Southern DPS Eulachon Section of the

Endangered Species Act Section 7(a)(2) Biological Opinion Supplemental Consultation on Remand for Operation of the Federal Columbia River Power System

Action Agencies: U.S. Army Corps of Engineers (Corps)
Bonneville Power Administration (BPA)
U.S. Bureau of Reclamation (Reclamation)

Consultation Conducted by: NOAA's National Marine Fisheries Service (NOAA Fisheries)
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7 Southern DPS Eulachon

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7 Southern Distinct Population Segment of Eulachon and Designated Critical Habitat

In this section, NOAA Fisheries responds to the Action Agencies' Biological Assessment of effects of the 2008/2010 RPA on the Southern Distinct Population Segment (DPS) of eulachon (*Thaleichthys pacificus*; hereafter "eulachon") (Corps et al. 2013), in which they conclude that the RPA may affect but is not likely to adversely affect the listed species. We have reviewed the Action Agencies' assessment and do not concur with this determination. A formal biological opinion, which includes evidence of adverse effects of the 2008/2010 RPA on the species and its designated critical habitat, is provided below. NOAA Fisheries concludes that the 2008/2010 RPA is not likely to jeopardize the continued existence of the Southern Distinct Population Segment of eulachon.

7.1 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The geographic scope of the 2008/2010 RPA includes the areas that are hydrologically influenced by the operation of the FCRPS projects. In the case of the mainstem Columbia River, this includes Libby and Hungry Horse dams and reservoirs and the reaches downstream to and including the Columbia River estuary and plume (i.e., nearshore ocean adjacent to the river mouth). The portions of this geographic area that overlap with the distribution of eulachon are:

- The lower Columbia River, defined as all tidally influenced area of the lower Columbia River from the mouth upstream to Bonneville Dam, and Bonneville Dam to RM 180.[1]
- The plume of the Columbia River affecting the coastal marine areas, defined as all U.S. coastal marine waters out to the 60 fathom depth contour.

[1] Based on information in Smith and Saalfeld (1955) that eulachon spawned in the Klickitat River, above Bonneville Dam, NOAA Fisheries extends the action area upstream to RM 180, the maximum possible upstream extent of the range of eulachon in the Columbia River.

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7.2 Current Rangewide Status of the Species and Designated Critical Habitat

Eulachon are endemic to the northeastern Pacific Ocean. They range from northern California to southwest and south-central Alaska and into the southeastern Bering Sea. NOAA issued a final rule on March 18, 2010 (52 FR 13012) determining that the eulachon spawning south of the Nass River in British Columbia to, and including, the Mad River in California meet the discreteness and significance criteria for comprising the Southern DPS of this species and listing it as threatened for ESA protection.

Puget Sound lies between two of the larger eulachon spawning rivers (the Columbia and Fraser rivers) but lacks a regular run of its own (Gustafson et al. 2010; also "eulachon Biological Review Team"). Within the conterminous U.S., most eulachon production originates in the Columbia River basin and the major and most consistent spawning runs return to the Columbia River mainstem and the Cowlitz River. Adult eulachon have been found at several Washington and Oregon coastal locations, and they were previously common in Oregon's Umpqua River and the Klamath River in northern California. Runs occasionally occur in many other rivers and streams but often erratically, appearing some years but not in others, and only rarely in some river systems (Hay and McCarter 2000; Willson et al. 2006; Gustafson et al. 2010). Hay and McCarter (2000) identified 33 eulachon spawning rivers in British Columbia, and 14 of these were classified as supporting regular yearly spawning runs.

Adult eulachon typically spawn at age 2 to 5, when they are 160 to 250 mm in length (fork length), in the lower portions of rivers that generally have prominent spring peak flow events or freshets (Hay and McCarter 2000; Willson et al. 2006). The spawning migration typically begins when river temperatures are between 0°C and 10°C, which usually occurs between December and June. Run timing and duration may vary interannually and multiple runs occur in some rivers (Willson et al. 2006). Most eulachon are semelparous (i.e., they reproduce just once, dying after they spawn). Fecundity ranges from 7,000 to 60,000 eggs per female, which are approximately 1 mm in diameter. Milt and eggs are released over sand or coarse gravel. Eggs become adhesive after fertilization, attach to sediments in the river bed and hatch in 3 to 8 weeks depending on temperature. Newly hatched larvae are transparent, slender, and about 4 to 8 mm in length (total length). Larvae are transported by spring freshets to estuaries (Hay and McCarter 2000; Willson et al. 2006), and juveniles disperse onto the continental shelf within the first year of life (Hay and McCarter 2000; Gustafson et al. 2010).

NOAA Fisheries published its final critical habitat designation on October 20, 2011 (76 FR 64324), designating approximately 335 miles of riverine and estuarine habitat in California, Oregon, and Washington within the geographical area occupied by the southern DPS of eulachon. The proposed critical habitat areas contain one or more physical or biological features essential to the conservation of the species that may require special management considerations or protection. NOAA excluded the tribal lands of four tribes from designation after evaluating the impacts of designation and benefits of exclusion associated with the tribes' ownership and management of these areas. NOAA did not identify any unoccupied areas that were essential to conservation, and thus did not include any unoccupied areas for designation as critical habitat. Within the action area for this consultation, NOAA Fisheries designated the 146.1 miles of the mainstem Columbia River from the mouth (46°15′9″ N/124°4′32″ W) upstream to the foot of Bonneville Dam (45°38′40″ N/121°56′27″ W) as critical habitat for the conservation of this species. Section 7.2.2 describes the status of designated critical habitat.

7.2.1 Status of the Southern DPS of Eulachon

The viability of the listed eulachon DPS in terms of its abundance, productivity, spatial structure, and diversity, and current threats, are discussed in the following sections.

7.2.1.1 Abundance and Productivity

There are few direct estimates of eulachon abundance. Escapement counts and spawning stock biomass estimates are only available for a small number of systems, and catch statistics from commercial and tribal fisheries are available for others. However, inferring population status or even trends from yearly catch-statistic changes requires assumptions that are difficult to corroborate (e.g., assuming that harvest effort and efficiency are similar from year to year, assuming a consistent relationship among the harvested and total stock portion, and certain statistical assumptions, such as random sampling). However, the combination of catch records and anecdotal information indicates that there were large eulachon runs in the past, which have severely declined. As a result, eulachon numbers are at, or near, historically low levels throughout the range of the southern DPS.

Abundance declines have occurred in the Fraser and other coastal British Columbia rivers (Hay and McCarter 2000, Moody 2008). Over a three-generation span of 10 years (1999 to 2009), the overall Fraser River eulachon population biomass has declined by nearly 97% (Gustafson et al. 2010). In 1999, the biomass estimates were 418 metric tons,[2] and by 2010 had dropped to just 4 metric tons. Abundance information is lacking for many coastal British Columbia sub-area populations, but Gustafson et al. (2010) found that eulachon runs were universally larger in the past. Furthermore, the eulachon Biological Review Team was concerned that four out of seven coastal British Columbia spawning groups may be at risk of extirpation as a result of phenomena associated with small populations and random genetic effects (Gustafson et al. 2010).

Under the Species at Risk Act, Canada designated the Fraser River population as endangered in May 2011 because of a 98% decline in spawning stock biomass over the

[2] The U.S. ton is equivalent to 2,000 pounds and the metric ton is equivalent to 2,204 pounds.

previous 10 years (COSEWIC 2011). From 2008 through 2012, the Fraser River eulachon population is estimated at 458,750 adults.

The Columbia River (including all of its tributaries upstream to RM 180) supports the largest known eulachon run. Although direct estimates of adult spawning stock abundance are limited, commercial fishery landing records begin in 1888 and continue as a nearly uninterrupted data set to 2010 (Gustafson et al. 2010). From about 1915 to 1992, historical commercial catch levels were typically more than 500 metric tons (500 metric tons equals approximately 12,728,100 fish at 11.55 fish per pound), occasionally exceeding 1,000 metric tons. In 1993, eulachon catch levels began to decline and averaged less than 5 metric tons from 2005 to 2008 (Gustafson et al. 2010). Although landings can be biased by level of fishing effort, evidence of persistent low eulachon returns as well as landings in the Columbia River from 1993 to 2000 prompted the states of Oregon and Washington to adopt a Joint State Eulachon Management Plan (WDFW and ODFW 2001). All recreational and commercial fisheries for eulachon were closed in Washington and Oregon in 2011. Beginning in 2010, ODFW and WDFW began eulachon biomass surveys similar to those conducted on the Fraser River (James 2013). Based on the two years of data that have been collected and analyzed, WDFW calculated a median spawner estimate of 40 million eulachon in the Columbia River in 2011 and 39 million in 2012 (James 2013).

