

Federal Recovery Outline

Pacific Eulachon Southern Distinct Population Segment

Prepared by
**National Marine Fisheries Service
Northwest Region**

Disclaimer

This outline is meant to serve as interim guidance for recovery efforts, including recovery planning, for the southern Distinct Population Segment of Pacific eulachon, until a full recovery plan is developed and issued. A recovery outline is not subject to formal review and is not a regulatory document. This outline is intended primarily for internal use by NMFS as a pre-planning document and the recommendations and statements found herein are non-binding and intended to guide, rather than require, actions. Nothing in this outline should be considered as a commitment or requirement for any governmental agency or member of the public. Formal public participation will be invited upon the release of the draft recovery plan for this Distinct Population Segment. However, any new information or comments that members of the public may wish to offer as a result of this recovery outline will be taken into consideration during the recovery planning process. Recovery planning has been initiated and a draft recovery plan is targeted for completion by September 2015. NMFS invites public participation in the planning process. Interested parties may contact Robert Anderson, Eulachon Recovery Coordinator, 1201 NE Lloyd Blvd., Suite 1100, Portland, OR 97218, Robert.C.Anderson@noaa.gov, (503) 231.2226.

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I. INTRODUCTION

Recovery Outline Purpose

The Federal Endangered Species Act of 1973 (ESA), mandates the National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NMFS) to develop and implement recovery plans for the conservation and survival of ESA-listed species under NMFS' jurisdiction. According to the 2010 NMFS and U.S. Fish and Wildlife Service Endangered and Threatened Species Recovery Planning Guidance:

A variety of actions may be necessary to achieve recovery, such as the ecological restoration of habitat or implementation of conservation measures with stakeholders. However, without a plan to organize, coordinate and prioritize the many possible recovery actions, the effort may be inefficient or even ineffective. Although recovery actions can, and should, start immediately upon listing a species as endangered or threatened under the ESA, prompt development and implementation of a recovery plan will ensure that recovery efforts target limited resources effectively and efficiently into the future. The recovery plan serves as a road map for species recovery—it lays out where we need to go and how best to get there.

This recovery outline presents a preliminary conservation strategy that will guide recovery actions in a systematic, cohesive way until a recovery plan is completed. The outline will assist in guiding and documenting pre-planning considerations for recovery plan development and decision-making.

General Information

Species name: Southern Distinct Population Segment of Pacific eulachon (*Thaleichthys pacificus*)

Listing status: Threatened

Date listed: March 18, 2010 (75 FR 13012)

Critical Habitat designated: October 20, 2011 (76 FR 65324)

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II. RECOVERY STATUS

In order to establish a recovery plan for a species, the current status of that species must be understood. The recovery status indicates how the species is doing at present how much the species' status must improve to no longer warrant the protections of the ESA. Three components were considered when determining recovery status: (1) the biological requirements of the species, (2) the threats that negatively impact the species, and (3) the conservation efforts that positively impact the species.

Biological Requirements

Life History. Pacific eulachon (*Thaleichthys pacificus*) (hereafter, eulachon), are an anadromous smelt in the family Osmeridae and are endemic to the northeastern Pacific Ocean; they range from northern California to southwest and south-central Alaska and into the southeastern Bering Sea (Figure 1). Puget Sound lies between two of the larger eulachon spawning rivers (the Columbia and Fraser Rivers) but lacks a regular eulachon run of its own (Gustafson et al. 2010). 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 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) and Hay (2002) 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 2–5, when they are 160–250 mm in length (fork length), in the lower portions of rivers that 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 7,000-60,000 eggs, which are approximately 1 mm in diameter. Milt and eggs are released over sand or coarse gravel. Eggs become adhesive after fertilization 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 rapidly 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).

Status. Attempts to evaluate the status of eulachon have been difficult due to the lack of reliable long term data. Interpretations of available abundance data for eulachon are confounded by intermittent reporting, fishery-dependent data, and the lack of directed sampling. In the final rule to list eulachon as a threatened species, NMFS concluded that eulachon were likely to become endangered in the foreseeable future throughout all of its range. Eulachon by-catch, dams/water diversions, climate impacts on freshwater habitat and ocean conditions, predation,

and the continued decline in adult eulachon abundance since 1993 to present were determined to be the most critical factors in the formulation of this conclusion.

Recent research efforts have focused on monitoring early life history stages and estimating adult abundance to better evaluate overall species status. Based on recent spawning stock biomass estimates for eulachon in the Columbia River basin, the Washington Department of Fish and Wildlife (WDFW 2013¹) estimated a mean of 41,000,000 spawners for 2010-2011 (range was 20,000,000 fish to 76,000,000 fish), and a mean of 39,000,000 spawners for 2011-2012 (range was 23,000,000 fish to 69,000,000 fish). The Department of Fisheries and Oceans Canada, using a spawning stock biomass index for the Fraser River², estimated 2,381,391 spawners in 2012. Unfortunately, the historical data for eulachon is largely based on commercial landing data and cannot be used to estimate historical spawner abundance.

Population Structure. The eulachon Biological Review Team (BRT) separated the distinct population segment (DPS) into four subpopulations in order to rank the threats they face. These are the Klamath River (including the Mad River and Redwood Creek), the Columbia River (including all of its tributaries), the Fraser River, and the British Columbia coastal rivers (north of the Fraser River up to, and including, the Skeena River).

The southern DPS of eulachon are distinguished from eulachon occurring north of the DPS range by a number of factors including genetic characteristics. Significant microsatellite DNA variation in eulachon has been reported from the Columbia River to Cook Inlet, Alaska (Beacham et al. 2005). Within the range of the southern DPS, Beacham et al. (2005) found genetic affinities among the populations in the Fraser, Columbia, and Cowlitz rivers and also among the Kemano, Klinaklini, and Bella Coola rivers along the central British Columbia coast. In particular, there was evidence of a genetic discontinuity north of the Fraser River, with Fraser and Columbia/Cowlitz samples diverging three to six times more from samples further to the north than they did from each other. Similar to the study of McLean et al. (1999), Beacham et al. (2005) found that genetic differentiation among populations was correlated with geographic distances.

