Science, Service, Stewardship

2016 5-Year Review: Summary & Evaluation of **Eulachon**

National Marine Fisheries Service
West Coast Region
Portland, OR

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5-Year Review: Southern Distinct Population Segment of Eulachon

Species Reviewed	Distinct Population Segment
Eulachon (*Thaleichthys pacificus*)	*Eulachon*

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Table of Contents

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1 General Information

1.1 Introduction

On 18 March 2010, the National Marine Fisheries Service (NMFS) published a final rule in the Federal Register (75 FR 13012) to list the southern distinct population segment (DPS) of eulachon (*Thaleichthys pacificus*) as threatened under the U.S. Endangered Species Act (ESA) (NMFS 2010). This listing encompassed all subpopulations of eulachon within the states of Washington, Oregon, and California and extended from the Skeena River in British Columbia south to the Mad River in Northern California (Figure 1). The Biological Review Team (BRT) concluded that the major threats to the of eulachon, included climate change impacts on ocean conditions and freshwater habitat, bycatch in offshore shrimp trawl fisheries, changes in downstream flow-timing and intensity due to dams or water diversions, and predation. These threats, together with large declines in abundance, indicated to the BRT that the southern DPS of eulachon was at moderate risk of extinction throughout all of its range (Gustafson et al. 2010, 2012). These factors collectively led the NMFS listing of the southern DPS of eulachon as a threatened species under the Federal ESA.

The ESA, under section 4(c)(2), directs the Secretary of Commerce to review the listing classification of threatened and endangered species at least once every five years. After completing this review, the Secretary must determine if any species should be: (1) removed from the list; (2) have its status changed from threatened to endangered; or (3) have its status changed from endangered to threatened. The most recent listing determination for eulachon occurred in 2010. This document describes the agency's five-year review of the ESA-listed southern DPS of eulachon.

1.1.1 Background on listing determinations

The ESA defines species to include subspecies and DPS of vertebrate species. A species may be listed as threatened or endangered. To identify a DPS, we applied the joint U.S. Fish and Wildlife Service (FWS) and NMFS DPS policy (61 FR 4722). Under this policy, a DPS of eulachon must be discrete from other populations, and it must be significant to its taxon.

1.2 Methodology used to complete the review

On February 6, 2015, we announced the initiation of a five-year review for eulachon (80 FR 6695). We requested that the public submit new information on this species that has become available since our 2010 listing. In response to our request, we did not receive any information from Federal and state agencies, Native American Tribes, conservation groups, fishing groups, and individuals.

To prepare this review, we asked scientists from our Northwest Fisheries Science Center to collect and analyze updated information related to the delineation of the DPS; new information on trends and status in abundance, productivity, spatial structure and diversity; and new information on selected threats.

To further inform this report, we considered the work of the Northwest Fisheries Science Center (Gustafson et al. 2010, 2012, 2016); technical reports; the listing record (including designation of critical habitat); and the eulachon recovery outline for eulachon.

In preparing this report, we considered all relevant information available. The present report describes the agency's findings based on all of the information considered.

1.3 Background – Summary of Previous Reviews, Statutory and Regulatory Actions, and Recovery Planning

1.3.1 Federal Register Notice announcing initiation of this review

80 FR 6695; February 6, 2015

1.3.2 Listing history

In 2010, NMFS listed eulachon under the ESA and classified it as a threatened species (Table 1).

Table 1. Summary of the listing history under the Endangered Species Act for Eulachon.

Species	DPS Name	Original Listing	Revised Listing(s)
Eulachon (*Thaleichthys pacificus*)	Eulachon	**FR Notice:** 75 FR 13012 **Date:** 3/18/2010 **Classification:** Threatened	**N/A**

1.3.3 Associated rulemakings

The ESA requires NMFS to designate critical habitat, to the maximum extent prudent and determinable, for species it lists under the ESA. Critical habitat is defined as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species at the time of listing if the agency determines that the area itself is essential for conservation. We designated critical habitat for eulachon in 2011 (76 FR 65324) (Table 2).

Table 2. Summary of rulemaking for 4(d) protective regulations and critical habitat for eulachon.