There are no long-term eulachon monitoring programs in Northern California. Large eulachon spawning aggregations once occurred regularly in the Klamath River, but abundance has declined substantially (Fry 1979; Moyle et al. 1995; Larson and Belchik 1998; Moyle 2002; Hamilton et al. 2005). Recent reports from Yurok tribal fisheries biologists report capturing several adult eulachon in presence/absence surveys (seine nets) and eggs and larvae in plankton tows in the Klamath River.

7.2.1.2 Spatial Structure and Diversity

Microsatellite genetic work, in addition to other biological data including the number of vertebrae size at maturity, fecundity, river-specific spawning times, and population dynamics (Gustafson et al. 2010) appears to confirm the existence of significant differentiation among populations in the southern DPS of eulachon. NOAA Fisheries' eulachon Biological Review Team separated the DPS into four subpopulations (Gustafson et al. 2010). These are the Klamath River (including the Mad River and Redwood Creek), the Columbia River (including all of its tributaries upstream to RM 180), the Fraser River, and the British Columbia coastal rivers (north of the Fraser River up to, and including, the Skeena River).

The Biological Review Team was concerned about risks to eulachon diversity because of data suggesting that Columbia River and Fraser River spawning stocks may be limited to a single age class combined with the species' semelparous life history (individuals spawn once and die). These characteristics likely increase the species' vulnerability to environmental catastrophes and perturbations and provide less of a buffer against year-class failure than species such as herring that spawn repeatedly and have variable ages at maturity (Gustafson et al. 2010).

7.2.1.3 Current Threats

Threats include human activities or natural events (e.g., fish harvest, volcanoes) that alter key physical, biological and/or chemical features and reduce a species' viability. Both natural and human-related threats are outlined and organized under the following five ESA listing factors: (1) destruction or modification of habitat; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; or (5) other natural or human factors. Table 7-1, lists the threats identified by the Biological Review Team and their qualitative ranking by sub-population. The threats are listed from most severe (1) to least severe (16).

Table 7-1. Eulachon threats and qualitative rankings by subpopulation.

	Eulachon Subpopulations[1]			
Threats	**Klamath**	**Columbia**	**Fraser**	**BC**
	Ranking[2]			
Climate-related impacts on ocean conditions	1	1	1	1
Dams/water diversions	2	4	8	11
Eulachon bycatch	3	2	2	2
Climate-related impacts on freshwater habitats	4	3	4	4
Predation	5	7	3	3
Water quality	6	5	5	8
Catastrophic events	7	8	10	5
Disease	8	11	11	7
Competition	9	12	12	9
Shoreline construction	10	10	9	6
Tribal fisheries	11	14	13	10
Nonindigenous species	12	15	15	13
Recreational harvest	13	13	14	14
Scientific monitoring	-	16	16	15
Commercial harvest	-	9	6	-
Dredging	-	6	7	12

[1] For a detailed description of the qualitative threats and assessment see Gustafson et al. 2010, pp. 166-170.
[2](-) indicates no ranking.

7.2.2 Status of Designated Critical Habitat

NOAA Fisheries has designated 16 specific areas in California, Oregon, and Washington as critical habitat for eulachon (76 FR 65324). The designated areas are a combination of freshwater creeks and rivers and their associated estuaries. The designated critical habitat areas contain at least one of the following physical and biological features essential to conservation of the species: (1) freshwater spawning and incubation sites; (2) freshwater and estuarine migration corridors; and (3) nearshore and offshore marine foraging sites. Freshwater spawning and incubation sites are essential for successful spawning and offspring production. Essential environmental components include specific water flow, quality, and temperature conditions; spawning and incubation substrates; and migratory access. Freshwater and estuarine migration corridors, associated with spawning and incubation sites, are essential for allowing adult fish to swim upstream to reach spawning areas and for allowing larval fish to proceed downstream and reach the ocean. Essential environment components include waters free of obstruction; specific water flow, quality, and temperature conditions (for supporting larval and adult mobility); and abundant prey items (for supporting larval feeding after the yolk sac depletion). Nearshore and offshore marine foraging habitat are essential for juvenile and adult survival; essential environmental components include water quality and available prey.

NOAA Fisheries identified a number of activities that may affect the physical and biological features essential to the conservation of southern DPS of eulachon across its range such that special management considerations or protection may be required. Major categories include dams and water diversions; dredging and disposal of dredged material; in-water construction or alterations, including channel modifications/diking, shoreline stabilization, sand and gravel mining, and road building and maintenance; pollution and runoff from point and non-point sources including industrial activities, urbanization, grazing, agriculture, and forestry operations; proposed tidal, wind, or wave energy projects; port and shipping terminals; and habitat restoration projects.[3] All of these activities may have an effect on eulachon or its habitat, including one or more of the essential physical and biological features of critical habitat, via their alteration of stream hydrology; water level and flow; water temperature; dissolved oxygen; erosion and sediment input/transport; physical habitat structure; vegetation; soils; nutrients and chemicals; fish passage; and estuarine/marine prey resources. The effects of specific activities on the quantity and quality of essential features vary between areas within the critical habitat designation. Section 7.3 (*Environmental Baseline*) describes activities that have negative effects on critical habitat in the action area for this consultation.

[3] Habitat restoration activities are efforts undertaken to improve habitat and can include the installation of fish passage structures and fish screens, in-stream barrier modification, bank stabilization, installation of instream structures such as engineered log jams, substrate augmentation, planting of riparian vegetation, and many other habitat-related activities. Although the primary purpose of these activities is to improve natural habitats for the benefit of native species, these activities nonetheless modify the habitat and need to be evaluated to ensure that they do not adversely affect the habitat features essential to eulachon.

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7.3 Environmental Baseline

See Chapter 5 in the 2008 Biological Opinion for a detailed description of the environmental baseline for the FCRPS see Chapter 5 in the 2008 Biological Opinion.

The following section evaluates the environmental baseline as the effects of past and ongoing human and natural factors within the action area for eulachon.

7.3.1 Biological Requirements of Eulachon within the Action Area

The Columbia River and its tributaries support the largest eulachon run in the world (Hay et al. 2002). Eulachon use the mainstem Columbia River within the action area to migrate to spawning grounds as adults and to emigrate from freshwater into marine waters as larvae. Large spawning aggregations of eulachon have been observed in the mainstem Columbia River and in the Cowlitz, Lewis, Sandy (Craig and Hacker 1940), Grays (Smith and Saalfeld 1955), Kalama (DeLacy and Batts 1963), and Elochoman rivers, and in Skamokawa Creek (WDFW and ODFW 2001). Smith and Saalfeld (1955) stated that eulachon were reported to spawn up to the Hood River on the Oregon side of the Columbia before the construction of Bonneville Dam (1938), but were not known to ascend beyond Cascade Rapids until 1896 when the locks and canal were built for steamboat passage.

Adult eulachon typically migrate into the Columbia River December through June, with peak migration typically occurring in January through March. Following spawning, eulachon eggs hatch in 20 to 40 days with incubation time dependent on water temperature (Gustafson et al. 2010). Shortly after hatching, the larvae are carried downstream and dispersed by estuarine, tidal, and ocean currents. However, larval eulachon may remain in low salinity, surface waters of estuaries for several weeks or longer before entering the ocean (Hay and McCarter, 2000).