Critical Habitat. Critical habitat was designated for eulachon on October 20, 2011 (76 FR 65324). Critical habitat for eulachon includes 16 specific areas in California, Oregon, and Washington. The designated areas are a combination of freshwater creeks and rivers and their associated estuaries, comprising approximately 335 miles of 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 of freshwater migration corridors include water flow, water quality and water temperatures to support larval and adult mobility; abundant prey items to support larval feeding

¹ E-mail from Brad James WDFW to Robert Anderson, NMFS, February 13, 2013.

² Based on a 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); accessed at <http://www.pac.dfo-mpo.gc.ca/science/species-especes/pelagic-pelagique/herring-hareng/herspawn/pages/river1-eng.htm>.

after the yolk sac is depleted; and obstructed passage 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 and reach the ocean.

We identified a number of activities that may affect the physical and biological features essential to the southern DPS of eulachon such that special management considerations or protection may be required. Major categories of such activities include: (1) dams and water diversions; (2) dredging and disposal of dredged material; (3) inwater construction or alterations; (4) pollution and runoff from point and non-point sources; (5) tidal, wind, or wave energy projects; (6) port and shipping terminals; and (7) habitat restoration projects. All of these activities may have an effect on one or more of the essential physical and biological features via their alteration of one or more of the following: 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.

Threats Assessment

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. It is imperative that these physical/biological/chemical factors limiting eulachon viability are evaluated, and that the causal threats are identified in order to successfully document and implement actions that will lead to the recovery of eulachon. In this recovery outline, 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 1, lists the threats identified by the BRT and their qualitative ranking by sub-population. The threats are listed from most severe (1) to least severe (16).

Table 1. Eulachon threats and qualitative rankings by sub-population³.

Threats	Klamath	Columbia	Fraser	BC
	Ranking			
Climate impacts on ocean conditions	1	1	1	1
Dams/water diversions	2	4	8	11
Eulachon by-catch	3	2	2	2
Climate 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

(-) no ranking due to insufficient data.

Threats and Limiting Factors

The BRT identified 16 threats to eulachon. The primary threats (the top four threats identified by the BRT) to eulachon in the coterminous U.S. (i.e., Klamath and Columbia sub-populations) are eulachon by-catch, dams/water diversions, climate impacts on freshwater habitat and ocean conditions. The primary threats to eulachon in Canada (i.e., Fraser River and B.C. coast sub-populations) are eulachon by-catch, predation, and climate impacts on freshwater habitat and ocean conditions. Secondary threats to eulachon identified by the BRT were water quality, catastrophic events, disease, competition, shoreline construction, Tribal fisheries, nonindigenous species, recreational harvest, scientific monitoring, commercial harvest, and dredging (Gustafson *et al.* 2010). The primary factors responsible for the decline of eulachon are the destruction, modification, or curtailment of habitat and inadequacy of existing regulatory mechanisms (75 FR 13012).

The following sections provide a summary on the primary threats to eulachon with respect to the five ESA listing factors.

Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

Climate Impacts

Climate impacts in the Pacific Northwest are predicted to result in changes in coastal ecosystems that may be similar to, or potentially even more severe than those experienced during past periods of strong El Niño events and warm phases of the Pacific Decadal Oscillation (PDO).

³ For a description of the qualitative threats assessment see Gustafson *et al.* 2010, p. 166-170.

These impacts may include warmer upper ocean temperatures, increased stratification and decreased productivity along the coast. However, a lack of certainty in future wind and weather patterns yields large uncertainties for future changes. For example, if upwelling winds remain unchanged from those of the past century, coastal upwelling may become less effective at pumping cold, nutrient-rich [water] to the upper ocean because of increased stability in the upper ocean caused by surface warming. Or, as some modeling studies and hypotheses suggest, upwelling winds may become more intense, and perhaps the timing for the upwelling season will change because of timing shifts in upwelling wind patterns. Regardless of the uncertainty in future wind patterns and upwelling dynamics, warmer ocean temperatures are expected to induce shifts in the size and species composition of zooplankton to smaller lipid-replete zooplankton instead of large, lipid-rich, cool-water species. Because of food chain effects and warmer ocean waters, forage fishes will decline and warm-water predators will increase (ISAB 2007).

All the above predicted changes will likely influence the growth, productivity, survival, and migration of eulachon. Pacific hake undergo seasonal migrations from their winter spawning and rearing grounds off southern California to their northern feeding grounds off the west coast of Vancouver Island in summer (Ware and McFarlane 1995, Benson et al. 2002). Large adult Pacific hake are known to prey on eulachon, and euphausiids (also the dominant prey species for adult eulachon) (Rexstad and Pikitch 1986, Buckley and Livingston 1997). Beamish et al. (2008, p. 34) stated that “The projected long-term increase in temperatures may result in more offshore hake moving into the Canadian zone, and in the spawning and rearing area off California moving north.” Thus projected ocean warming is thus likely to result in an altered distribution of both predators on eulachon and competitors for food resources.