Species	DPS Name	4(d) Protective Regulations	Critical Habitat Designations
Eulachon (*Thaleichthys pacificus*)	Eulachon	**N/A**	**FR notice:** 76 FR 65324 **Date:** 10/20/2011

Section 9 of the ESA prohibits the take of species listed as endangered. The ESA defines take to mean harass, harm, pursue, hunt, shoot, wound, trap, capture, or collect, or attempt to engage in any such conduct. For threatened species, the ESA does not automatically prohibit take, but instead authorizes the agency to adopt regulations it deems necessary and advisable for species conservation including regulations that prohibit take (ESA section 4(d)). At this time, NMFS has not issued protective regulation for eulachon. Following issuance of the recovery plan for eulachon, NMFS will start the process to consider protective regulations for eulachon.

1.3.4 Review History

Numerous scientific assessments that have been conducted to assess the status of eulachon. These assessments include status reviews conducted by our Northwest Fisheries Science Center and the Department of Fisheries and Oceans, Canada. A list of these assessment is found in Table 3.

Table 3. Summary of previous scientific assessments for eulachon.

Species	DPS Name	Document Citation
Eulachon (*Thaleichthys pacificus*)	Eulachon	Hay, D. E., and McCarter, P. B. 2000 Willson, M. F., et al. 2006 Moody, M. F. 2008 Gustafson, R. G., M. J. Ford, D. Teel, and J. S. Drake. 2010 Moody, M. F., and T. Pitcher. 2010 COSEWIC 2011 Levesque, C. A., and T. W. Therriault. 2011 Gustafson, R. G. et al. 2012 McAllister, M. 2012 Schweigert, J., et al. 2012 COSEWIC 2013

1.3.5 Recovery Priority Number at Start of 5-year Review Process

On June 15, 1990, NMFS issued guidelines (55 FR 24296) for assigning listing and recovery priorities. We assess three criteria to determine a species' priority for recovery plan development, implementation, and resource allocation: (1) magnitude of threat; (2) recovery potential; and (3) existing conflict with activities such as construction and development. Table 4 lists the recovery priority number for eulachon, as reported in NMFS 2015a.

1.3.6 Recovery Plan or Outline

Table 4. Recovery Priority Number and Endangered Species Act Recovery Plans for Eulachon.

Species	DPS Name	Recovery Priority Number	Recovery Plans/Outline
Eulachon (*Thaleichthys pacificus*)	Eulachon	11	**Title:** Federal Recovery Outline Pacific Eulachon Southern Distinct Population Segment Available at: http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/eulachon/eulachon_recovery_outline_070113.pdf **Date:** 6/21/2013 **FR Notice:** 78 FR 40104

