

Additionally, vegetation clearing associated with fill may reduce site productivity, and eliminate EFH structure. Vegetation clearing and the associated surface disturbance often result in the colonization or expansion of non-native plant species that compete with native plants, in a reduction of the habitat available for rare plants, and in a reduction of diversity and food sources for aquatic and terrestrial animals.

Submerged aquatic vegetation beds in estuaries provide key habitats for marine and anadromous organisms. Seagrasses supply many habitat functions, including: (1) the support of large numbers of epiphytic organisms; (2) the damping of waves and slowing of currents which enhances sediment stability and increases the accumulation of organic and inorganic material; (3) the binding of sediments by roots, thus reducing erosion and preserving sediment microflora; and, (4) the provision of horizontal and vertical complexity to habitat by roots and leaves, which, together with abundant and varied food sources, support densities of fauna generally exceeding those in unvegetated habitats (Thayer et al. 1984). Estuarine emergent vegetation (e.g., hardstem bulrush, soft rush, Lyngby's sedge) typically provides habitat for nematodes, oligochaetes, chironomid pupae, and polychaete annelids. Bridge replacement or repair activities that remove emergent vegetation would remove habitat for important invertebrate food species.

Bridge replacement and repair activities may alter the timing of estuarine wetland hydrology, and these changes may make the wetland nonfunctional for species that have evolved with specific hydrologic regimes. Increased impervious surfaces and the diversion of surface runoff or stormwater to treatment facilities may disrupt the groundwater recharge to wetlands. Changes in hydrology may change other wetland functions including nitrogen and phosphorus cycling, particularly de-nitrification, thermoregulation, primary production, and habitat for EFH species. Partial fills of wetlands may re-distribute water within a wetland, thus changing the hydrologic regime of the remaining habitat.

Temporary detour routes and bridges associated with the proposed actions have the potential to encroach upon estuarine wetlands. Implementation of the Fluvial Environmental Performance Standard will minimize the use of fills within functional floodplains and allow normative physical processes to occur within the stream-floodplain corridor. This will likely improve the existing condition of this

parameter in many bridge locations by improving the stream/floodplain interface, which has direct implications for improving wetlands. Efforts will be made at the design stage of each project to minimize effects on sensitive areas including wetlands. Vegetation clearing will be minimized and cleared vegetation will be replaced to specifications detailed in Section 3.

Bank Disturbance

Access and excavation for bridge replacement and repair activities may disturb the bank, release sediment, remove structural habitat along the edge of the water, and result in bank instability and habitat simplification. Sessile macroalgae that occur on estuarine banks with natural or artificial cobble to solid rock substrate may be destroyed or displaced.

Some effects may be unavoidable, particularly temporary effects during construction and permanent effects on banks directly underneath proposed structures (i.e., where an existing structure has been widened, requiring vegetation removal and possibly additional riprap armoring). However, bridge construction permitted under this program will minimize potential effects on existing bank conditions by adhering to the environmental performance standards in Section 3.

Site restoration activities in disturbed areas will generally involve grading banks to appropriate slopes and replacing any vegetation removed. Many of the bridges that are proposed for replacement currently promote bank degradation by encroaching upon floodplains and constricting flows. In addition, many of these bridges have required the placement of riprap or other armoring materials within or near banks, with adverse effects on bank conditions at and downstream of the bridge location. Adherence to environmental performance standards will likely result in localized beneficial effects to estuarine bank conditions throughout the State.

In-water Work

Proposed bridge work may require the use of machinery in the water. As with all bridge activities, accidental release of diesel fuel, motor oil, hydraulic fluid, and other contaminants may occur during in-water work. Operation of back-hoes, excavators, and other equipment requires the use of fuel and lubricants, which, if spilled into the water or into the adjacent wetland or riparian zone, can seriously degrade water quality constituents of EFH.

The effects of hardened embankments on an estuary include the simplification of bank habitat and the alteration of tidal processes. Simplification reduces vegetative refugia (which assist in predator avoidance), and may degrade or eliminate shallow water habitat.

Several of the environmental performance standards presented in Section 3 will minimize the effects of the Bridge Program on groundfish EFH. Performance standards will avoid or minimize project-related effects on water quality or aquatic habitat by controlling staging and equipment operation, by minimizing hardened structures within waterbodies, and by maintaining normative fluvial processes.

Conservation measures include proper equipment staging, the preparation of spill prevention and containment plans, and the routing of stormwater generated on bridge surfaces to stormwater treatment facilities. All construction sites are subject to minor spills and drips of materials that could eventually cause minor chemical contamination. However, the adverse effects on water quality are expected to be local and negligible. Moreover, treatment of stormwater at bridges that currently lack treatment facilities will be a net benefit to groundfish EFH.

The proposed action will involve minimal or no activities within intertidal areas. The environmental performance standards that address in-water work will guide construction timing and methods in order to limit impacts to estuarine benthic communities in the event that the proposed action occurs within or near a benthic community.

Sediment

The release of sediment from actions associated with bridge replacement and repair may affect water quality during the project, and may have residual effects following the project. Localized increases in sedimentation will likely result from excavation and grading of the streambank. The release of sediment during in-water work and the movement of eroded material into the water may increase turbidity, with direct or indirect effects on EFH. Most effects of sediment will be short-term and directly related to the extent and duration of in-water work. The removal of riparian vegetation for site access and staging may cause a short-term increase in runoff and increase sediment loads, and may also mobilize fine sediment on the stream bottom. Soil compaction from equipment can reduce the ability of the site to grow vegetation and can contribute to erosion and sedimentation.