Initial eulachon survival during the critical transition period between the larval and juvenile stages is likely linked to the intensity and timing of upwelling in the northern California Current Province. However, the potential shift of peak upwelling to one month later than normal [as predicted under some future climate change scenarios] may result in a temporal trophic mismatch between eulachon larval entry into the ocean and presence of preferred prey organisms whose productivity is dependent on the earlier initiation of upwelling conditions. These conditions would likely have significant negative impacts on marine survival rates of eulachon and recent recruitment failure of eulachon may be traced to mortality during this critical period. Larval and juvenile eulachon are planktivorous and are adapted to feed on a northern or boreal suite of copepods during the critical larval/juvenile transition. There are two main suites or assemblages of copepod species over the continental shelf off the west coast of North America: a boreal shelf assemblage (e.g., *Calanus marshallae*, *Pseudocalanus mimus*, and *Acartia longiremis*) that normally occurs from central Oregon to the Bering Sea and a southern assemblage (e.g., *Paracalanus parvus*, *Mesocalanus tenuicornis*, *Clausocalanus* spp., and *Ctenocalanus vanus*) that is most abundant along the California coast (Mackas et al. 2001, 2007). Changes in the relative abundance and distribution of these copepod assemblages covary with oceanographic conditions (Roemmich and McGowan 1995, Mackas et al. 2001, 2007, Peterson and Keister 2003, Zamon and Welch 2005, Hooff and Peterson 2006). When warm conditions prevail, as during an El Niño year or when the PDO is positive, the distribution of zooplankton communities can shift to the north, and the southern assemblage of copepods (these are lipid poor species that represent diminished food value, and likely would result in decreased eulachon growth, fitness, and survival) can become dominant off southern Vancouver Island (Mackas et

al. 2007). For example, the abundance of boreal shelf copepods was much lower than normal and southern species dominated off southern Vancouver Island during the warm years between 1992 and 1998 (Mackas et al. 2007). Thus warmer ocean conditions may be expected to contribute to a mismatch between eulachon life history and preferred prey species.

Ocean conditions off the Pacific Northwest in 2005 were similar to what may be expected if climate change predictions for the next 100 years are accurate. According to Barth et al. (2007, p. 3,719), there was a “1-month delay in the 2005 spring transition to upwelling-favorable wind stress in the northern California Current,” and during May to July, upwelling-favorable winds were at their lowest levels in 20 years and “nearshore surface waters averaged 2°C warmer than normal.” Eulachon returns to spawning rivers in the southern DPS were poor during this period of unfavorable ocean conditions from 2004 to 2008 (JCRMS 2008) and may portend how eulachon will respond to warming ocean conditions.

Dams and Water Diversions

Columbia River Basin

The Columbia River has the largest annual discharge of any river on the Pacific coast of North America and is the second largest river in the United States. The Columbia River drains an area of 259,000 square miles flowing 1,243 miles from its headwaters in British Columbia to its mouth in the Pacific Ocean near Astoria, Oregon (ISAB 2000). The river strongly affects regional seawater properties of the northeast Pacific Ocean contributing between 60% (winter) to 90% (summer) of the total freshwater input between San Francisco and the Strait of Juan de Fuca (Bottom *et al.* 2005).

Between 1933 and 1982, 21 large dams were constructed on the Columbia and Snake Rivers. Development of a large-scale hydropower system has changed seasonal flow rates, reduced sediment transport, and discharge (i.e., the rate of flow) to the nearshore ocean environment (ISAB 2000). Physical changes in the estuary and regulation of river flow have also altered the dynamics of seawater intrusion, circulation, and sedimentation processes in the estuary, and have had large ecosystem-level consequences (ISAB 2000).

Changes in flow due to construction of the Columbia River mainstem dams have had the greatest influence on the current hydrograph. The magnitude of the spring-freshet flow has decreased by more than 40% with the development of hydropower and irrigation. Approximately 75% of this loss is due to flow regulation, with irrigation withdrawal accounting for approximately 20%, and climate change for approximately 5% (Bottom *et al.* 2005). The timing of maximum spring-freshet flow also shifted two weeks earlier due to hydropower and irrigation development, flood control and climate warming, (mean pre-development date of 12 June compared to modern mean date of 29 May). The spring freshet has become longer, weaker, and earlier while winter flows are less sharply peaked than before flow regulation (Bottom *et al.* 2005). The total discharge has also changed from the pre-development period. The annual average flow at the mouth has been reduced from about 8,500 cubic meters per second (m^3s^{-1}) to less than 7,000 m^3s^{-1} , with climate change and water withdrawal each responsible for approximately 50% of the reduction (Bottom *et al.* 2005).

The Columbia River plume is a freshwater/saltwater interface where freshwater exiting the Columbia River meets and rises above the denser saltwater of the Pacific Ocean. The plume's location varies seasonally with discharge, prevailing near-shore winds, and ocean currents. In summer, the plume extends far to the south and offshore along the Oregon coast. During the winter, it shifts northward and inshore along the Washington coast. Strong density gradients between ocean and plume waters create fronts where organic matter and organisms are concentrated (Fresh *et al.* 2005). The change to the Columbia River flow regime has reduced the plume size, shape and intensity. The plume provides important habitat for forage species including eulachon, which can dominate the forage species assemblage in subsurface waters (12-24 meters) Emmett *et al.* (2004). The significance of these changes to the plume environment on eulachon larval growth, development, and marine survival remains an area of uncertainty.

Canada

In British Columbia there are an estimated 802 licensed dams in the Fraser River basin, mostly for irrigation purposes in the dryer areas above Hope (Birtwell *et al.* 1988). The impact on eulachon of water withdrawals associated with reservoirs in the Fraser River has not been studied. The other eulachon river in British Columbia where hydrology has been significantly altered by water diversions is the Kemanon River where a hydroelectric plant began operating in 1954 (Lewis *et al.* 2002).

California

The six hydroelectric dams on the Klamath and Trinity Rivers, as well as associated irrigation withdrawals in the upper Klamath River basin, have shifted the spring peak flow of the lower Klamath River from its historical peak in April to its current peak in March, one full month earlier (NRC 2004).

Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

Bycatch—Shrimp Fishery

Eulachon are taken as bycatch in shrimp trawl fisheries off the coasts of Washington, Oregon, and California (NWFSC 2008, 2009a, 2010a). Offshore trawl fisheries for ocean shrimp (*Pandalus jordani*) extend southward from the west coast of Vancouver Island to the U.S. West Coast off Cape Mendocino, California (Hannah *et al.* 2003). *Pandalus jordani* is known as the ocean pink shrimp or smooth pink shrimp in Washington, simply pink shrimp in Oregon, and Pacific Ocean shrimp in California.

Al-Humaidhi *et al.* (2012) provide estimates of the number of individual eulachon caught in the Oregon and California ocean shrimp trawl fishery as bycatch from 2004 to 2010 (except for 2006 when these fisheries were not observed). These estimates were derived from West Coast Observer Program (WCGOP) data. The WCGOP began coverage of Washington ocean shrimp licenses in 2010, with the same coverage criteria used for Oregon and California State ocean shrimp fisheries coverage (Al-Humaidhi *et al.* 2012). The total estimated bycatch of eulachon in the Oregon and California ocean shrimp fisheries ranged from 217,841 fish in 2004 to a high of

1,008,259 fish in 2010 (Al-Humaidhi et al. 2012). For all years observed, fleet-wide eulachon bycatch estimates in the Oregon ocean shrimp fishery were much higher than in the California fishery. In 2010, estimated eulachon bycatch in the Washington ocean shrimp fishery was 66,820 fish; and the total 2010 estimated eulachon bycatch for all three states combined was 1,075,081 (Al-Humaidhi et al. 2012). Eulachon encountered as bycatch in these fisheries come from a wide range of age classes but are all assumed to be part of the southern DPS.

The estimated bycatch of eulachon in the ocean shrimp fisheries increased considerably between 2007 (218,476 fish) and 2010 (1,075,081 fish). There are three reasons for this increase: (1) the inclusion of bycatch data for Washington), (2) increased effort in the fisheries, and (3) an increased bycatch rate in the fisheries. It is unknown whether the increasing bycatch rate of eulachon is a result of increasing eulachon abundance. Prior to 2003, when use of by-catch reduction devices (BRDs) became mandatory in all the U.S. West Coast shrimp trawl fisheries, 32–61% of the total catch in the ocean shrimp fishery in Oregon consisted of non-shrimp biomass, including various species of smelt (Hannah and Jones 2007). As of 2005, following required implementation of BRDs, the total by-catch by weight had been reduced to about 7.5% of the total shrimp catch, and osmerid smelt by-catch was reduced to an estimated average of 0.7% of the total catch across all BRD types (Hannah and Jones 2007).

Bycatch—Groundfish Fishery

Several recent reports (NWFSC 2008, 2009a, 2009b, 2010a, 2010b; Bellman et al. 2008, 2009, 2010, 2011; Al-Humaidhi et al. 2012) provide data on estimated bycatch of eulachon in U.S. West Coast commercial fisheries, which were derived from the WCGOP and the at-sea hake observer program) A-SHOP. Eulachon were observed as bycatch in the following fisheries: (1) limited entry (LE) bottom trawl fishery, (2) at-sea Pacific hake/whiting mothership fishery, (3) at-sea Pacific hake/whiting tribal mothership fishery, (4) at-sea Pacific hake/whiting catcher-processor fishery, and (5) Washington, Oregon, and California commercial shrimp trawl fishery (Al-Humaidhi et al. 2012). Al-Humaidhi et al. (2012) provided estimated bycatch of eulachon from 2002 to 2010 as number of individual fish in the LE groundfish trawl and at-sea Pacific hake fisheries.

Observer data indicate that eulachon were not encountered in the Washington portion of the LE bottom trawl fishery from 2002 to 2010. The majority of eulachon encounters in the LE bottom trawl fishery from 2002 to 2010 occurred in the Oregon portion of the fishery, although eulachon were also encountered (in very low numbers) in the California portion of the fishery in 2004 and 2010. Total eulachon bycatch for the LE bottom trawl fishery from 2002 to 2010 was estimated at 1,030 total individual fish (Al-Humaidhi et al. 2012). Bycatch in this fishery was recorded in six of the nine observed years, with no bycatch reported in 2005, 2006, or 2008 (Al-Humaidhi et al. 2012). The highest observed yearly bycatch in the LE bottom trawl fishery (for all areas combined) was recorded in 2002 (819 eulachon).

The offshore fishery for Pacific hake occurs along the coasts of northern California, Oregon, and Washington from April through November. The total eulachon bycatch for the offshore Pacific hake fishery from 2002 to 2010 was estimated to be 256 individual fish. Bycatch in this fishery was recorded in four of the nine observed years, and no bycatch was reported in 2002, 2003, 2004, 2005, or 2010 (Al-Humaidhi et al. 2012).

Not all observed smelt (family *Osmeridae*) bycatch in the LE bottom trawl and at-sea Pacific hake fisheries has always been identified at the species level. Because of sampling conditions and time constraints, it is likely that some portion of observed eulachon bycatch may have been recorded as “other non-groundfish,” in the early years of the two observer programs. The proportion of eulachon bycatch recorded as “other non-groundfish” is unquantifiable, but likely was not very large given the current level of estimated bycatch.

Disease and Predation

Disease

The BRT found very little information relative to impacts of diseases on eulachon. Hedrick et al. (2003) isolated viral hemorrhagic septicemia virus (VHSV) for the first time from adult eulachon collected in March 2001 in Oregon’s Sandy River. Six of 15 pooled samples, each consisting of 5 fish, tested positive for VHSV. The overall impact of this virus on eulachon is difficult to assess. This virus has been isolated from a wide range of marine fish hosts and given the right conditions may “cause significant disease associated with morbidity and mortality in populations of marine fish” (Hedrick et al. 2003, p. 212).

Predation

Numerous sources provide general lists of predators of eulachon (Willson et al. 2006) and predation rates.