The residence time of larval eulachon in the estuary before entering the ocean is unknown. Misitano (1977) caught large numbers of 6- to 8-mm, yolk bearing eulachon larvae in the estuary in 1973, indicating a downstream draft to the ocean soon after hatching. Richardson et al. (1977) caught larval smelt, of which some were known to be eulachon, during June through October in waters north of Newport where upwelling was present (including the plume). In this case, median size increased from less than 30 mm in June to greater than 35 mm in July and to about 45 mm in October. Phillips et al. (2009) found more juvenile and adult eulachon in micronekton[4] tows (30 meters depth) in inshore waters (less than 200 meters deep) off the Oregon coast than in offshore waters. These were tows along transects off the Columbia River as well as Hecata Head, Newport, and Willapa Bay.

[4] Micronekton are relatively small but actively swimming organisms ranging in size between plankton (< 2 cm), which drift with the currents, and larger nekton (> 10 cm), which have the ability to swim freely without being overly affected by currents.

Side-by-side, simultaneous trawls in the surface waters (0 to 39 feet [0 to 12 meters]) and at midwater in the plume (39 to 59 feet [12 to 18 meters]) during June 2000 caught eulachon in the lower of the two strata (Emmett et al. 2004).

7.3.2 Activities Affecting Eulachon and Designated Critical Habitat within the Action Area

Many of the threats identified in Section 7.2.1.3 are relevant to the action area for this consultation. Aquatic habitats have been significantly modified in the lower Columbia River by a variety of anthropogenic activities, including dams and water diversions, dredging, urbanization, agriculture, silviculture, and the construction and operation of port and shipping terminals. Since the development of the Canadian and FCRPS storage projects in the upper Columbia basin (1940s through 1970s), water is stored during spring and released for power production and flood control during winter, shifting the annual hydrograph. Water withdrawals and flow regulation in the Columbia River basin have reduced the Columbia River's average flow, altered its seasonality, and altered sedimentation processes and seasonal turbidity events, e.g., estuary turbidity maximum (Simenstad et al. 1982, 1990; Sherwood et al. 1990; Weitkamp 1994, as cited in NMFS 2008; NRC 1996). Water withdrawals and flow regulation have significantly affected the timing, magnitude, and duration of the spring freshet through the Columbia River estuary such that they are about one-half of the pre-development levels (NMFS 2008), all of which are important for adult, larval, and egg life stages.

In the Columbia River estuary, both the quantity and timing of instream flows have changed from historical conditions (Fresh et al. 2005). Jay and Naik (2002) reported a 16% reduction of annual mean flow over the past 100 years and a 44% reduction in spring freshet flows. Jay and Naik (2002) also reported a shift in flow patterns in the Columbia to 14 to 30 days earlier in the year, meaning that spring freshets are occurring earlier in the season. In addition, the interception and use of spring freshets (for irrigation, reservoir storage, etc.) have caused increased flows during other seasons (Fresh et al. 2005). It is unknown what effect these changes in hydrology may have on eulachon habitat.

Dredging in the mainstem Columbia River and tributaries is required to maintain adequate depth of navigation channels. Dredging activities, which include the disposal of dredged material, may affect depth, sediment quality, water quality, and prey resources for eulachon. Dredging and the aquatic disposal of dredged material can remove, and/or alter the composition of, substrate materials at the dredge site, as well as bury them at the disposal site, (potentially altering the quality of substrate for use as a spawning site).

Several types of in-water construction or alterations occur in the Columbia River and its tributaries including bridge and road construction and repair; construction or repair of breakwaters, docks, piers, and boat ramps; gravel removal or augmentation; pile driving; and bank stabilization (LCFRB 2004a). These types of activities may affect eulachon essential habitat features by altering the water and sediment quality, substrate composition, and eulachon migratory corridors.

Pollution and runoff from urbanized areas, industrialized areas, and agricultural lands in the lower Columbia River basin may affect eulachon essential habitat features by altering the water quality, sediment quality, and substrate composition.

The construction and operation of port and shipping terminals in the lower Columbia River pose the risk of leaks, spills, or pipeline breakage and may affect water quality. In addition, activities associated with the construction, operation, and maintenance of these projects may affect water quality, sediment quality, and prey resources for larval eulachon.

As part of the habitat restoration actions under the 2008/2010 RPA, the Action Agencies have implemented 45 habitat restoration projects in the Columbia River estuary since 2007 (Section 3.2). The extent to which these habitat restoration actions have benefited eulachon is unknown. However, habitat restoration projects that target the restoration of natural ecosystem processes, especially hydrologic reconnections, are likely to increase material fluxes between aquatic and terrestrial environments during peak flow periods, which may lead to increases in phytoplankton and zooplankton production—the primary food resource for eulachon larvae in the estuary–plume environment. Whether the effects of future restoration projects in the Columbia River estuary will have beneficial, neutral, or negative effects on eulachon remains uncertain as well.

7.3.3 Summary: Status of Eulachon and Designated Critical Habitat within the Action Area

At the time of listing, the abundance of eulachon is low and declining in the lower Columbia River, as in all surveyed populations throughout the DPS (Gustafson et al. 2010). The threats described above are likely to reduce survival of eulachon within the action area and to reduce the functioning of spawning and incubation areas and migration corridors in designated critical habitat.

7.4 Effects of the 2008/2010 RPA on Eulachon

Effects of the 2008/2010 RPA on eulachon are described below.

7.4.1 Passage at Bonneville Dam

Bonneville dam likely impedes or delays up-river passage of individual adult eulachon, and eliminates or reduces spawning production at sites upstream of Bonneville Dam.

7.4.1.1 River Mile 146.1 to River Mile 180

There have been reports of adult eulachon ascending the Columbia River beyond Bonneville Dam, both before and after construction of the Bonneville Dam at RM 146.1, with some runs large enough to support recreational harvest (OFC 1953; Smith and Saalfeld 1955; Stockley 1981). Cascade Rapids at RM 148.5 was likely a natural barrier to eulachon migration in the Columbia River (OFC 1953). A ship lock constructed at Cascade Locks in 1896 allowed fish to circumvent the rapids and subsequently eulachon were reported as far upstream as Hood River, Oregon at RM 169, and the Klickitat River at RM 180 (Smith and Saalfeld 1955). Following completion of Bonneville Dam, both Cascade Rapids and Cascade Locks were submerged, removing the rapids as a passage barrier.

Currently, passage for some anadromous fish at Bonneville Dam is maintained via fish ladders, but it is highly unlikely that eulachon can ascend the ladders due to water velocities. However, eulachon have been documented passing through the shipping locks at the dam (OFC 1953). Eulachon have been reported upstream of the dam in several years including 1936, 1945, and 1953 (OFC 1953; WDFW and ODFW 2009, in NMFS 2010b, as cited in Corps 2010 BA), and in 2001, 2003, 2005, and 2008 (Johnsen et al. 1988; Corps 2003 as cited in Corps 2010 BA; Martinson et al. 2010).

Although there are reports of adult eulachon ascending the Columbia River beyond Bonneville Dam, both before and after construction of the Bonneville Dam at RM 146.1, with some runs large enough to support recreational harvest, there is no documentation of spawning eulachon above Bonneville Dam. Therefore, NOAA considers this area above Bonneville Dam to the Klickitat River to be of minor importance to the species.

In 1953, eulachon were observed spawning in Tanner Creek on the Oregon side of the Columbia River near the base of Bonneville Dam. In 2001, eulachon migrated as far as Bonneville Dam (Howell et al 2001). In 2003, two adult eulachon were observed in the smolt monitoring facility on the upstream side of Bonneville Dam (Corps 2003, as cited in Corps 2010 BA). In 2005, five adult eulachon were noted at Powerhouse two (Martinson et al. 2006). In May of 1988, 8,200 adult eulachon were noted in samples from April 17 to April 24 in the downstream migrant trap-1 at Bonneville Dam in powerhouse 1 and 2 (Johnsen et al. 1988). Taking into account the hourly sample rate, this suggests a fallback passage of about 95,500 adult eulachon through the bypass system (Johnsen et al. 1988). No eulachon were reported at Bonneville Dam in 2012 (winter) and 2013 (spring)(Conder 2013).