The environmental performance standards will minimize erosion and turbidity stemming from bridgework within or near estuarine areas (Section 3). Temporary, localized effects are possible during bridge replacement activities; however, conducting all in-stream work during specified in-water work periods will minimize the potential for these increases.

Staging

Most bridge construction or repair activities require the use of equipment and materials that must be parked near a project site. Locations within the ODOT

right-of-way that provide close, convenient access to a project site are usually located in wide, open, level spots along the highway. The locations of staging areas are limited by available space and adherence to distance buffers designed to protect water quality and aquatic resources.

Parked equipment may leak oil, hydraulic fluid, or fuel that contaminates the soil or is transported into the estuary or wetland. Equipment repair and maintenance (fueling, changing oil, lubrication) may also result in spills of fuel, oil, antifreeze, or hydraulic fluids that contaminate the soil or are transported into the estuary or wetland.

The temporary stockpiling of repair or waste materials may result in contamination of soil or water with wood preservatives or other toxic substances being removed from a bridge replacement and repair project site. The Pollution and Erosion Control Environmental Performance Standard will be applied to every bridge replacement or repair activity included in this consultation. Plans will detail appropriate staging methods that minimize the delivery of sediment, contaminants, or construction materials to aquatic resources. Restrictions will be made regarding equipment use and refueling, and staging and special containment measures will be required for stationary equipment that operates near a regulated waterbody.

Rocky Shelf EFH

Rocky shelf EFH may affected by actions associated with bridge repair or replacement, such as erosion repair, slope/bank stabilization, culvert repair or removal, shoulder repair, bridge repair, scour repair, concrete work, and temporary bridges. Where roads or structures are located directly above rocky coasts or over chasms cut into headlands, these activities may affect intertidal rocky areas, tide pools, and inshore subtidal rocky habitats as a result of leaks or spills from equipment, the downslope transport of sediment, or the unavoidable downslope movement of rocks or other repair materials below the MHHW line. Bridge work where rocky shelf EFH occurs immediately below US-101 would mostly take place from the highway due to lack of access on the steep slopes below. It is highly unlikely that construction equipment would be placed below the MHHW line in these areas due to lack of access.

Adherence to the environmental performance standards developed for this program will significantly reduce the likelihood that groundfish rocky shelf EFH is adversely affected by bridge replacement or repair work. At this time, no bridges are scheduled for replacement within rocky shelf EFH. However, bridge repair work could occur within this type during the life of the Bridge Program. All potential repair work authorized under this consultation will implement environmental performance standards that address construction activity within or near aquatic resources.

7.4.3 Determination of Effects on Groundfish EFH

There are 48 bridges within the range of groundfish EFH. Of these, 46 bridges are in the Coast Range ecoregion, one is in the Klamath Mountains ecoregion, and one is in the Willamette Valley ecoregion. Forty two are located in a riverine environment and six are located in a bay or estuary.

Bridges where repair or replacement activities may affect groundfish EFH occur in 11 5th Field HUCs. Within this groundfish EFH, the greatest concentration of bridges occurs in the Middle Fork Coquille watershed, which accounts for 23% of the gross API.

The disturbance of streambanks may cause indirect effects on groundfish EFH. The area of streambank disturbance was estimated by multiplying the number of bridges that may affect groundfish EFH (48), by the permanent and temporary streambank disturbance area assumed for each bridge (40 feet of permanent disturbance and 300 feet of temporary disturbance). The total amount of permanent streambank disturbance at these 48 bridges is approximately 1,920 feet, or 0.36 river miles. The total amount of temporary streambank disturbance that could affect groundfish EFH is approximately 14,400 feet, or 2.7 river miles.

Based on this analysis for the Bridge Program, ODOT/FHWA makes a determination of ***will adversely affect*** for groundfish EFH. However, implementation of the environmental performance standards will minimize adverse effects on EFH for groundfish. These conclusions are based on the following considerations: (1) the Bridge Program requires individual review of each project to ensure that the proposed action will be in compliance with the environmental performance standards identified herein, and that each applicable conservation measure is included as an enforceable condition of the permit document; (2) the cumulative effect of the conservation measures applied to each project will ensure that any short-term effects on water quality, habitat access, habitat elements, channel conditions and dynamics, flows, and watershed conditions will be minor and of short duration. The ecological design approach that will be applied to program bridges is expected to result in many projects that will have long-term beneficial effects on aquatic habitat parameters; and the individual and combined effects of all actions permitted are not expected to impair currently properly functioning habitats, appreciably reduce the functioning of already impaired habitats, or retard the long-term progress of impaired habitats toward the proper functioning condition essential to survival and recovery at the population or species scale.

7.4.4 Potential Adverse Effects on Pacific Salmon EFH and Associated Mitigation/Avoidance Measures

A formal assessment of the freshwater EFH components for listed ESUs of Pacific salmon is not presented separately in this document, as the analysis of effects of the Bridge Program on 14 listed salmonid ESUs and their designated critical habitat presented in Section 5 fulfills this requirement for EFH analysis. However, an assessment

of the mitigated effects on the estuarine EFH composite for salmonids is summarized below.

Estuaries provide a protected and food-rich environment for juvenile salmon growth, and allow a transition for both juveniles and adults between the fresh and saltwater environments. Adults also may hold and feed in estuaries before beginning their upstream migration.