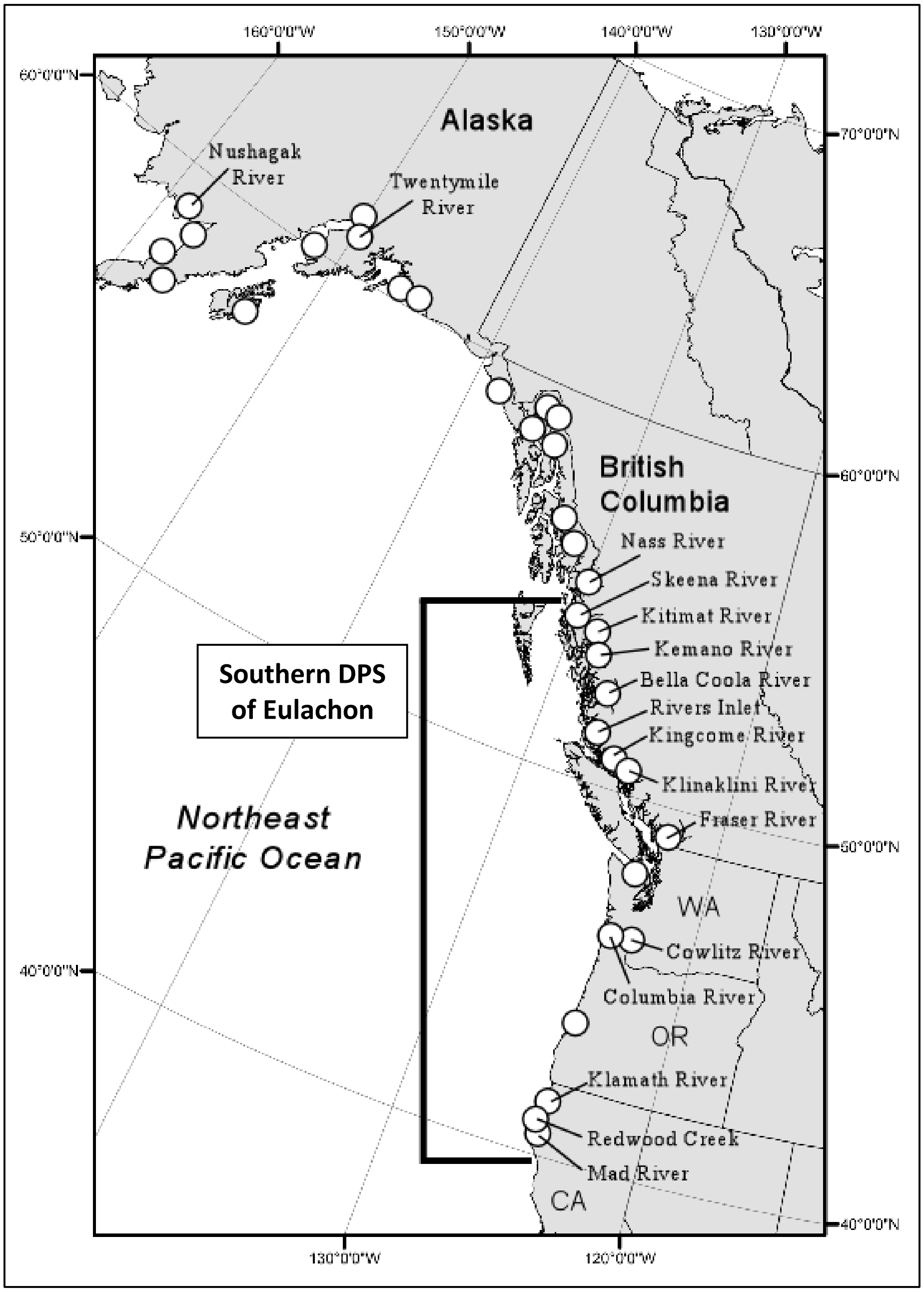

Figure 1. Distribution of the southern Distinct Population Segment of eulachon (*Thaleichthys pacificus*).

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2 · Review Analysis

In this section we review new information to determine whether the eulachon DPS delineation remains appropriate.

2.1 Delineation of species under the Endangered Species Act

Is the species under review a vertebrate?

DPS Name	YES	NO
Eulachon	X	

Is the species under review listed as a DPS?

DPS Name	YES	NO
Eulachon	X	

Was the DPS listed prior to 1996?

DPS Name	YES	NO	Date Listed if Prior to 1996
Eulachon		X	n/a

Prior to this 5-year review, was the DPS classification reviewed to ensure it meets the 1996 DPS policy standards?

In 1991 NMFS issued a policy on how the agency would delineate DPSs for listing consideration under the ESA (56 FR 58612). Under this policy a group of populations is considered an "evolutionarily significant unit" (ESU) if it is substantially reproductively isolated from other con-specific populations, and it represents an important component in the evolutionary legacy of the biological species. The 1996 joint NMFS-FWS DPS policy (61 FR 4722) affirmed that a stock (or stocks) of species is considered a DPS if it represents an ESU of a biological species. Accordingly, in listing the eulachon DPS under the DPS policy in 1999, we used the joint DPS policy to delineate the DPS under the ESA.

2.1.1 Summary of relevant new information regarding delineation of the eulachon DPS

DPS Range

This section provides a summary of relevant new information. For additional details see: *Gustafson et al. 2016: Status Review Update for Eulachon (Thaleichthys pacificus) Listed under the Endangered Species Act: Southern Distinct Population Segment.*

New genetic evidence—Two genetic studies have been published since the 2010 status review (Gustafson et al. 2010) was released, one utilizing microsatellite DNA differentiation to study population structure among samples of eulachon in Alaska (Flannery et al. 2013) and another utilizing newly developed single nucleotide-polymorphisms (SNPs) (Candy et al. 2015).