The available information regarding eulachon distribution indicates that the existence of Bonneville Dam will impede or delay upriver passage of individual adult eulachon. Based on the monitoring data at Bonneville Dam, NOAA Fisheries estimates a range between 2 to 95,500 adults that may be affected in a single year—ranging from insignificant physiological, developmental, behavioral, and energetic effects to fatalities, with corresponding reductions in productivity. Based on the available information, the occurrence of eulachon passing through the locks at Bonneville Dam and becoming trapped in the bypass system will be very infrequent. Furthermore, while the maximum number of eulachon potentially trapped at Bonneville Dam in a single year is unknown, using the 95,500 number of adult eulachon from 1988 as a threshold would represent a maximum of 0.245% at the subpopulation (Columbia River) and 0.228% at the DPS level[5] in a single year.

7.4.2 FCRPS Operations on the Hydrograph of the Columbia River

See Chapter 5 in the 2008 BiOp for a detailed discussion of the effects of annual operation of the 14 FCRPS projects on the hydrograph.

Implementation of the 2008/2010 RPA will continue to alter the hydrograph of the Columbia River in a manner that increases flows during the fall–winter period by 8.9%, 12.4%, 15.1%, 27%, 19.7%, and 10.2%, respectively, during the months of October through March, and decreases flows during the spring–summer period by 0.7%, 10.4%, 12.7%, 10.4%, 2.5%, and 1.4%, respectively, during the months of April through September (Figure 7-1). These operational effects on the hydrograph have the potential to affect eulachon spawning production, egg incubation, and larval growth, development, and survival in the estuary–plume environment. The fraction of the hydrograph of the Columbia River that is due to the operations of the FCRPS (Figure 7-1) is approximately 30% (BPA et al. 2001) of the overall change in the hydrograph under the 2008/2010 RPA. NOAA Fisheries calculated these net changes in flows based on the HYDSIM model simulated-mean monthly Columbia River flows at Bonneville Dam for the water years 1929–1978 (USBR 1999, as cited in NOAA 2008; BPA et al. 2001).

[5] Based on combining the WDFW spawner estimates and the spawning stock biomass index for the Fraser River of 120 tonnes at 9.9 fish per pound results in an estimated 2,381,391 fish (DFO 2012) for a DPS spawner estimate of 41,881,391 fish; accessed at http://www.pac.dfo-mpo.gc.ca/science/species-especes/pelagic-pelagique/herring-hareng/herspawn/pages/river1-eng.htm.

	Life Stage	Approximate River Miles	River System	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Eulachon															
	Adult migration [1]	0-146	Columbia River												
	Adult migration [2]	0-146	Columbia River												
	Adult migration [2]		Grays River												
	Adult migration [2]		Cowlitz River												
	Adult migration [2]		Kalama River												
	Adult migration [2]		Lewis River												
	Adult migration [2]		Sandy River												
	Spawning [1]	30-146	Columbia River												
	Spawning [2]	30-146	Columbia River												
	Spawning [2]		Grays River												
	Spawning [3]	30-73	Columbia River												
	Spawning [2]		Cowlitz River												
	Spawning [2]		Kalama River												
	Spawning [2]		Lewis River												
	Spawning [2]		Sandy River												
	Eggs/Larval emergence-drift [1, 2]	Plume-146	Columbia River												
	Eggs/Larval emergence-drift [2]	Plume-146	Columbia River												
	Eggs/Larval emergence-drift [2]	Plume-23	Grays												
	Eggs/Larval emergence-drift [3]	Plume-146	Columbia River												
	Eggs/Larval emergence-drift [2]	Plume-68	Cowlitz River												
	Eggs/Larval emergence-drift [2]	Plume-73	Kalama River												
	Eggs/Larval emergence-drift [2]	Plume-85	Lewis River												
	Eggs/Larval emergence-drift [2]	Plume-121	Sandy River												
FCRPS Flow Change Direction and Amount-cfs [4]		**Increase**	**Decrease**	26874	20966	13071	1607	46828	69489	34715	4349	1413	7771	11254	15029
FCRPS Flow Change Direction and Amount-Precentage [4]				27.0%	19.7%	10.2%	0.7%	10.4%	12.7%	10.4%	2.5%	1.4%	8.9%	12.4%	15.1%
							Peak Flow Period								
(1) LCFRB 2004. Lower Columbia Salmon and Steelhead Recovery and Subbasin Plan. Tech Foundation.															
(2) Gustafson et al. 2010. Table A-9.															
(3) Ramono et al. 2002															
(4) NOAA Fisheries 2008 - SCA															
Activity Level - Peak															
Activity Level - Non-Peak															

Figure 7-1. Chronology of eulachon life history events in Columbia River Basin and alterations in the hydrograph of the Columbia River (at Bonneville Dam) under the 2008/2010 RPA (***NOTE****: the flow amounts described in Section 7.4.2 and in this figure are based on preliminary estimates and will be reviewed further for the final supplemental opinion*).

The principal habitat-related effects on eulachon as a result of the implementation of the 2008/2010 RPA are the hydrological effects on the estuary–plume environment, which is utilized by eulachon larvae and juveniles for rearing and maturation. Implementation of the 2008/2010 RPA, especially during the April through July period, a period that coincides with eulachon larval ocean entry and residence timing (Figure 7-1), is likely to affect the chemical and physical processes of the estuary–plume environment (NMFS 2008), and therefore may have negative impacts on marine survival of eulachon larvae during the freshwater–ocean transition period.

The extent to which freshwater-derived dissolved and particulate matter to the ocean may influence the survival of eulachon larvae during the freshwater–ocean transition period is uncertain. However, Gustafson et al. (2010) noted that variable year-class strength in marine fishes with pelagic larvae is dependent on survival of larvae prior to recruitment and is driven by match-mismatch of larvae and their planktonic food supply, oceanographic transport mechanisms, and variable environmental ocean conditions. Based on this link between planktonic food supply, environmental ocean conditions, and eulachon larvae, decreased freshwater inputs during the months of April through September may affect the chemical and physical processes of the estuary–plume environment, and thus planktonic food supply, as a result of water management operations under the 2008/2010 RPA.

Emmett et al. (2004) noted that the plume environment of the Columbia River provides important habitat for forage species, including eulachon, which were the most dominant forage species in subsurface waters (12–24 meters). Figure 7-2 shows the percentage of eulachon caught in surface trawl surveys by fork length. The 60 to 75 mm fork length fish were identified as age-0 eulachon, and the 90 to 115 mm fork length fish were identified as age-1 eulachon (Emmett 2013).

These eulachon were collected in June, which coincided with the spring-freshet–coastal-upwelling event (cool phase), and the age-1 eulachon are fish from the previous years' production, which suggests that juvenile eulachon either reside in the estuary–plume environment for extended periods (greater than 1 year), or that they return to the plume–ocean environment during the spring-freshet–coastal-upwelling event to feed on the rich abundance of phytoplankton, especially during cool phase PDO events.

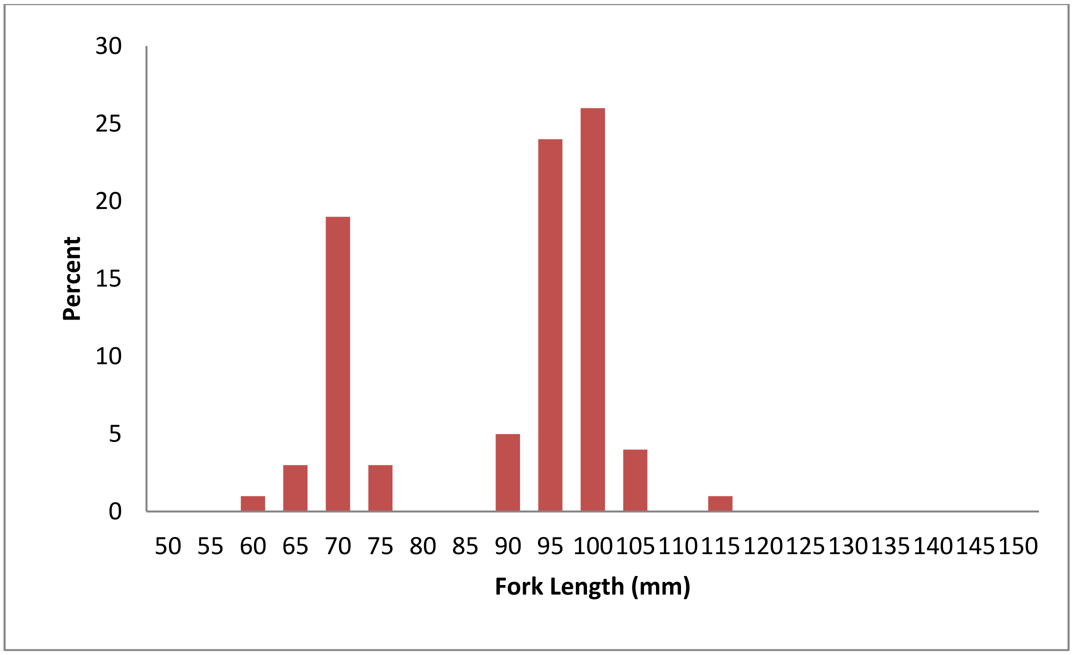

Figure 7-2. Juvenile eulachon data in the estuary–plume environment (Emmett et al (2004).