Simenstad and others (1982) hypothesized three important estuarine functions that enhance the growth and survival of Pacific salmon:

Physiological Transition

Salmonids undergoing physiological change may benefit from the gradual change from fresh to salt water within the estuary.

Predator Avoidance

Although the abundance of predators is higher in the estuary, juvenile salmon may disperse into habitats (e.g., aquatic vegetation, shallow areas, small side channels, etc.) that offer protection from predators. In addition, turbidity is often higher, which reduces the efficiency of predators.

Optimum Foraging Conditions

The size, distribution, and density of many prey organisms in the estuary appear to be optimal for juvenile salmon.

The possible effects of the program on Pacific salmon EFH that are of particular concern with respect to the Bridge Program include the following:

- Lowered water quality
- Altered timing/quantity of fresh water in-flow
- Loss of habitat resulting from diking, dredging, filling
- Diminished habitat complexity
- Loss of channels, eel grass beds, woody material
- Increased predation resulting from habitat simplification
- Diminished prey/competition for prey.

Floyd (2003) summarized mechanisms by which Pacific salmon EFH may be altered or degraded. The major effects on Pacific salmon EFH that may occur as a result of the Bridge Program are discussed below.

Riparian Vegetation Removal

Bridge replacement and repair activities along banks with riparian vegetation may degrade the function of existing riparian habitat by removing vegetation and de-stabilizing the banks. Potential effects to Pacific salmon EFH include the loss of riparian shade and cover, the loss of organic inputs, and the loss of habitat complexity. Detritus probably constitutes the dominant pathway of trophic carbon into estuarine food webs, and riparian vegetation is often the dominant source of organic matter contributing to the estuarine detritus pool (Simenstad and Wissmar 1996 *in* Floyd 2003).

Riparian vegetation removal will likely be required as part of the proposed action. However, the amount of riparian vegetation cleared at individual bridge sites is small fraction of the available riparian vegetation for the estuarine systems in the range of the project. Riparian vegetation clearing will rarely extend more than 75 feet on either side of a replaced bridge. For most systems, temperature increases due to riparian vegetation removal on this scale will not be measurable. Environmental performance standards will require that vegetation removed that is not part of the new permanent bridge footprint be replaced with a functional equivalent. The environmental performance standards also require a monitoring plan that will ensure the long-term survival of replacement plantings. Some temporary minor effects on water temperature in some stream systems may be expected while the replaced riparian vegetation matures, but over time, the new growth will be functionally equivalent to the vegetation removed by the project. Therefore, these effects on stream temperature are considered to be temporary, and in most cases minor.

Wetlands

Bridge replacement and repair activities may take place in estuarine wetlands. Wetland size may be reduced by the placement of fill, reducing or eliminating habitat for submerged aquatic or emergent vegetation, and reducing food web support.

Fill may cause direct harm to Pacific salmon EFH by burying plants; or by removal of material from wetlands for the purpose of creating open and/or deeper water. Excavation of exotic plants, or the drainage of adjacent lands may modify hydrologic regimes to the detriment of wetland plant species that may provide refugia or rearing habitat constituents of Pacific salmon EFH.

Fill in estuarine wetlands may reduce water quality by eliminating normal settling, filtration, adsorption of contaminants and nutrients, and denitrification of surface runoff formerly entering the estuarine system through that wetland. Without these wetland functions present, excess nutrients in surface water may lead to algae blooms and subsequently to lowered dissolved oxygen content in streams. During the bridgework and until revegetation is complete, adjacent

waters are likely to have increased turbidity from surface runoff and erosion of fill materials.

The vegetation clearing associated with fill may reduce site productivity and eliminate EFH structure. Vegetation clearing and associated surface disturbance often result in the colonization or expansion of non-native plant species that compete with native plants, or in the reduction of habitat available for rare plants and of diversity and temporal supplies of food sources for aquatic and terrestrial animals.

Submerged aquatic vegetation beds in estuaries provide key habitats for marine and anadromous organisms. Seagrasses supply many habitat functions, including: (1) the support of large numbers of epiphytic organisms; (2) the damping of waves and slowing of currents which enhances sediment stability and increases the accumulation of organic and inorganic material; (3) the binding of sediments by roots, which reduces erosion and preserves sediment microflora; and, (4) the provision of horizontal and vertical complexity to habitat by roots and leaves, which, together with abundant and varied food sources, support densities of fauna generally exceeding those in unvegetated habitats (Thayer et al. 1984).

Estuarine emergent vegetation (e.g., hardstem bulrush, soft rush, Lyngby's sedge) typically provides habitat for nematodes, oligochaetes, chironomid pupae, and polychaete annelids. Bridge replacement and repair activities that remove emergent vegetation will remove habitat for important invertebrate food species.

Bridge replacement and repair activities in estuaries may require disturbance of the benthic substrate. Such disturbance could cause mortality to benthic invertebrate prey species and the loss of benthic habitat for invertebrates that provide food for salmonids.

Bridge replacement and repair activities in estuaries have the potential to disturb or remove submerged aquatic vegetation. Construction access and drilling activities in estuaries will be permitted on the condition that submerged aquatic vegetation is avoided. Best management practices designed to avoid submerged aquatic vegetation will also be implemented.