Flannery et al. (2013) examined eulachon population structure among 26 rivers in Alaska by analyzing variation at the same 14 microsatellite DNA loci used by Beacham et al. (2005) to analyze population structure in British Columbia and the Columbia River. All collections occurred in either 2003 or 2004, and there was no temporal sampling at any of the 26 locations (Flannery et al. 2013). Eulachon in Alaska exhibited a low degree of genetic divergence, with a broad scale regional level of population structure. Samples from the northern region (Yakutat Forelands, Cook Inlet, and Prince William Sound) were significantly different from samples obtained from the southern region (Behm and Lynn canals, Stikine Strait, and Berners Bay) (Flannery et al. 2013); however, there was little inter-regional differentiation. According to Flannery et al. (2013, p. 1040), "The level of genetic divergence between regions was four times as great as that within regions." The fine scale genetic population structure that Beacham et al. (2005) described, based on samples of eulachon from British Columbia and the Columbia River, was absent in Alaskan eulachon (Flannery et al. 2013).

Candy et al. (2015) examined eulachon population structure among 12 sampling locations ranging from Washington (Columbia and Cowlitz rivers) to south-central Alaska (Twenty-mile and Kenai rivers in Cook Inlet) by analyzing genetic variation among a panel of 3,911 putatively neutral SNPs and a panel of 193 putatively adaptive SNPs. There was no temporal sampling at any of the 12 locations included in the Candy et al. (2015) study.

According to Candy et al. (2015), the neutral and adaptive eulachon SNP panels showed a regional population structure that was similar to that observed by Beacham et al. (2005) using microsatellite DNA markers. Candy et al. (2015) interpreted their results as indicating that:

> … there is a three-population southern Columbia-Fraser group (Cowlitz, Columbia, and Fraser rivers), a seven-population British Columbia (BC) – SE Alaska group (Stikine, Nass, Skeena, Klinaklini, Kingcome, Kemano and Bella Coola rivers) and a two-population northern Gulf of Alaska (GOA) group (Twenty Mile and Kenai rivers).

Surprisingly, pairwise F_{ST} comparisons for the neutral SNPs showed that Columbia River eulachon were not significantly differentiated from any other population (all pairwise $F_{ST} \leq 0.0000$) (Candy et al. 2015, their table 2). However, the adaptive SNPs displayed statistically significant pairwise F_{ST} values for the Columbia River sample compared to all other rivers, with the exception of the Cowlitz River. The Columbia River sample consisted of larval eulachon collected downstream of the Cowlitz River, so these larvae may have originated from the Cowlitz River (Candy et al. 2015).

Small et al. (2015) described preliminary results of a study using microsatellite DNA variation to examine potential temporal differences in genetic population structure of eulachon in the Columbia River Basin. An early winter run of eulachon typically enter the Columbia and eventually the Cowlitz River, often in late November, December, or early January. This early winter run has been given the popular label of “scout” or “pilot” run (Stockley and Ellis 1970), as these fish enter several weeks prior to the main eulachon run. In addition, the 2010 BRT (Gustafson et al. 2010, p. 47) stated that “Comparison of average dates of initial landings in the commercial fishery in the Cowlitz River (January 25) and in the Sandy River (March 21) confirm that a nearly two month period separates the average run timing in these two tributaries.” In light of these temporal differences in spawn timing in the Columbia River Basin, Small et al. (2015) proposed to examine genetic population structure among: 1) 95 larval samples from the early winter, or “pilot,” run in the Cowlitz River; 2) a mainstem Columbia River collection of 95 larval eulachon near the end of the larval outmigration period; and 3) 95 tissue samples from Sandy River eulachon. Additional eulachon samples were also analyzed from samples collected near Ucluelet and Pachena Bay, offshore of the west coast of Vancouver Island (WCVI) (Small et al. 2015). The early winter run larval samples from the Cowlitz River proved not to be eulachon, and the mainstem larval Columbia River samples and Sandy River sample were genetically indistinguishable. The early winter run samples were most likely longfin smelt (*Spirinchus thaleichthys*), another closely related anadromous osmerid, and not eulachon. Small et al. (2015) also stated that samples collected off WCVI showed no detectable genetic differences with Columbia River eulachon. Earlier studies (Schweigert et al. 2012) had determined that about 56% of eulachon collected off WCVI could be genetically assigned as originating in the Columbia River. More recent estimates indicate that about two-thirds of the eulachon collected off WCVI could be genetically assigned back to the Columbia River (Gustafson et al. 2016).