Hickey et al. (2010) examined the interaction between the Columbia River plume and coastal ocean environment, ocean- and river-derived nutrient fluctuations, and primary productivity. This study illustrates the complex interaction between flow from the Columbia, upwelling, wind and buoyancy-driven shear, and primary productivity in the estuary–plume environment. Hickey et al. (2010) concluded that

> Based on the physical and chemical observations, it is clear that most of the turbulent mixing in the plume occurs at the estuary bar and at the tidal plume front, over very short time scales. There was no evidence for distinct plume phytoplankton communities, and no evidence for distinct physiological responses in the plume versus outside the plume. This is consistent with the plume entraining and mixing phytoplankton from the near-field coastal waters; while the plume has strikingly different physical and chemical properties, it acts more as biological capacitor (capturing nearshore coastal waters and sometimes adding nutrients), rather than serving as a distinct source or sink for phytoplankton.

In a ten year study on the biotic and abiotic factors influencing forage fish and pelagic nekton communities in the Columbia River plume throughout the upwelling season, Litz et al. (2013) examined the assemblages of forage fish, predator fish, and other pelagic nekton in coastal waters associated with the Columbia River plume. They found that resident euryhaline forage fish species, such as smelts, showed a high affinity for inshore habitat and the lower salinity plume during spring. Overall, their study revealed that temporal dynamics in abundance and community composition were associated with seasonal abiotic phenomenon, but not interannual, large-scale oceanographic processes. Forage fish assemblages differed seasonally and spatially from the assemblages of major piscivorous predators, suggesting a potential role of the plume as refuge for forage fish.

These studies highlight the connection between river-derived nutrients, coastal-upwelling, chemical and physical process in the estuary-plume environment, primary productivity, and the importance of the estuary–plume environment to eulachon larvae and age-0 juveniles. In the absence of direct data on the link between decreases in freshwater inputs into the estuary-plume environment and effects on eulachon larvae and age-0 juveniles to assess the significance of effects, we determined, based on available information, that the magnitude of reduced freshwater delivery to the estuary–plume environment under the 2008/2010 RPA during the months of April through September (0.7%, 10.4%, 12.7%, 10.4%, 2.5%, and 1.4% reduction respectively [Figure 7.1]) is likely to be of a magnitude and duration sufficient to adversely affect primary productivity because some eulachon larvae and age-0 juveniles will be subjected to decreases in food availability and, therefore, increased competition or reduced fitness.

Furthermore, it is unknown whether the implementation of the 2008/2010 RPA during the months of October through March will or will not affect eulachon. Shifts in the timing, magnitude, and duration of the hydrograph of the Columbia River through implementation of the 2008/2010 RPA, which ranges from –12.7% to +27.0%, is the best proxy to evaluate potential effects on eulachon run timing and spawning production. However, based on an examination of the historical landings and recent abundance data, we did not find a consistent pattern to link shifts in the timing, magnitude, and duration of the hydrograph of the Columbia River and effects on run timing or spawning production—during the months of November through March. Likewise, we do not think that the 2008/2010 RPA-related changes in the hydrograph during the months of November through March are of a magnitude sufficient to cause a significant shift in the ocean entry mechanism of eulachon larvae, as larvae are carried downstream and dispersed by estuarine, tidal, and ocean currents and may remain in low salinity, surface waters of estuaries for several weeks or longer before entering the ocean. Since the upwelling of the California current typically occurs April through September, which coincides with peak river discharge, the increase in river flows during the months of November through March are unlikely to enhance rearing and maturation conditions for larval eulachon in the estuary–plume environment during this time.

Overall, the available evidence indicates that shifts in the timing, magnitude, and duration of the hydrograph of the Columbia River, through the implementation of the 2008/2010 RPA, are likely to adversely affect eulachon. These effects will disproportionately manifest on eulachon larvae compared to habitat-related effects on adult and juvenile eulachon that reside in the estuary–plume environment, especially during the months of May through July when freshwater inputs to the estuary–plume environment are significantly diminished, which in turn could affect phytoplankton production—the primary food resource for eulachon larvae in the estuary–plume environment. Implementation of the 2008/2010 RPA will decrease freshwater inputs to the estuary–plume environment by 0.7%, 10.4%, 12.7%, 10.4%, 2.5%, and 1.4%, respectively (Figure 7.1), during the months of April through September, which may result in decreases in phytoplankton abundance and/or changes in phytoplankton community structure in the estuary–plume environment, which could reduce the species' fitness and survival potential.

It is NOAA's best professional estimate that these flow-related effects are likely to be negligible to non-existent in April; negligible to significant during the months of May, June, and July; and are likely to be negligible in August and September.

Scaling effects—NOAA does not equate decreases in freshwater inputs to the estuary–plume environment through the implementation of the 2008/2010 RPA into an equivalent level of effect on primary and secondary productivity or eulachon. For example, a 10.4% decrease in freshwater inputs into the estuary–plume environment in the month of May does not translate into a 10.4% decrease in phytoplankton production or larval mortality as there are many external factors, such as predation; ocean-forcing factors, e.g., upwelling, wind and buoyancy-driven shear plume mixing, that determine the overall fitness and survival potential of eulachon in the estuary–plume environment. We expect the magnitude of adverse effects to be significantly less than the corresponding decreases in river discharge.

Based on the preceding analysis, it is NOAA's best professional estimate that the aggregated effects of the 2008/2010 RPA on eulachon productivity and abundance will be less than 1% over the next five years.[6] The less than 1% estimate includes the 0.456% of adult eulachon trapped at Bonneville Dam, and the remaining 0.001% to 0.534% is an estimate of the range of habitat-related effects on individual eulachon larvae and age-0 juveniles. Therefore, while the information suggests that the existence of Bonneville Dam will impede or delay upriver passage of individual adult eulachon, and water management operations under the 2008/2010 RPA are likely to adversely affect the fitness, survival, and productivity of individual eulachon, the proportion and magnitude of these effects are likely to be minor at the subpopulation and DPS levels.

7.4.3 Effects on Critical Habitat

This section analyzes the potential effects of the 2008/2010 RPA on eulachon critical habitat.

The physical and biological features of freshwater spawning and incubation sites include water flow, water quality, water temperatures, suitable substrate for spawning and incubation, and migratory access for adults and juveniles. These features are essential to conservation because without them the species cannot successfully spawn and produce offspring. The physical and biological features (PBFs) of freshwater and estuarine migration

[6] Based on the 2010-2013 median abundance estimates for eulachon in the Columbia River—section 7.2.1.1.

corridors associated with spawning and incubation sites include flow, water quality, water temperature, and food to support larval and adult mobility; abundant prey items to support larval feeding after the yolk sac is depleted; and free passage (i.e., no obstructions) for adults and juveniles. These features are essential to conservation because they allow adult fish to swim upstream to reach spawning areas, and they allow juvenile fish to proceed downstream to reach the ocean. In the Pacific Ocean, we identified nearshore and offshore foraging sites as an essential habitat feature for the conservation of eulachon, and we determined that abundant forage species and suitable water quality are specific components of this habitat feature. However, we were unable to identify any specific areas in marine waters that meet the definition of critical habitat under section 3(5)(A)(i) of the ESA. Given the unknown, but potentially wide, distribution of eulachon prey items, we could not identify ‘‘specific areas’’ where either component of the essential features is found within marine areas believed to be occupied by eulachon. Moreover, prey species move or drift great distances throughout the ocean and would be difficult to link to any ‘‘specific’’ areas.