Bridge replacement and repair activities may alter the timing or duration of estuarine wetland hydrology. These changes may make the wetland nonfunctional for species that have evolved with specific hydrologic regimes. Increased impervious surfaces and the diversion of surface runoff or stormwater to treatment facilities may disrupt the groundwater recharge to wetlands. Changes in hydrology may change other wetland functions including nitrogen and phosphorus cycling, particularly de-nitrification, thermoregulation, primary production, and physical habitat for EFH species. Partial fills of wetlands may re-distribute water within a wetland, thus changing the hydrologic regime of the remaining habitat.

Temporary detour routes and bridges associated with the proposed action have the potential to encroach upon estuarine wetlands. Implementation of the environmental performance standards will ensure the reduction of fill within functional floodplains and allow normative physical processes to occur within the stream-floodplain corridor. This will likely improve the existing condition of this parameter in many bridge locations by improving the stream/floodplain interface, which has direct implications for wetlands. Efforts will be made at the design stage of each bridge replacement project to minimize effects on sensitive areas including wetlands. Vegetation clearing will be minimized, and cleared vegetation will be replaced to specifications detailed in the Site Restoration Environmental Performance Standard. Temporary detour roads and structures will be completely obliterated upon project completion, and disturbed areas will be restored to pre-project conditions.

Bank Disturbance

Access and excavation may disturb banks, release sediment, remove structural habitat along the edge of the water, and result in bank instability and habitat simplification. Sessile macroalgae that occur on estuarine banks with natural or artificial cobble to solid rock substrate may be destroyed or displaced.

Some effects on streambanks may be unavoidable, particularly temporary effects during construction and permanent effects on banks directly underneath proposed structures (i.e., where an existing structure has been widened, requiring vegetation removal and possibly additional riprap armoring). However, bridge construction permitted under this program will minimize potential effects on existing bank conditions by adhering to the environmental performance standards detailed in Section 3. Site restoration activities in disturbed areas will generally involve grading banks to appropriate slopes and replacing any vegetation removed. Many of the bridges that are proposed for replacement currently promote bank degradation by encroaching upon floodplains and constricting flows. In addition, many of these bridges have required the placement of riprap or other armoring materials within or near banks which has had direct adverse effects on bank conditions at and downstream of the bridge location. Removal and replacement of these bridges with structures adhering to the environmental performance standards will likely result in localized beneficial effects to estuarine bank conditions throughout the State.

In-Water Work

Some bridge work will require machinery to work within the water. As with all bridge replacement and repair activities, the accidental release of diesel fuel, motor oil, hydraulic fluid, and other contaminants may occur. Operation of back-hoes, excavators, and other equipment requires the use of fuel and lubricants which, if spilled into the water or into the adjacent wetland or riparian zone, can

seriously degrade water quality constituents of Pacific salmon EFH. Petroleum-based contaminants (such as fuel, oil, and some hydraulic fluids) contain poly-cyclic aromatic hydrocarbons (PAHs), which can cause acute toxicity to fish at high levels of exposure and can also cause chronic lethal as well as acute and chronic sub-lethal effects on aquatic organisms (Neff 1985).

The effects of hardened embankments on an estuary include the simplification of bank habitat and the alteration of tidal processes. Simplification reduces vegetative refugia sites for fish (which assist in predator avoidance), eliminates shallow water habitat, and eliminates benthic habitat. Following the environmental performance standards and adhering to in-water work windows will minimize effects on Pacific salmon EFH.

Implementation of the environmental performance standards described in Section 3 will minimize the potential for hazardous spills and leakages to affect Pacific salmonid EFH. The proposed action will involve minimal or no activities within intertidal areas. Conservation measures include proper equipment staging, the preparation of spill prevention and containment plans, and the routing of stormwater generated on bridge surfaces to stormwater treatment facilities. All construction sites are subject to minor spills and drips of materials that could eventually cause minor chemical contamination of streams and waters; however, any adverse effects on water quality are expected to be negligible and temporary. Moreover, treating stormwater from bridges that currently lack treatment facilities will result in a net benefit to water quality and aquatic resources.

Sedimentation

Actions associated with bridge construction and repair may cause localized increases in turbidity and sedimentation from excavation and grading of the streambank. The release of sediment during in-water work and movement of eroded material into the water from the bank will generate increased suspended solids and turbidity, causing short-term degradation of EFH. The extent of these effects will be directly related to the duration of in-water work.

Actions associated with the Bridge Program may also cause turbidity by mobilizing fine sediment already within the channel substrate, thus increasing turbidity levels. These short-term increases in turbidity may be offset by reduced erosion in the action area. The removal of riparian vegetation for site access and staging may cause a short-term increase in runoff and increase sediment loads. Soil compaction from equipment can reduce the ability of the site to grow vegetation and can contribute to erosion and sedimentation.

The environmental performance standards described in Section 3 will be followed to minimize erosion and turbidity stemming from bridgework within or near estuarine areas. Temporary, localized effects are possible during bridge replacement activities; however, conducting all in-stream work during specified

in-water work periods will minimize the potential for temporary, localized increases in turbidity.

Staging

Most bridge replacement and repair activities require the use of equipment and materials that must be parked near a project site. Locations within the ODOT right-of-way that provide close, convenient access to a project site are usually in wide, open, level spots along the highway. The locations of staging areas are limited by available space and adherence to distance buffers from estuaries to protect water quality and aquatic resources.

Parked equipment may leak oil, hydraulic fluid, or fuel that contaminates the soil or is transported into the estuary or wetland. Equipment repair and maintenance (fueling, changing oil, lubrication) may also result in spills of fuel, oil, antifreeze, or hydraulic fluids that contaminate the soil or are transported into the estuary or wetland.