Predators include fish (white sturgeon, spiny dogfish, sablefish, salmon sharks, arrowtooth flounder, salmon, Dolly Varden, Pacific halibut, Pacific cod), sea birds (harlequin ducks, pigeon guillemots, common murre, mergansers, cormorants, gulls, eagles), marine mammals (baleen whales, orcas, dolphins, pinnipeds, belugas (Willson et al. 2006), and terrestrial mammals (brown bears, wolves). Hake, which have been expanding northward, can be very abundant and may be significant predators as well (Willson et al. 2006). Jeffries (1984) reported that eulachon were eaten by 50%, 87%, 44%, and 12% of the harbor seals present in January, February, March, and April, respectively. Brown et al. (1989) determined that 98% of the preys eaten by harbor seals in the Columbia River during the winters of 1986 to 1988 were eulachon, and that 100% of harbor seal stomachs examined contained eulachon (Brown et al. 1989, NMFS 1997). Brown et al. (1989) also estimated that the more than 2,000 harbor seals present during mid-winter 1987 in the Columbia River consumed from 2.5 to 10.2 million eulachon or from 105 to 428 mt (assuming an average weight of 42 g per eulachon), which is equal to 12% to 50% of the Columbia River commercial fishery landings of eulachon for that year.

Inadequacy of Existing Regulatory Mechanisms

At the time of listing, the primary factors responsible for the decline of eulachon are the destruction, modification, or curtailment of habitat and inadequacy of existing regulatory mechanisms (75 FR 13012), specifically the lack of regulations concerning bycatch of eulachon in commercial fisheries. During recovery planning, NMFS will work with the commercial

fishing industry to identify potential management actions that can be taken to minimize eulachon bycatch.

Other Natural or Human Factors

Competition

Euphausiids (principally *Thysanoessa spinifera* and *Euphausia pacifica*) are a primary prey item of eulachon in the open ocean and are also eaten by many other competing species. Tanasichuk et al. (1991) showed that euphausiids were the most important prey for both spiny dogfish and Pacific hake off the lower west coast of Vancouver Island. Livingston (1983) determined that euphausiids constituted 72% and 90% of the diet by weight of Pacific hake examined off Oregon and Washington, respectively, in 1967, and 97% of the diet by weight of Pacific hake 350–449 mm long off Oregon in 1980. Similarly, Outram and Haegele (1972) indicated that euphausiids were the most numerous prey items of Pacific hake off the British Columbia coast in 1970, occurring in 94% of Pacific hake stomachs analyzed. Rexstad and Pikitch (1986, p. 955) stated that “euphausiids constitute the primary source of food for Pacific hake in the North Pacific.” The offshore Pacific hake stock migrates northward from winter spawning grounds to feed off the coast of the Pacific Northwest in the summer. This stock represents the largest component of the offshore pelagic fish biomass in the California Current system (Ware and McFarlane 1995). Recent evidence (Benson et al. 2002, Cooke et al. 2006, and Phillips et al. 2007) indicates that Pacific hake spawning may be shifting further north within the northern California Current system. This places more young of the year Pacific hake in that ecosystem (Phillips et al. 2007) in direct competition with eulachon for their preferred prey, euphausiids.

Euphausiid Fisheries

A commercial fishery for euphausiids (also known as krill) occurs in the British Columbia portion of the Strait of Georgia (DFO 2007b). According to DFO (2007b, p. 6), euphausiid biomass in British Columbia waters “is dominated by five [species]: *Euphausia pacifica*, *Thysanoessa spinifera*, *T. inspinata*, *T. longipes* and *T. raschii*,” and *E. pacifica* accounts for 70–100% of the biomass in the Strait of Georgia. The Integrated Fisheries Management Plan for euphausiids limits annual total allowable catch (TAC) of euphausiids in the Strait of Georgia to 500 mt (DFO 2007b). DFO (2007b, p. 3 of its Appendix A) stated that this level of harvest is considered to “be conservative and sustainable” within the Strait of Georgia. Eulachon originating from rivers draining into the Strait of Georgia likely leave the strait for waters over the continental shelf prior to reaching a size where they would begin consuming euphausiids, and thus the impact of this euphausiid fishery on eulachon is expected to be minor.

Although no directed commercial fishery for euphausiids has occurred in U.S. waters off the West Coast, recognition of the importance of krill in the diet of many species influenced the Pacific Fisheries Management Council to propose a ban on commercial harvest of all species of krill (euphausiids) in the Exclusive Economic Zone off the U.S. West Coast, which includes California, Oregon, and Washington (PFMC and NMFS 2008). This krill harvest ban was formally implemented as Amendment 12 to the Coastal Pelagic Species Fishery Management Plan in July 2009 (NMFS 2009).

Nonindigenous Species

Potential impacts and risks of nonindigenous aquatic species to native fish species include increased predation, increased competition for habitats and food, alteration of food webs, and transmission of new diseases and parasites (ISAB 2008). The negative impact of nonindigenous species is recognized as one of the leading factors causing imperilment of native North American freshwater aquatic species (Lassuy 1995, ISAB 2008) and was listed as a factor leading to the extinction of 40 North America fish species and subspecies, representing a full 68% of those lost over the past 100 years (Miller et al. 1989). NRC (2004) reported that 17 nonindigenous fish species inhabit the Klamath River basin, but their impact on eulachon has not been studied. Schade and Bonar (2005) estimated that the percent of total fish species that are nonnative in streams in California, Oregon and Washington, were 39.6%, 24.5%, and 18.4%, respectively.

Conservation Assessment

The following actions have been or are currently underway to address the conservation needs of eulachon.