7.4.3.1 PBF—Flow (Freshwater and Estuarine Site Type)

The Columbia River, from the mouth (46°14′48″ N/124°4′33″W) to RM 146.1, accounts for 43.6% of the total critical habitat designation for eulachon. Implementation of the 2008/2010 RPA will continue to alter the hydrograph of the Columbia River in a manner that increases flows during the fall–winter period (October through March) and decreases flows during the spring–summer period (April through September). Effects on the hydrograph of the Columbia River via the FCRPS (see Chapter 5 in the 2008 FCRPS BiOp for a detailed discussion of the annual operation of the 14 FCRPS projects on the hydrograph) have the potential to affect the PBFs that support eulachon spawning and incubation in the Columbia River. While there are no studies that have examined the PBFs that support eulachon spawning and incubation in relation to changes in the hydrograph of the Columbia River, what is known is that the continued operations of the FCRPS under the 2008/2010 RPA will continue to alter the hydrograph of the Columbia River in a manner that may affect eulachon spawning and incubation (Figure 7.1).

It is also unknown if increases (November through March) in discharge would have positive, neutral, or negative effects; or if decreases (April through July) in discharge would have positive, neutral, or negative effects on the PBFs that support eulachon spawning and incubation. However, implementation of the 2008/2010 RPA will continue to alter the hydrograph of the Columbia River in a manner that decreases flows by 0.7%, 10.4%, 12.7%, 10.4%, 2.5%, and 1.4%, respectively, during the months of April through September, and will increase flows by 8.9%, 12.4%, 15.1%, 27%, 19.7%, and 10.2%, respectively, during the months of October through March. Based on this line of evidence, we determined that the available information on the magnitude of reduced freshwater to the estuary under the 2008/2010 RPA during the months of April through September is likely to be of a magnitude and duration sufficient to adversely affect the PBF flow.

Based on the available information, implementation of the 2008/2010 RPA does not meet the insignificant or discountable standard; therefore implementation of the 2008/2010 RPA will adversely affect the PBF flow.

7.4.3.2 PBF—Water Quality (Freshwater and Estuarine Site Type)

Implementation of the 2008/2010 RPA will continue to alter water quality (reduced spring turbidity levels), water quantity (seasonal changes in flows and consumptive losses resulting from use of stored water for agricultural, industrial, or municipal purposes), water temperature (including generally warmer minimum winter temperatures and cooler maximum summer temperatures), and water velocity (reduced spring flows and increased cross-sectional areas of the river channel) (NMFS 2008).

Total Dissolved Gas

Implementation of the 2008/2010 RPA can result in total dissolved gas (TDG) levels in the tailrace of Bonneville Dam that exceed the water quality standard of 110% of saturation set by the Oregon and Washington's water quality authorities. However, the effects of TDG are moderated by hydrostatic pressure with depth in the water column—each meter of depth compensates for 10% of gas supersaturation as measured at the water surface. When the level of dissolved gas is 120% of saturation at the surface, it is reduced to 100% at two meters. The tissues of a eulachon at two meters or more will be in equilibrium with the surrounding water. Further, voluntary spill for fish passage typically begins at Bonneville Dam in mid-April. Even in 2011, a year with high levels of "involuntary" spill, hourly TDG readings at the Washougal, Washington gage did not exceed 120% until mid-May (USGS 2011).

Chemical Contaminants

The high lipid content of eulachon suggests they are susceptible to absorption of lipophilic organic contaminants (Higgins et al. 1987; Pickard and Marmorek 2007). The U.S. Environmental Protection Agency (EPA 2002) examined contaminants in fish, including three whole eulachon collected between RM 39 to 41 in the Columbia River during the late 1990s. In general, these three individuals had some of the lowest levels of organic chemicals of all the fishes tested, but the highest average concentrations of arsenic (0.89 µg/g whole body weight) and lead (0.50 µg/g). Arsenic is a suspected carcinogen in fish and can cause other types of tissue lesions, especially in the liver. Other effects include embryo mortality and developmental deformities (see Eisler 1988; McGeachy and Dixon 1989; Sorensen 1991; Cockell et al. 1992; Rankin and Dixon 1994; Woodward et al. 1994). Data from trout fingerlings and adult bluegills suggest whole body concentrations above 1.0 µg/g would be harmful (McGreachy and Dixon 1990, 1992; Gildehus 1996; Jarvinen and Ankley 1999).

Lead exposure is also associated with a number of health problems in fish, including reduced hatchability of eggs and increased mortality and deformities in early life stages, reduced growth in juveniles, retardation of sexual maturity, and histopathological changes in gonads (Eisler 1988; Farang et al. 1994; Jarvenin and Ankley 1999). Fish embryos appear to be more sensitive to lead than older fry and juvenile stages. The estimated effects threshold for lead is 0.4 µg/g wet weight based on whole body concentrations (Jarvenin and Ankley 1999).

Johnson and Norton (2005) used semipermeable membrane devices, which mimic the accumulation of compounds in the fatty tissues of fish, to sample water for organic contaminants from RM 147, above Bonneville Dam, to RM 54, below Longview, Washington, during 2003 and 2004. The major sources of dichlorodiphenyltrichloroethane (DDT) compounds including dichlorodiphenyldichloroethylene (DDE), dichlorodiphenyldichloroethane (DDD), and dieldrin were above Bonneville Dam: a winter/spring peak was consistent with runoff from agricultural lands in Eastern Washington. Measurements of polychlorinated biphenyls (PCBs) during spring increased by almost a factor of two in the sampled reach. Polychlorinated biphenyls were detected only below Longview, suggesting a trend toward increasing concentrations in the lower river.

With respect to the cleanup of PCB-contaminated sediments at Bradford Island (between Powerhouse 1 and the spillway at Bonneville Dam), the Corps (2010) reported that contaminated sediments were limited to the project forebay. Johnson and Norton (2005) found no evidence of an increase in water column PCB concentrations in the reach between Bonneville Dam to below Longview, implying that Bonneville Dam/Bradford Island has not been a source of PCBs in the water column within the action area for this consultation.

Based on the available information, the effects of the 2008/2010 RPA on the PBF water quality are likely to be insignificant.

7.4.3.3 PBF—Water Temperature (Freshwater and Estuarine Site Type)

Implementation of the 2008/2010 RPA will continue to alter water quality (reduced spring turbidity levels), water quantity (seasonal changes in flows and consumptive losses resulting from use of stored water for agricultural, industrial, or municipal purposes), water temperature (including generally warmer minimum winter temperatures and cooler maximum summer temperatures), and water velocity (reduced spring flows and increased cross-sectional areas of the river channel) (NMFS 2008).

In general, flow regulation has increased minimum winter temperatures when adult eulachon are migrating through and spawning in the Columbia River and has reduced average spring temperatures compared to an undeveloped system (NMFS 2008). These patterns are due to the increased thermal inertia of large volumes of stored water, increased solar radiation over the larger surface area of the reservoirs, and altered seasonal flow regimes. Temperatures in the reach below Bonneville Dam are also affected by tidal exchange with the ocean and by tributaries to the estuary (especially the Lewis, Cowlitz, Elochoman, and Grays rivers in Washington and the Clatskanie River and several smaller streams in Oregon).

Hicks (2000) recommended that in setting water quality standards for eulachon, the 7-day average of the daily maximum temperatures not exceed 12°C to 14°C prior to May 1, with no single daily maximum temperature greater than 16°C. Water temperatures at tidal freshwater sites, in the mixing zone, and at marine sites near the mouth of the estuary ranged from about 4°C to 10°C (39°F to 50°F) during January through April in 2003 to 2006 (see Figure 4 in Bottom et al. 2008).