Preparation of repair materials may result in the contamination of soil or water with chemicals that leach or leak from structural materials. The temporary stockpiling of repair or waste materials may result in contamination of soil or water with wood preservatives or other toxic substances being removed from a bridge replacement and repair project site.

The Pollution and Erosion Control Environmental Performance Standard will be applied to every bridge replacement or repair activity included in this consultation. Plans will detail appropriate staging methods that minimize the delivery of sediment, contaminants, or construction materials to aquatic resources. Restrictions will be made regarding equipment use and refueling, and staging and special containment measures will be required for stationary equipment that operates near a regulated waterbody.

Rocky Shelf EFH

Rocky shelf EFH may be affected by ODOT bridge replacement and repair activities where bridges are located directly above rocky coasts or over chasms cut into headlands. These activities may affect intertidal rocky areas, tide pools, and inshore subtidal rocky habitats as a result of leaks or spills from equipment, the downslope transport of sediment, or the unavoidable downslope movement of rocks or other repair materials below the MHHW line. Bridgework in these locations will mostly take place from the highway due to lack of access down the steep slopes. Where rocky shelf EFH occurs immediately below US-101, it is highly unlikely that bridge replacement and repair equipment will be placed below the MHHW line due to lack of access.

The effects of bridge replacement and repair activities on the estuarine EFH of nine non-listed ESUs are not likely to be significantly different than those effects discussed for listed salmonids in the Effects Analysis section herein (Section 5), or for the effects of bridge replacement and repair activities on estuarine EFH presented above.

Determination of Effects on Pacific Salmon EFH

There are 389 bridges within the range of Pacific salmon EFH. Of these, 54 are within the Coast Range ecoregion, 22 are within the Blue Mountains ecoregion, 12 are within the Columbia Basin ecoregion, eight are within the East Cascades ecoregion, 88 are within the Klamath Mountains ecoregion, 22 are within the Lava Plains ecoregion, 31 are within the West Cascades ecoregion, and 152 are within the Willamette Valley ecoregion. The 389 bridges identified as being within the range of Pacific salmon EFH include 18 that are located upstream of manmade barriers.

Bridges where repair or replacement activities may affect Pacific salmon EFH occur in 110 5th Field HUCs. Within the Pacific salmon EFH, the greatest concentration of bridges occurs within the Willamette Valley Ecoregion, which accounts for 40% of the gross API.

The disturbance of streambanks may have indirect effects on Pacific salmon EFH. The amount of streambank disturbed can be estimated to help determine the magnitude of the effect. Streambank disturbance area was estimated by multiplying the number of bridges that could potentially affect Pacific salmon EFH (389), by the assumed permanent and temporary streambank disturbance area assumed for each bridge (40 feet of permanent disturbance and 300 feet of temporary disturbance). The total amount of permanent streambank disturbance that could affect Pacific salmon EFH is approximately 15,560 feet, or three river miles of streambank. The total amount of temporary streambank disturbance that could affect Pacific salmon EFH is approximately 116,700 feet or 22 river miles of streambank.

Based on this analysis for the Bridge Program, ODOT/FHWA makes a determination of ***will adversely affect*** for Pacific salmon EFH. The environmental performance standards and temporal staging of the proposed action described in Section 3 of this BA are considered adequate to minimize adverse effects on Pacific salmon EFH for this project. These conclusions are based on the following considerations: (1) the Bridge Program requires individual review of each project to ensure that the proposed action will be in compliance with the environmental performance standards identified herein, and that each applicable conservation measure is included as an enforceable condition of the permit document; (2) the cumulative effect of the conservation measures applied to each project will ensure that any short-term effects on water quality, habitat access, habitat elements, channel conditions and dynamics, flows, and watershed conditions will be brief,

minor, and scheduled to occur at the times that are least sensitive to most disturbance (i.e., in-water work periods coincide with non-channel forming stream flows); (3) the ecological design approach that will be applied to each bridge in this program to protect and stimulate natural habitat forming processes is expected to result in many projects that will have long-term beneficial effects on aquatic habitat parameters; and (4) the individual and combined effects of all actions permitted in this way are not expected to impair currently properly functioning habitats, appreciably reduce the functioning of already impaired habitats, or retard the long-term progress of impaired habitats toward the properly functioning condition essential to survival and recovery at the population or species scale.

8.0 Marine Mammal Protection Act

The Marine Mammal Protection Act of 1972 (MMPA) established a moratorium, with certain exceptions, on the taking of marine mammals in waters of the United States. The term "marine mammal" is defined as any mammal which is morphologically adapted to the marine environment, including sea otters and members of the orders Sirenia, Pinnipedia, and Cetacea. The term "take" is statutorily defined to mean "to harass, hunt, capture, or kill, or attempt to harass, hunt, capture or kill any marine mammal". Harass has been defined by Congress to mean "any act of pursuit, torment, or annoyance". Harassment for the purposes of the MMPA is divided into two categories:

> Level A Harassment – has the potential to injure a marine mammal or marine mammal stock in the wild; or
>
> Level B Harassment – has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.

All marine mammals that appear in the coastal waters of Oregon are protected under the MMPA. In addition, the Steller sea lion (*Eumetopias jubatus*), sperm whale (*Physeter macrocephalus*), humpback whale (*Megaptera novaengliae*), northern right whale (*Eubalaena glacialis*), blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus),* and sei whale (*Balaenoptera borealis*) are also protected under the ESA and are addressed in the ESA consultation for this project.