Fisheries Regulations

Directed Fisheries in the United States – The states of Oregon and Washington enacted permanent rules prohibiting directed harvest of eulachon in recreational and commercial fisheries in the Columbia River and its tributaries; commercial fishing closed permanently effective December 1, 2010 and recreational fishing closed permanently effective January 1, 2011. On March 1, 2013, the state of California issued regulations prohibiting the take or possession of eulachon in recreational fisheries.

Bycatch in Pink Shrimp Fisheries – Effective December 2010, the state of Oregon requires all shrimpers fishing within the Oregon Fisheries Conservation Zone to employ ridged-grate bycatch reduction devices. The state of Washington adopted ridged-gate BRD regulation effective in January 2012. The Oregon Fish and Wildlife Commission changed the administrative rules governing the use of BRDs in the pink shrimp fishery to reduce the bycatch of eulachon. The new rules require the use of rigid-grate BRDs with bar spacing no more than 1.0 inch starting in 2011, and 0.75 inch beginning in 2012. Initial reports are that most fishers have already converted to rigid-grate BRDs with 0.75 inch bar spacing.

Directed Fisheries in Canada – Since 1995 the Canada Department of Fisheries and Oceans (DFO) has suspended commercial eulachon fisheries in the Fraser River; closed the commercial shrimp fishery in Queen Charlotte Sound; adopted “eulachon action levels” by DFO management that warn of possible shrimp fishing closures when cumulative eulachon bycatch level is reached; and required BRDs installed in shrimp trawls to reduce eulachon by-catch. The commercial eulachon fishery remains closed in the Fraser River. However, there are currently 16 ZU (introduced) eulachon license eligibilities.

Aboriginal harvest for food, social and ceremonial purposes is authorized by communal licenses in the lower Fraser River; a total of eight bands may apply for licenses for small amounts of eulachon.

The recreational fishery for eulachon is closed in the Fraser River area. For areas on the coast that remain open, fishing is permitted by gill net and dip net with a daily limit of 20kg and a possession limit of 40kg.

ESA Regulations

Eulachon were listed as a threatened species under the Endangered Species Act on March 18, 2010.

The final critical habitat designation for the eulachon became effective on, and includes 335 miles of freshwater creeks and rivers and their associated estuaries habitat in 16 specific areas within the states of California, Oregon, and Washington.

Federal agencies, in consultation with NMFS under ESA section 7, ensure that their activities do not jeopardize listed species or adversely modify critical habitat.

Ongoing Research Actions

Washington Department of Fish and Wildlife – For the past three years WDFW has been conducting research on eulachon in the Columbia River to assess the freshwater distribution and spawning stock biomass for the Columbia River sub-population.

For the past two years WDFW has deployed observers on shrimp trawlers to collect eulachon bycatch data.

Oregon Department of Fish and Wildlife – For the past three years the Oregon Department of Fish and Wildlife (ODFW) has assisted WDFW in conducting research on eulachon in the Columbia River to assess freshwater distribution and conduct spawning stock biomass estimates for the Columbia River sub-population.

NOAA's Northwest Fisheries Science Center – For the past year the NWFSC has been collaborating with WDFW in conducting research on eulachon in the Columbia River to assess eulachon run-timing, sex ratios, fecundity, freshwater distribution, and spawning stock biomass estimates for the Columbia River sub-population.

Canada – Since 1995 DFO has conducted a spawning stock biomass surveys in the Fraser River, and since 1973 have conducted offshore biomass surveys off the west coast of Vancouver Island.

Cowlitz Indian Tribe - Since 2010 the Cowlitz Indian Tribe has conducted research on eulachon in the Columbia River, Cowlitz River, and Grays River to assess spawning distribution.

Yurok Indian Nation – Since 2010 the Cowlitz Indian Tribe has conducted research on eulachon in the Klamath River to assess presence/absence and spawner abundance estimates.

Quinalt Indian Tribe – In 2013 the Quinalt Indian Tribe began a study to determine eulachon spawn-timing, relative abundance, and habitat use in the rivers that flow into Grays Harbor, WA.

Ongoing Conservation Actions

Elwah River – In 2000, as part of a comprehensive restoration effort in the Elwah River basin, the Elwha and Glines Canyon dams were acquired by the federal government and removal of the dams began in 2011.

Klamath River – Pending Congressional approval, the Iron Gate dam, Copco 1 dam, Capco 2 dam, and J.C. Boyle dam are scheduled to be removed in 2020.

Department of Fisheries and Oceans, Canada – Beginning in 1995 DFO has suspended dredging in the Fraser River during the eulachon spawning season.

National Marine Fisheries Service – In 2012 NMFS issued the U.S. Army Corps of Engineers a biological opinion on their operations and maintenance dredging program for the Columbia River that includes measures to reduce impacts to eulachon in the Columbia River.

Washington Department of Ecology – the Washington Department of Ecology has issued the U.S. Army Corps of Engineers 401 water quality certifications on their operations and maintenance dredging program for the Columbia River that that includes measures to reduce impacts to eulachon in the Columbia River.

Washington Department of Fish and Wildlife – WDFW has also established an in-water work period for the Cowlitz River (mouth to river mile 49.5) is July 16 to August 15 to conserve eulachon.

Salmon and Steelhead Habitat Restoration Projects – Habitat restoration projects continue to be implemented in northern California and the Pacific Northwest to improve habitat functions.

Summary Statement of Recovery Needs

Major threats to eulachon still exist, even with the protections afforded by the listing and critical habitat designation. The foremost threat is climate impacts on ocean conditions (species-wide), in addition to by-catch (species-wide), climate impacts on freshwater habitat (species-wide), dams and water diversions (Columbia River and Fraser River sub-populations), and predation (species-wide).