Impact on DPS Definition—The 2010 BRT considered whether the available genetic data (McLean et al. 1999, McLean and Taylor 2001, Beacham et al. 2005) provided any evidence for “markedly different” populations, but concluded that although the genetic data provides evidence for discreteness (lack of gene flow), there was little evidence to support the existence of deep intraspecific phylogenetic breaks that the 2010 BRT believed were necessary to be considered “marked.” However, support for both a discrete and a significant eulachon population south of the Nass River/Dixon Entrance was provided by evidence that eulachon in this southern area are “markedly separated on the basis of ecological and physiological features” from eulachon to the north (Gustafson et al. 2010).

Candy et al. (2015, p. 11) invoked both meristic (vertebral counts) and genetic (SNP and microsatellite DNA data) information to bring into question the 2010 BRT's majority opinion that the northern boundary of the southern DPS of eulachon extends to the Skeena River. Candy et al. (2015) stated that "the data suggested that the southern distinct population segment (DPS) extends only as far north as the Fraser River, instead of possibly the Nass River as proposed by Gustafson et al. (2012)." Firstly, meristic data in the form of differences in average vertebral counts of eulachon among river systems were considered largely uninformative, for purposes of determining discreteness and significance, by the 2010 BRT. As Levesque and Therriault (2011, p. 5) stated, "… meristic series vary as a function of temperature and that variation in vertebral number can be environmentally induced." At best, these meristic data indicate that eulachon from southern rivers experienced warmer temperatures during development than eulachon developing in more northern rivers, and that complete mixing of northern and southern groups does not occur, as this would overwhelm the differences in the mean vertebral counts. As most vertebrate poikilotherms exhibit similar latitudinal clines in these meristic characters, their similar occurrence in eulachon offers, at best, weak evidence that eulachon in the southern and northern portion of their range are "markedly separated" from one another. Secondly, the pattern and level of genetic differentiation of eulachon displayed in Candy et al. (2015) were similar to that reviewed by the 2010 BRT based on the Beacham et al. (2005) study. The 2010 BRT did not believe that the then available genetic data provided evidence that eulachon in the Fraser and Columbia rivers were "markedly separated" from other populations, as required by the DPS policy. It should be emphasized that the discreteness and significance criteria (USFWS-NMFS 1996) define a DPS, which is likely to be composed of many stocks or subpopulations, and these criteria incorporate evidence of discreteness and significance for many factors, not just genetic differentiation.

The 2010 BRT was concerned that Beacham et al. (2005) compared microsatellite DNA variation of samples between the Fraser and Columbia rivers taken in only a single year, and thus the temporal stability of genetic variation observed between these two rivers could not be adequately assessed. Nevertheless, after review of the Beacham et al. (2005) study, the 2010 status review (Gustafson et al. 2010, p. 64) stated that "there appears to be little doubt that there is some genetic structure within eulachon and that the most obvious genetic break appears to occur in southern British Columbia north of the Fraser River." The study of Candy et al. (2015) verifies this result with a new class of genetic markers; however, this additional genetic analysis, with essentially parallel results and similar lack of temporal genetic sampling as in Beacham et al. (2005), would not be expected to change the consensus opinion of the BRT as to the northern boundary of the southern DPS of eulachon. Finally, the 2010 BRT found it difficult to identify a clear northern terrestrial or river boundary for this southern DPS as the majority of the 2010 BRT believed this boundary is largely associated with oceanographic, not terrestrial, processes and is largely defined by the extent of the Northern California Current (Gustafson et al. 2010).

DPS Delineation Conclusion

NMFS found that no new information that has become available since the previous status review that would justify a change in boundaries for the southern DPS of eulachon.

2.2 Recovery Criteria

The ESA requires NMFS to develop recovery plans for each listed species. Recovery plans must contain, to the maximum extent practicable, objective measureable criteria for delisting the species, site-specific management actions necessary to recover the species, and time and cost estimates for implementing the recovery plan.