Based on the available information, the effects of the 2008/2010 RPA on the PBF temperature are likely to be insignificant.

7.4.3.4 PBF—Substrate (Freshwater Site Type)

In the lower Columbia, sand shoals may range in size from 6 feet to 12 feet in height (RM 4 to RM 106), and from 2 feet to 4 feet in height (RM 107 to RM 125); may measure more than 400 feet in width; and range from 2,000 feet to 4,000 feet in length.

Riverine sediment transport to the estuary, an important process affecting the quantity and quality of estuarine habitat for fishes, is correlated with peak river flows. It is impossible to separate the effects of flow regulation and irrigation withdrawal precisely from climatic variability. However, Bottom et al. (2005) estimated that the corresponding change in annual average sediment transport (at Vancouver, Washington) for flows during 1945 to 1999 was about 50% to 60% of the 19th century (1858 to 1899) virgin sediment transport. The reduction in sands and gravels is higher (greater than 70% of predevelopment) than for silts and clays.

The reduced spring freshet also affects bedload transport within the lower Columbia. At discharges below 300,000 cfs at Bonneville Dam, the bedload transport rate is quite low and sand wave movement is typically only a few feet per day. However, when the flow exceeds 400,000 cfs, the bedload transport rate increases and sand waves can migrate downstream at around 20 feet per day (Corps 2011).

Sherwood et al. (1990) estimated an annual sediment discharge rate in the Columbia River of 14.9 million metric tons per year for the period 1868 through 1934. They contrasted that estimate with more recent flows (1958–1981), and reported a decrease in average sediment discharge of nearly 50% to 7.6 million metric tons per year due primarily to the decrease in freshet flow. Jay and Naik (cited in Gelfenbaum and Kaminsky 2002) re-examined relationships between sediment load and flow by reconstructing the historical sediment loads as reported in Sherwood et al. (1990). For the pre-dam period (1879–1935) the estimated annual total sediment load averaged 15.1 million metric tons per year, but decreased to 9.7 million metric tons per year between 1936 and 1999. If only the period following completion of the hydrosystem is included (1975–1999) then the annual average flow is reduced to 7.3 million metric tons per year: a 51% average reduction relative to the pre-dam period.

Based on work by Romano et al. (2002), they determined that adult eulachon spawn in the Columbia River at depths ranging from 3 feet to 42 feet. However, Romano et al. (2002) concluded that "given the dynamic nature of channel substrates, we believe these areas [Federal Navigation Channel] do not provide stable surfaces that would allow an adhesive egg to incubate."

From this information we expect few eulachon to spawn in high energy areas with active shoaling. Furthermore, mature eulachon eggs are likely "drawn" into this high energy sand wave environment in the lower Columbia as part of their seaward migration under all discharge scenarios. Therefore it is unlikely that changes in discharge within the range identified above would adversely affect substrate for spawning and incubation in the lower Columbia.

Based on the available information, the effects of the 2008/2010 RPA on the PBF substrate are likely to be insignificant.

7.4.3.5 PBF—Food (Estuarine Site Type)

The Columbia River, from the mouth (46°14′48″ N/124°4′33″W) to RM 146.1, accounts for 43.6% of the total critical habitat designation for eulachon. Implementation of the 2008/2010 RPA will continue to alter the hydrograph of the Columbia River in a manner that increases flows during the fall–winter period (October through March) and decreases flows during the spring–summer period (April through September). Effects on the hydrograph of the Columbia River, via the FCRPS, (see Chapter 5 in the 2008 FCRPS Biological Opinion for a detailed discussion of the annual operation of the 14 FCRPS projects on the hydrograph) have the potential to affect the PBFs that support eulachon larval feeding in the Columbia River. While there are no direct studies that have examined the PBFs that support eulachon larval feeding in relation to changes in the hydrograph of the Columbia River, what is known is that the continued operations of the FCRPS under the 2008/2010 RPA will continue to alter the hydrograph of the Columbia River in a manner that may affect eulachon larval feeding (Figure 7.1).

Implementation of the 2008/2010 RPA will affect the timing and magnitude of freshwater inputs into the estuary, which will have some affect primary productivity—the primary food resource for eulachon larvae; however, the magnitude of these effects via the 2008/2010 RPA on eulachon prey, e.g., phytoplankton, copepods, and mysids, are basically unknown.

As part of the habitat restoration actions under the 2008/2010 RPA, the Action Agencies have implemented 45 habitat restoration projects in the Columbia River estuary since 2007 (Section 3.2). The extent to which these habitat restoration actions have benefited eulachon is unknown. However, habitat restoration projects that target the restoration of natural ecosystem processes, especially hydrologic reconnections, are likely to increase material fluxes between aquatic and terrestrial environments during peak flow periods, which may lead to increases in phytoplankton and zooplankton production—the primary food resource for eulachon larvae in the estuary–plume environment. Whether the effects of future restoration projects in the Columbia River estuary will have beneficial, neutral, or negative effects on eulachon remains uncertain as well.

As there are no known studies that have directly measured or predicted reductions in primary productivity tied directly to decreases in freshwater inputs, the only way to estimate the magnitude of effects is to compare the area of the designation affected, and the magnitude of reductions in freshwater inputs into the estuary as a surrogate to estimate the magnitude of effects on primary productivity.

As the Columbia River accounts for 43.6% of the total critical habitat designation for eulachon, the area influenced by the FCRPS is significant. However, implementation of the 2008/2010 RPA will continue to alter the hydrograph of the Columbia River in a manner that decreases flows by 0.7%, 10.4%, 12.7%, 10.4%, 2.5%, and 1.4%, respectively, during the months of April through September. From these lines of evidence, it is reasonable to infer that the magnitude of effects on primary productivity is likely to be high enough to affect phytoplankton production in the estuary in a manner that will affect the fitness and survival of some eulachon larvae during the estuary–ocean transition period. While the ratio of effects between decreases in discharge and decreases in primary productivity cannot be estimated, when these lines of evidence, i.e., area affected, time of year, and percent decreases in freshwater inputs to the estuary are taken into consideration, the effects on primary productivity are likely to be of a magnitude and duration sufficient to adversely affect the PBF food.

Based on the available information, implementation of the 2008/2010 RPA does not meet the insignificant or discountable standard; therefore implementation of the 2008/2010 RPA will adversely affect the PBF food.

7.4.3.6 Summary

Based on the preceding analysis, it is NOAA Fisheries' best professional estimate that the aggregated effects of the 2008/2010 RPA are likely to adversely affect the conservation value of eulachon critical habitat, but will not appreciably diminish the conservation value of critical habitat at the watershed or designation scale for eulachon. This finding is based on an evaluation of the aggregated effects of the 2008/2010 RPA, especially measures to increase spring and summer flows (RPA Actions 4, 6, 10–14 and 17), which are likely to proportionately increase primary productivity in the estuary. Therefore, the 2008/2010 RPA will not further degrade the affected PBFs and therefore the PBFs would remain functional to serve the conservation role for the species.

7.5 Cumulative Effects

Cumulative effects are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Within the freshwater portion of the action area, non-Federal actions are likely to include human population growth, water withdrawals (i.e., those pursuant to senior state water rights) and land use practices. In the action area, state, tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives, shoreline growth management and resource permitting. For example, currently, all commercial and recreational eulachon fisheries are prohibited in the states of Washington and Oregon. Therefore, effects of harvest on eulachon productivity and abundance is minimal (a low-level tribal subsistence fishery still occurs on the Cowlitz River).

As these cities border riverine systems, diffuse and extensive growth will increase overall volume of contaminant loading from wastewater treatment plants and sediments from sprawling urban and suburban development into riverine, estuarine, and marine habitats. Impacts from heightened agricultural production will likely result in two negative impacts on eulachon. The first impact is the greater use and application of pesticide, fertilizers, and herbicides and their increased concentrations and entry into freshwater systems. Second, increased output and water diversions for agriculture may also place greater demands upon limited water resources. Water diversions will reduce flow rates and alter habitat throughout freshwater systems. As water is drawn off, contaminants will become more concentrated in these systems, exacerbating contamination issues in habitats for eulachon.