III. PRELIMINARY RECOVERY STRATEGY

The preliminary recovery strategy describes initial decisions that have been made about how to recover eulachon. First, a Priority Number was determined for eulachon to rank its priority for recovery plan development and implementation. Next, a Recovery Vision Statement was made to clearly define the overall goal of recovery. Priority tasks were then developed which, if implemented, would improve the potential for recovery. Finally, a preliminary action plan for NMFS was written. This plan outlines potential coordination efforts between divisions within NMFS and with other entities involved in eulachon management and recovery. This is a starting point from which the full recovery strategy for eulachon will be developed.

Recovery Priority Number

On a scale of 1-10, the recovery priority number assigned to eulachon is 7, indicating the risk of extinction is believed to be moderate. The recovery potential for this species is likely high if recreational and commercial fisheries remain closed and if activities that decrease habitat quality and quantity, particularly in spawning and rearing habitat, are carefully monitored and limited. However, conflict exists between the recovery of the eulachon and economic interests. Dam and water users and commercial and recreational fisheries are among the entities that may be affected by efforts to recover eulachon.

The recovery potential for this species is considered moderate because the limiting factors and threats to the species existence are poorly understood, and the probability of success of management actions is not known. At present there is a conflict between the recovery of the Southern DPS and economic interests. Commercial and recreational eulachon fishing and commercial shrimp trawling are among the industries that will be affected by efforts to recover the Southern DPS.

Recovery Vision Statement

The goal for the recovery plan is to conserve and protect eulachon and its habitat so that its long-term survival is secured and it can be considered for removal from the list of threatened and endangered species (delisted).

The following statement is what a recovered DPS of eulachon should look like in the future.

Healthy, self-sustained, biologically viable sub-populations of eulachon exist throughout their historic range, to include spawning within each of the four sub-populations with the DPS represented by multiple and abundant year-classes in marine and freshwater environments, and are sufficiently abundant, productive to provide ecological and public benefits.

Recovery Tasks to Improve Potential for Recovery

The goal of this recovery outline is to set out a plan to conserve and recover eulachon by identifying actions that may improve its potential for recovery. These include, but are not limited to, the following:

Research and Monitoring:

1. Continue funding in-river spawning stock biomass surveys to develop long-term eulachon spawner abundance estimates for all four sub-populations.
2. Investigate the causal mechanisms and migration/behavior characteristics affecting survival of larval eulachon during their first weeks in the Klamath, Columbia, and Fraser Rivers plume and nearshore ocean environments.
3. Investigate the ecological importance of the tidal freshwater, estuary, plume, and nearshore ocean environments to the viability and recovery of eulachon in the Klamath, Columbia, and Fraser Rivers.
4. Develop an oceanographic indicators ecosystem conditions model to determine the significance of plume and ocean conditions that affect eulachon survival.
5. Develop and implement a marine abundance survey for eulachon.
6. Determine a method to correlate in-river and marine abundance estimates of eulachon.
7. Expand genetic research to refine eulachon population structure and stock composition.
8. Develop an approach to determine the significance of climate-related impacts on ocean conditions that affect eulachon survival.
9. Determine the significance of water quality degradation, e. g., toxics – identify and prioritize potential contaminants of concern, on eulachon recovery potential.
10. Investigate the long-term effects on the management of the Toutle River Sediment Retention Structure on sedimentation processes in the Toutle and Columbia Rivers.

Management Actions:

1. Maintain a conservative eulachon fisheries program for all four sub-populations.
2. Maintain regulations that require the use of rigid-grate BRDs with bar spacing no more than 0.75 inch for the pink shrimp fisheries.
3. Continue to work with the U.S. Army Corps of Engineers, the Bonneville Power Administration, and the Bureau of Reclamation to implement management strategies to operate the hydropower system for the Columbia River to more closely approximate the shape of the natural hydrograph and to enhance flows and water quality to improve eulachon survival in the plume and nearshore ocean environments.
4. Continue to work with the U.S. Army Corps of Engineers to maintain dredging and disposal best management practices and state and Federal requirements for the Columbia River Navigation Channel Operations and Maintenance Dredging Program.
5. Continue to support the removal of the Klamath River dams.
6. Determine by-catch rates of eulachon in trawl fishery operations that are not currently covered by on-board observers.

7. Establish better inter- and intra-agency coordination regarding scientific research conducted on eulachon.

Recovery actions will be further refined in the recovery plan and will be specific to several regions, including, but not limited to, the Columbia River, the Cowlitz River, the Sandy River, the Klamath River, the Elwha River, and coastal marine areas, which include several estuaries/bays. These regions have different characteristics and will require different types of actions to achieve recovery. Actions specific to life-stages in each region will be identified to address more localized factors that currently suppress potential for recovery for eulachon.

Preliminary Action Plan

While NMFS is responsible for developing and implementing recovery plans, the plans will have a greater likelihood of success if they are developed in partnership with entities that have the responsibility and authority to implement specific recovery actions. Hence, NMFS is considering initiating a series of outreach efforts in various forums to ensure high levels of communication and interaction with the public, stakeholders and agencies throughout the development and finalization process of the recovery plan, including the following:

- NMFS will coordinate with the tribes in California, Oregon, Washington, and Canada during the development of the recovery plan.
- NMFS Protected Resources Division will coordinate with other NOAA line offices and NMFS divisions including the NOAA's Restoration Center, NOAA's Office of Law Enforcement, Habitat Conservation Division, Sustainable Fisheries Division, and the NMFS Science Centers to ensure consistency and effectiveness in the recovery plan development.
- NMFS shall focus on linking and coordinating other ESA programs to eulachon recovery planning, and developing stronger, more collaborative partnerships with other entities whose decisions affect eulachon. This should include providing outreach to federal action agencies regarding their obligations under ESA section 7(a)(1) to implement actions that conserve and recover eulachon. NMFS will also need to coordinate and improve communication with federal and state agencies regarding joint management responsibilities and competing species needs.

IV. PRE-PLANNING DECISIONS

Product

Draft Recovery Plan for eulachon.