2.2.1 Does the species have a final, approved recovery plan containing objective, measurable criteria?

DPS Name	YES	NO
Eulachon		X

2.2.2 Adequacy of recovery criteria

Based on new information considered during this review, are the recovery criteria still appropriate?

DPS Name	YES	NO
Eulachon – N/A		

Are all of the listing factors that are relevant to the species addressed in the recovery criteria?

DPS Name	YES	NO
Eulachon – N/A		

2.3 Updated Information and Current Species' Status

For additional information regarding the status of eulachon see *Gustafson et al. 2016: Status Review Update of Eulachon (Thaleichthys pacificus) Listed under the Endangered Species Act: Southern Distinct Population Segment.*

2.3.1 Analysis of Population Viability Criteria

At this time, no population viability criteria have been developed for eulachon due to a lack of sufficient data.

Updated Risk Summary

Adult spawning abundance of the southern DPS of eulachon has clearly increased since the listing occurred in 2010. A number of data sources including: 1) SSB estimates in the Columbia and Fraser Rivers; 2) catch per unit effort in small mesh bottom trawl surveys off West Coast Vancouver Island; 3) incidental catch in the West Coast bottom trawl survey; and 4) estimated bycatch in ocean shrimp trawl fisheries, indicate that eulachon abundance in some subpopulations within the southern DPS were substantially higher from 2011–2015 compared to indications of very low abundance from 2005–2010 (Gustafson et al. 2016). The improvement in estimated abundance in the Columbia River, relative to the time of listing, reflects both changes in biological status and improved monitoring. The documentation of eulachon returning to the Naselle, Chehalis, Elwha, and Klamath rivers over the 2011–2015 also likely reflects both changes in biological status and improved monitoring (Gustafson et al. 2016).

The 2010 BRT was concerned: 1) that abundance had declined to what appeared to be historically low levels in the Fraser River and nearly so in the Columbia River; 2) that the very limited available monitoring data suggested that eulachon in northern California had experienced an abrupt decline several decades previously; and 3) that attempts to estimate actual spawner abundance in some rivers in British Columbia that were known to have supported significant First Nations fisheries in the past had resulted in very low estimates of spawning stock.

Since the 2010 status review (Gustafson et al. 2010), monitoring of annual abundance of eulachon in several areas of the DPS has increased substantially. Annual monitoring of SSB has continued in the Fraser River (1995–2015), expanded to the Columbia (2011–2015), Grays (2011–2013, 2015), Cowlitz (2015) Naselle (2015), and Chehalis (2015) rivers. In addition, WDFW has retrospectively estimated historical SSB in the Columbia River for 2000–2010 using pre-2011 expansions of eulachon larval densities (Gustafson et al. 2016). These retrospective estimates indicate that total eulachon run biomass in the Columbia River may have been as high as 3,150 metric tons (mt) in 2001 and as low as 35 mt in 2005 (Gustafson et al. 2016). Mean SSB over the five-year period (2006–2010) immediately prior to the 2010 BRT's analysis was estimated at 20 mt in the Fraser River and 153 mt in the Columbia River. In contrast, mean SSB over last five years (2011–2015) was estimated at 127 mt in the Fraser River and 4,007 mt in the Columbia River (Gustafson et al. 2016).

The situation in the Klamath River is also more positive than it was at the time of the 2010 status review with adult eulachon presence being documented in the Klamath River in the spawning seasons of 2011–2014, although it has not been possible to calculate estimates of SSB in the Klamath River (Gustafson et al. 2016). However, since Moody's (2008) compilation of information on eulachon abundance, very little additional data on the status of eulachon in coastal rivers north of the Fraser River has become available. Newly obtained CPUE estimates for the Kemano and Kitimat rivers suggest substantial recent declines without apparent recovery

(COSEWIC 2011). Anecdotal observations as reported in several First Nations' newsletters and in annual environmental reports are compiled in Table 8 for this area of the DPS (Gustafson et al. 2016). The Skeena (2010–2015), Kemano (2015), and Kingcome (2012) rivers have apparently supported substantial runs of spawning eulachon in recent years; however, eulachon in the Kitimat River (2012, 2014) have reportedly remained at low levels (Gustafson et al. 2016).