8.1 Distribution

Marine mammals primarily live in ocean waters, bays, and estuaries, but some species will forage inland in coastal streams and rivers. Whales are found almost exclusively in open sea aquatic habitats, whereas pinnipeds (such as seals and sea lions) require both aquatic and terrestrial habitats. Pinniped species regularly use land for haulouts, and breed in remote rookery areas along the coast. Pinnipeds congregate during the pupping and breeding season in rookeries that are protected from disturbance and predators, such as isolated beaches, reefs, and rock islands (NOAA Fisheries 2003d). Pinnipeds also use haulout areas to congregate and throughout the year. These may include rocks, reefs, beaches, jetties, breakwaters, navigational aids, or floating docks. Several pinniped species are known to forage inland as they follow salmon runs and other prey species' migrations up river. Because of the geographic distribution of cetaceans and pinnipeds in the ocean and coastal areas, Bridge Program construction activities are unlikely to affect cetaceans, though they may affect pinniped species.

To determine which bridge repair and replacement activities have the potential to affect marine mammals, GIS analysis was used to screen all program bridges. The screening process incorporated the known habitat types occupied by marine mammals and the known range of various marine mammals, notably inland pinniped distribution.

The following assumptions were used in the marine mammal screening process:

Marine mammal range extends as far inland as the head of tides for Coastal streams and rivers (ODSL 1989)—including the Columbia River as far inland as Bonneville Dam and Willamette Falls on the Willamette River in Oregon City (REO 2002), and the lower reaches of the Chetco River, Rogue River, Umpqua River, Siuslaw River, Alsea River, Siletz River, Nestucca River, and Nehalem River (NOAA Fisheries 2004).

Marine mammals may be present at identified haulouts and rookeries (ODFW 2003c).

Coastal Dune and Beaches, Coastal Headlands and Islets, Bays and Estuaries, Marine Nearshore, Marine Shelf, and Oceanic are the only Johnson and O'Neil (2001) habitat types capable of providing marine mammal habitat.

Construction activity (i.e., noise and disturbance) will have no effect on marine mammals beyond 1,640 feet (except near seal and sea lion rookeries, where this distance is considered to be 3,000 feet). This distance is based upon mitigation measures used for similar construction projects ([February 6, 2003, 68 FR 6116] [July 23, 2001, 66 FR 38258] [October 29, 1998, 63 FR 58012], Caltrans 2001). Steller sea lion rookeries are designated critical habitat in Oregon and are protected by a 3,000-foot buffer surrounding the critical habitat designated in the Federal Register (August 27, 1993 58 FR 45269) and the Three Arch National Wildlife Refuge rookery (Robin Brown, Marine Mammal Program Manager, Oregon Department of Fish and Wildlife, pers. comm. August 30, 2002).

Bridges meeting all of the following criteria will be documented as having no potential to affect marine mammals:

Bridge APIs that are greater than 1,640 feet from a Johnson and O'Neil (2001) habitat type identified as potentially supporting marine mammals (Kiilsgaard and Charley 1999).

Bridges APIs greater than 1,640 feet from an identified head of tide for coastal rivers and streams (except the Columbia River as far inland as Bonneville Dam and Willamette Falls on the Willamette River in Oregon City, and the lower reaches of the Chetco River, Rogue River, Umpqua River, Siuslaw River, Alsea River, Siletz River, Nestucca River, and Nehalem River) (ODSL 1989).

Bridges with APIs that are in the Grays/Elokoman, Lower Columbia/Clatskanie, Lower Willamette, Lower Columbia/Sandy 4th field HUC and are greater than 1,640 feet from the Columbia and Willamette River (REO 2002).

Bridges with APIs greater than 3,000 feet from an identified marine mammal rookery or haulout (ODFW 2003c).

Based on these screening criteria, there are 14 bridges where repair or replacement activities have the potential to affect marine mammals. One bridge (00924A, Schooner Creek Bridge) is located within 3,000 feet of a documented harbor seal haulout.

8.2 Effects Pathways

This biological assessment provides an analysis of the potential effects of the proposed action on the habitat elements that are critical for sustained, viable populations of marine mammals. Actions can affect the viability of marine mammals by altering one or more physical, chemical, or biological parameters. Effects to marine mammals are delivered via the displacement, disruption, removal, or other alteration of effects pathways including air, chemicals, or incidental take of the species (e.g., via direct physical injury). Further discussion of each of these effects pathways follows.

<u>Air</u>

Noise Disturbance
Adverse effects to marine mammals from noise disturbance may lead to flushing from haulout sites, an increase in energy expenditure, or an overall avoidance or abandonment of functional habitat. Construction activities have the potential to affect marine mammals both in the water and at haulout sites along the Oregon Coast. Close approach by humans may cause resting pinnipeds such as sea lions to go into the water, and disturbances that cause stampedes on rookeries may cause trampling or abandonment of pups (NOAA Fisheries 1992). Areas exposed to repeated disturbance may be permanently abandoned or exhibit reduced use, which could adversely affect the condition and survival of young through the interruption of normal nursing cycles (NOAA Fisheries 1992). Occasional disturbance at low levels may have little long-term effect (NOAA Fisheries 1992).

There is no documented threshold for noise disturbance for marine mammals. However, NOAA Fisheries has considered the effects of construction noise, such as pile driving and blasting, on marine mammals within a 1,640-foot radius of the activities (Caltrans 2001). For the purposes of this analysis, noise disturbance effects on marine mammals are considered possible within a distance of 1,640 feet from the bridge APIs.