Scope of Recovery Plan

Species Recovery Unit Multi-Species Ecosystem

Recovery Plan Preparation

NMFS is in the process of putting together a recovery team comprised of scientists knowledgeable in eulachon biology to develop biological viability criteria. The NMFS Northwest Region Protected Resources Division will initiate the preparation of a draft recovery plan for eulachon (using the most recent Recovery Planning Guidance from June 2010) with a goal of releasing an internal draft by spring of 2015. Primary authorship of the Recovery Plan will be the responsibility of NMFS staff.

Administrative Record

The administrative record will be housed in the NMFS NWR Portland office in Portland, OR.

Schedule and Responsibility for the Draft Recovery Plan

To be completed:

2013

Finalize recovery outline
Publish Federal Register Notice — intent to prepare a recovery plan for eulachon
Form recovery team
Hold recovery team meetings
Form stakeholder group
Initiate development of recovery plan chapters
Initiate recovery planning website for public outreach

2014

Continue development of recovery plan chapters
Develop management actions
Hold recovery team meetings
Develop biological viability criteria – population viability analysis
Develop oceanographic indicators ecosystem conditions model
Host stakeholder group meetings

2015

Issue draft recovery plan for co-manager review
Issue draft recovery plan for public review

2016

Revise draft recovery plan pursuant to comments received
Finalize recovery plan
Initiate recovery plan implementation for priority actions

Outreach and Stakeholder Participation

In order to facilitate communication with various stakeholders, NMFS will hold a series of stakeholder group meetings and construct and maintain a web site that provides technical information about eulachon life history, species needs, and viable population analyses to facilitate access by Federal, state, regional planning organizations, county governments, special interest groups, non-governmental organizations, and the public. The web site will also identify actions that could conserve and recover eulachon.

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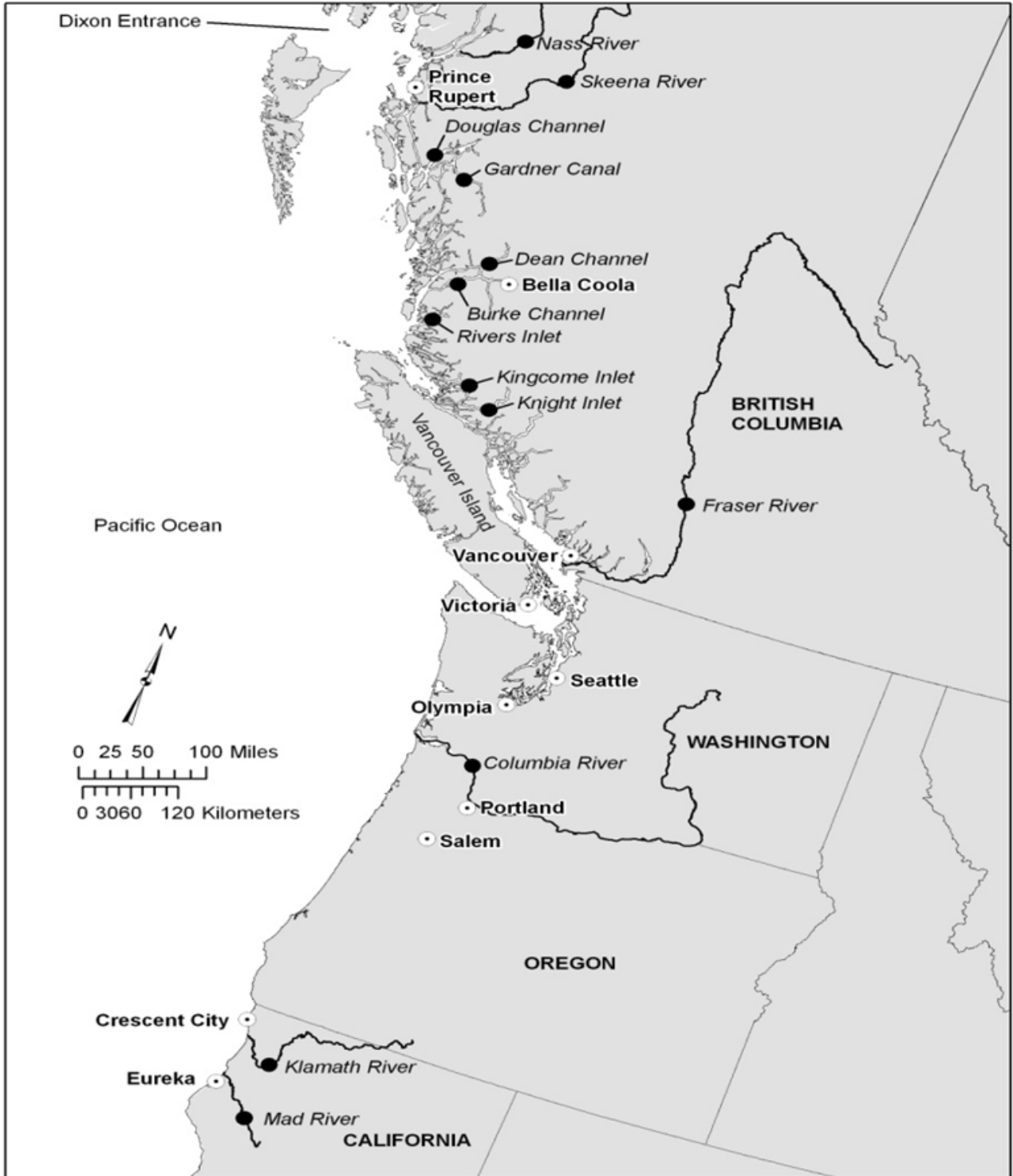


Figure 1. Distribution of the southern Distinct Population Segment of Pacific eulachon (*Thaleichthys pacificus*) listed as a threatened species under the Endangered Species Act.