Although these factors are ongoing to some extent and likely to continue in the future, past occurrence is not a guarantee of a continuing level of activity. That will depend on whether there are economic, administrative, and legal impediments or safeguards in place. Therefore, although NMFS finds it likely that the cumulative effects of these activities will have adverse effects commensurate with or greater than those of similar past activities; it is not possible to quantify these effects.

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7.6 Integration and Synthesis

The Integration and Synthesis section is the final step of NOAA Fisheries' assessment of the risk posed to the species and critical habitat from implementation of the 2008/2010 RPA. In this section, we add the effects of the action to the environmental baseline and the cumulative effects to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both survival and recovery of the species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat.

As described in Section 7.4.1, we estimated a range between 2 to 95,500 adult eulachon that may be affected—with effects ranging from insignificant physiological, developmental, behavioral, and energetic effects to fatalities, due to passage-related effects at Bonneville Dam. Based on this information, and the likelihood that the occurrence of eulachon passing through the locks at Bonneville Dam and becoming trapped in the bypass system will be very infrequent, and that a loss of 95,500 adult eulachon would represent a maximum of 0.245% of the subpopulation (Columbia River) and 0.228% at the DPS abundance in a single year, NOAA Fisheries expects the effect on productivity and abundance to be small. NOAA Fisheries does not expect these effects to rise to a level that is likely to appreciably diminish productivity and abundance at the subpopulation and the DPS levels.

As described in Section 7.4.2, shifts in the timing, magnitude, and duration of the hydrograph of the Columbia River, through the implementation of the 2008/2010 RPA, is likely to adversely affect eulachon fitness and survival. These effects will disproportionately manifest on eulachon larvae compared to habitat-related effects on adult and juvenile eulachon that reside in the estuary–plume environment, especially during the May through July period when freshwater inputs to the estuary–plume environment are significantly diminished (Figure 7-1), which in turn affects phytoplankton production—the primary food resource for eulachon larvae in the estuary–plume environment.

Based on the evidence presented in this biological opinion, and our assessment of the 2008/2010 RPA, it is NOAA's best professional estimate, that the aggregated effects of the 2008/2010 RPA on eulachon productivity and abundance will be less than 1% over the next five years.[7] NOAA Fisheries does not expect adverse effects of the 2008/2010 RPA on eulachon to rise to a level that is likely to appreciably diminish productivity and abundance at the subpopulation and the DPS levels. This finding is based on an evaluation of the aggregated effects of the 2008/2010 RPA, especially measures to increase spring and summer flows, and RPA Actions 4, 6, 10–14 and 17, which are likely to proportionately increase primary productivity in the estuary–plume environment and the survival potential

[7] Based on the 2010-2013 median abundance estimates for eulachon in the Columbia River—section 7.2.1.1

of larval eulachon. Therefore, the effects of the 2008/2010 RPA will not be significant enough to appreciably reduce the productivity and abundance of eulachon at the subpopulation or DPS scale. Furthermore, the predicted reductions in productivity and abundance would have no appreciable effect on the species’ diversity or spatial distribution. Likewise, as described in Section 7.4.3, we expect the effects of the 2008/2010 RPA will not rise to the watershed or designation scale for their critical habitat, therefore the effects of the 2008/2010 RPA will not appreciably diminish the conservation value of critical habitat.

7.7 Conclusion

After reviewing the effects of the 2008/2010 RPA on the species and its critical habitat, the environmental baseline, and any cumulative effects, NOAA Fisheries concludes that the 2008/2010 RPA is not likely to jeopardize the continued existence of the southern DPS of eulachon, or result in the destruction or adverse modification of designated critical habitat.

7.8 Incidental Take Statement

NOAA Fisheries has not yet promulgated an ESA section 4(d) rule prohibiting take of threatened eulachon. Anticipating that such a rule may be issued in the future, we have included a prospective incidental take exemption for eulachon. The elements of this ITS for eulachon would take effect on the effective date of any future 4(d) rule prohibiting take of eulachon. Nevertheless, the amount and extent of incidental take, as specified in this statement, will serve as one of the criteria for reinitiation of consultation pursuant to 50 C.F.R. § 402.16(a), if exceeded.

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA may prohibit the take of threatened species, respectively, without special exemption when issued. Take is defined as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct." Incidental take is defined as "take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity." Under the terms of section 7(b)(4) and section 7(o)(2), taking of threatened species, as may be defined by a 4(d) rule, that is incidental to and not intended as part of the agency action will not be considered to be prohibited under the ESA, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described in this section are nondiscretionary and must be undertaken by the Corps, BPA, and Reclamation. The FCRPS Action Agencies have a continuing duty to regulate the activities covered by this Incidental Take Statement. If the FCRPS Action Agencies fail to assume and implement the terms and conditions of this Incidental Take Statement, the protective coverage of section 7(o)(2) may lapse. To monitor the effect of incidental take, the FCRPS Action Agencies must report the progress of the action and its effect on each listed species to NOAA Fisheries, as specified in this Incidental Take Statement [50 C.F.R § 402.14(i)(3)].

7.8.1 Amount or Extent of Take

For non-habitat–related effects of the 2008/2010 RPA, direct impacts of the 2008/2010 RPA on eulachon can be estimated by looking at the available eulachon data from the downstream migrant trap at Bonneville Dam. Based on a single incident in 1988, up to 95,500 adults could be harmed or killed in a given year at Bonneville Dam (Section 7.4.1). However, given that this level of trapping has not occurred since 1988, NOAA Fisheries does not expect this amount of take to occur each year. Therefore, incidental take shall not exceed 95,500 adult eulachon in any 2 years out of any 5-year period.

Incidental take caused by the habitat-related effects through the implementation of 2008/2010 RPA cannot be accurately quantified as a number of fish to be taken, because the distribution and abundance of fish within the action area cannot be attributed entirely to habitat conditions, nor can NOAA Fisheries precisely predict the number of fish that are reasonably certain to be harmed or killed due to habitat degradation, i.e., habitat-related effects through the implementation of the 2008/2010 RPA, as the effects of the 2008/2010 RPA would take place over a large geographic area, and most injuries or fatalities are likely to occur in areas where fish cannot be observed (e.g., Pacific Ocean).

In such circumstances, NOAA Fisheries uses the causal link established between the activity and the likely changes in habitat conditions affecting the listed species to describe the extent of take. Therefore, NOAA will rely on RPA Actions 4, 6, 10–14 and 17 to assess whether the extent of take has been exceeded. Specifically, annual water management plans inconsistent with these RPA actions (which result in the HYDSIM estimated flow modifications described in Section 7.4.2) would be cause for reinitiation of consultation.

7.8.2 Reasonable and Prudent Measures

The following reasonable and prudent measures and terms and conditions in this Incidental Take Statement are necessary and appropriate to minimize the impacts of incidental take associated with the proposed FCRPS operation, as well as to monitor and evaluate activities sufficient to determine whether (1) the RPA is being implemented as expected, (2) the effects of the action considered in the Opinion are occurring as expected, (3) actions to minimize take are being implemented, and (4) authorized take is not being exceeded.

1. The FCRPS Action Agencies (or their designated contractors conducting research) shall monitor the level of eulachon take associated with specific actions (that must be annually coordinated with NOAA Fisheries) and will report the take of eulachon actually observed to NOAA Fisheries' designated FCRPS take determination coordinator no later than six months after the completion of the action.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the FCRPS Action Agencies must comply with the following terms and conditions, which implement the reasonable and prudent measures described above. These terms and conditions are not discretionary and are valid for the duration of this Opinion. To address passage-related adverse effects at Bonneville Dam, the Action Agencies will:

- Annually monitor and report numbers of adult eulachon observed in samples from the Juvenile Bypass System.

7.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. The following recommendations are discretionary measures that are consistent with this obligation and therefore should be carried out by the Action Agencies.

<Placeholder: NOAA Fisheries, in consultation with the Action Agencies, is developing a set of conservation recommendations.>

7.10 Reinitiation of Consultation

Please see Chapter 12 in the 2008 FCRPS BiOp.

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