Visual Disturbance
Visual disturbance due to human activity can adversely affect marine mammals; however, there is no documented visual disturbance threshold for marine mammals. Critical habitat for Steller sea lions in Oregon includes an air zone that extends 3,000 feet vertically and an aquatic zone that extends 3,000 feet seaward (horizontally) from historically occupied sea lion rookeries (August 27, 1993, 58 FR 45269). For the purposes of this analysis, effects are considered possible within a distance of 3,000 feet from known marine mammal haulout or rookery sites. This is likely an over-estimate considering marine mammals are not always present at these locations.

Chemicals

Because marine mammals inhabit the marine environment and occasionally the lower reaches of larger river systems, there is no potential for a construction-related spill to affect them.

Species Pathway

Marine mammal haulout and rookery sites include remote islands, rocks, reefs, and beaches, often in areas exposed to wind and waves where access by terrestrial predators is limited (NOAA Fisheries 1992). In addition, marine mammals are known to utilize manmade structures such as breakwaters, navigational aids, and floating docks for haulout sites (August 27, 1993, 58 FR 45269). The Bridge Program has the potential to remove or adversely modify man-made structures that support hauled out marine mammals.

8.3 Minimization and Avoidance Measures

The effects of actions proposed under this consultation may be delivered by one or multiple pathways. These effects can vary in magnitude and severity between the individual organism, population, and community scales. The degree to which the proposed action affects viable marine mammal populations is dependent on the intensity, magnitude, duration, timing, and repetition of the action causing the effect. Minimization and avoidance measures for the Bridge Program consist of specific environmental performance standards that provide for habitat and species conservation during bridge repair and replacement. Section 3 provides detailed information regarding these environmental performance standards and conservation measures.

8.4 Analysis of Effects

No activity associated with the Bridge Program would cause Level A Harassment as defined by the MMPA, and those activities that could cause Level B Harassment will be avoided by the implementation of the environmental performance standards.

Air

Noise Disturbance
Construction noise occurring within 1,640 feet of marine mammal habitat has the potential to affect marine mammals that are either hauled out (resting), breeding, feeding, or simply swimming by. To avoid adverse effects from Bridge Program activities, construction will be carried out in conformance with environmental performance standards, including the Wildlife Avoidance Environmental Performance Standard, which will minimize noise levels and restrict loud noises to certain times of the year (see section 3.3). The Wildlife Avoidance Environmental Performance Standard will further require monitors to be on site during certain construction activities to ensure that construction noise does not harm or disrupt any marine mammals within or entering into the 1,640-foot noise disturbance threshold.

Visual Disturbance

For purposes of the Bridge Program, visual disturbance occurring within 3,000 feet of marine mammal habitat may affect marine mammals. To avoid adverse effects on marine mammals from visual disturbance, the Wildlife Avoidance Environmental Performance Standard will be implemented, and will require monitors to be on site during construction activities to prevent construction activities from harming or disrupting any marine mammals at rookeries or haulouts within the 3,000-foot visual disturbance threshold.

Chemicals

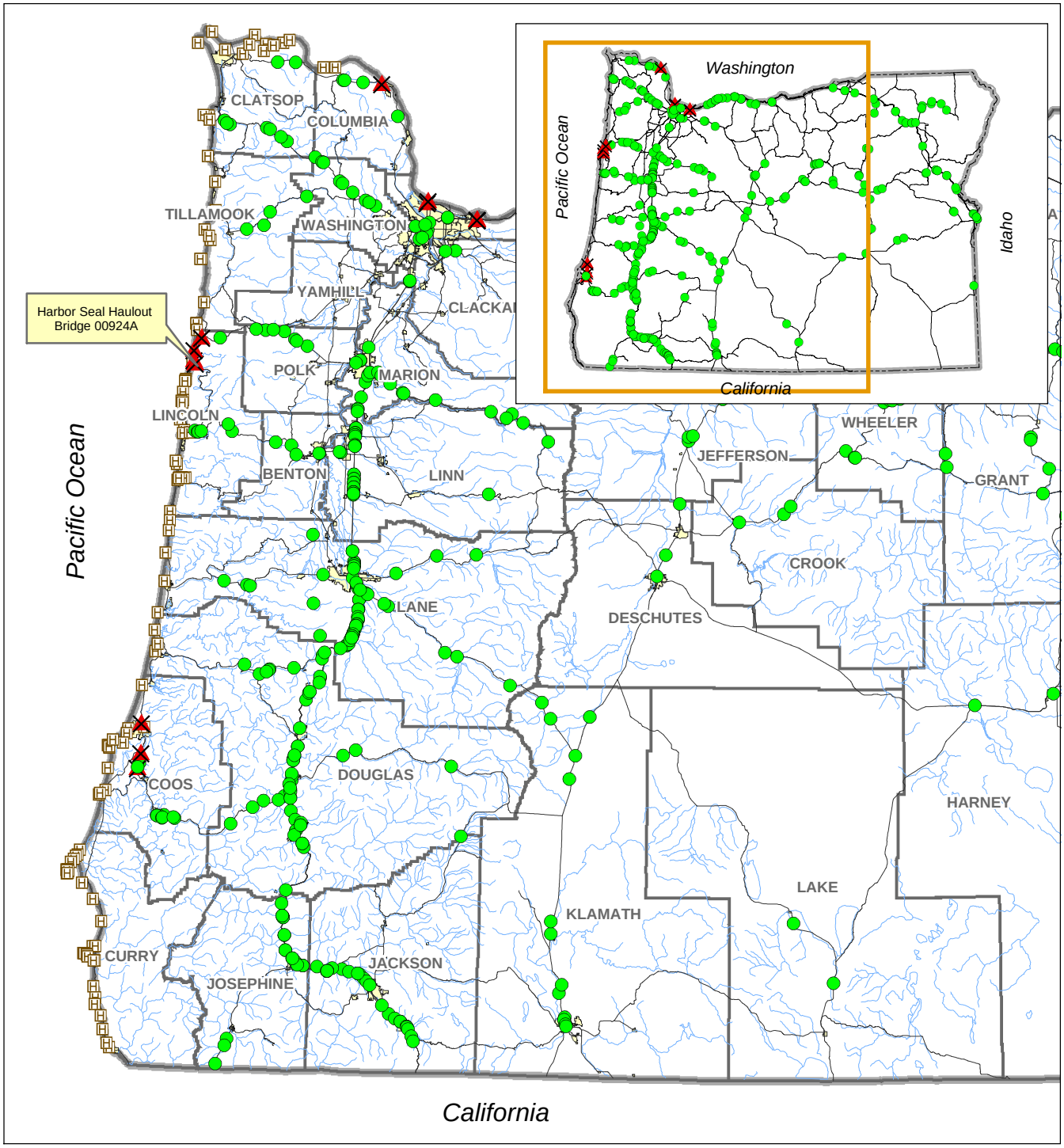
Because marine mammals inhabit the marine environment and occasionally the lower reaches of larger river systems, there is no potential for a construction-related spill (which are usually a few gallons at most) to affect them. Any spills that reach water in areas where marine mammals are likely to be present are likely to be quickly diluted to undetectable levels. Implementation of the Pollution and Erosion Control Environmental Performance Standard (Section 3.3) will ensure that chemical spills at construction sites are either avoided, or contained and cleaned up before they reach a marine environment; thus, there should be no adverse effects on marine mammals through the chemical effects pathway.

Species

Direct removal or modification of haulouts or rookery sites may affect marine mammals. Indirect effects may also occur through effects on prey species. However, implementation of the Environmental Performance Standards outlined in Section 3.3, including the Wildlife Avoidance Environmental Performance Standard and the Water Quality Environmental Performance Standard (which includes bridge demolition conservation measures), should ensure that direct and indirect effects on marine mammals are avoided.

Determination of Effects

There are a total of 14 bridges where repair and replacement activities may affect marine mammals (Figure 8.4-1; Table 8.4-1). These bridges are generally not located in preferred marine mammal habitat; therefore, there is a low probability that marine mammals will be present during construction activities. As a result of this and of the application of the environmental performance standards, (particularly the Wildlife Avoidance Environmental Performance Standard) at these bridges, the Bridge Program will result in negligible Level B Harassment, and negligible incidental take of marine mammals.



OTIA III Bridges

- Potential to Affect
- No Potential to Affect
- Marine Mammal Haulout Locations
- City
- Streams and Rivers
- County
- Highway
- State Boundary

This product is for informational purposes, and may not be suitable for legal, engineering or surveying purposes. This information or data is provided with the understanding that conclusions drawn from such information are the responsibility of the user.

Figure 8.4-1

OTIA III: Statewide Bridge Delivery Program
Marine Mammals

N W E S

0 10 20 40 60
Miles

MB&G
Mason, Bruce & Girard, Inc.
Natural Resource Consultants since 1921

Spatial Data Source: See Document Bibliography.
screening\BA_figures\mammal.mxd. Mar 1, 2004

Table 8.4-1. Program Bridges that may affect marine mammals.

Record No.	Bridge ID No.	Feature Crossed	No. of Spans	5th Field HUC	6th Field HUC	Location
1	9591	Hwy 2w	3	Beaver Cr./Columbia R.	Green Cr./ Columbia Side Ch.	Within Range
2	04516A	Unknown	1	Columbia Slough/Willamette R.	Willamette R./Columbia R.	Within Range
3	1950	Central OR RR	3	Coos Bay	Coos Bay	Within Range
4	8281	US 101 NB (Hwy 009)	3	Coos Bay	Lower Millicoma	Within Range
5	6875	Sandy R.	10	Lower Sandy R.	Beaver Cr.	Within Range
6	6945	Conn 2 Jordan Rd	1	Lower Sandy R.	Beaver Cr.	Within Range
7	06875A	Sandy R.	10	Lower Sandy R.	Beaver Cr.	Within Range
8	06945A	Conn 2 Jordan Rd.	1	Lower Sandy R.	Beaver Cr.	Within Range
9	00925A	Unknown	5	Lower Siletz R./Drift Cr.	Lower Drift Cr./Siletz R.	Within Range
10	00924A	Schooner Cr.	6	Lower Siletz R./Drift Cr.	Schooner Cr.	Within 3,000 ft of Harbor Seal Haulout
11	03173A	Beaver Cr.	24	Lower Coquille	Beaver Slough	Within Range
12	7333	Unknown	16	Salmon Cr.	Vancouver	Within Range
13	00922A	Unknown	3	Salmon R./Siletz/Yaquina Bay	Devils Lake	Within Range
14	13491	Unknown	3	Salmon R./Siletz/Yaquina Bay	Lower Salmon R.	Within Range