Although eulachon abundance in monitored populations has generally improved, especially in the 2013–2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years. Therefore, it is too early to tell whether recent improvements in the southern DPS of eulachon will persist or whether a return to the severely depressed abundance years of the mid-late 1990s and late 2000s will reoccur.

2.3.2 Five-Factor Analysis

Section 4(a)(1)(b) of the ESA directs us to determine whether any species is threatened or endangered because of any of the following factors: (A) the present or threatened destruction, modification, or curtailment of its habitat or range; (B) overutilization for commercial, recreational, scientific, or educational purposes; (C) disease or predation; (D) the inadequacy of existing regulatory mechanisms; or (E) other natural or human-made factors affecting its continued existence. Section 4(b)(1)(A) requires us to make listing determinations after conducting a review of the status of the species and taking into account efforts to protect such species.

Limited new information has become available regarding the threats (Table 5) to eulachon identified by the BRT in the 2010 status review. Below we provide a summary of relevant new information relating to each of the five factors, where available, as well as efforts being made to protect the species. For additional details regarding relevant new information, see *Gustafson 2016 et al. Status Review Update of Eulachon (Thaleichthys pacificus) Listed under the Endangered Species Act: Southern Distinct Population Segment.*

Listing Factor A: Present or threatened destruction, modification or curtailment of its habitat or range

Habitat Cross-Over Analysis—while not specific to eulachon, significant habitat restoration and protection actions at the Federal, state, tribal, and local levels have been implemented to improve degraded habitat conditions for Pacific salmon and steelhead stocks in the Pacific Northwest and California. While these efforts have been substantial and are expected to improve freshwater and estuarine habitat conditions for the targeted species, we do not yet have evidence demonstrating that these improvements in habitat conditions will yield similar benefits for eulachon. Nonetheless, these habitat restoration actions likely have yielded indirect benefits to eulachon, especially habitat restoration actions in estuarine habitats that provide material influx that support food web processes that may contribute to improvements in eulachon fitness and survival in estuarine and nearshore environments.

Table 5. Eulachon Threats and Level of Threat Severity in each Subpopulation.

Threats	Klamath	Columbia	Fraser	BC
Climate change impacts on ocean conditions	high	high	high	high
Dams /water diversions	moderate	moderate	very low	very low
Eulachon by-catch	moderate	high	moderate	high
Climate change impacts on freshwater habitat	moderate	moderate	moderate	moderate
Predation	moderate	moderate	moderate	moderate
Water quality	moderate	moderate	moderate	low
Catastrophic events	very low	low	very low	low
Disease	very low	very low	very low	very low
Competition	low	low	low	low
Shoreline construction	very low	moderate	moderate	low
Tribal/First Nations fisheries	very low	very low	very low	low
Non-indigenous species	very low	very low	very low	very low
Recreational harvest	very low	low	very low	very low
Commercial harvest	very low	low	low	very low
Scientific monitoring	very low	very low	very low	very low
Dredging	very low	moderate	low	very low

Climate Change Impacts On Ocean Conditions

The increasing trend in eulachon spawner abundance since 2011 in the Columbia River Basin and in 2015 in the Fraser River, and apparent increase in other less well monitored regions of the DPS at least partially reflect favorable environmental conditions in marine waters of the northern California Current in recent years. It is well established that ocean conditions during the first weeks or months of marine life have a large influence on overall marine survival for salmon (Pearcy 1992, Pearcy and McKinnell 2007). Although not as thoroughly documented for eulachon as for Pacific salmon, it is likely that ocean conditions also exert a large influence on early marine survival of eulachon. Accordingly, a large portion of the short-term variation in population productivity of eulachon may be due to ocean conditions, which fluctuate at short time scales.

Although the specific environmental conditions in the marine environment likely resulted in high marine survival rates of eulachon and subsequent high adult returns for the Columbia River and increase in occurrence in other parts of the DPS, such as the Klamath and Elwha rivers, since 2011–2012. However, changes in ocean and freshwater conditions beginning in early 2014 due to exceptionally warm ocean waters and associated terrestrial impacts, plus a strengthening El Niño event, suggest that this period of high marine survivals will not persist, and eulachon returns in the next few years may be considerable lower than those experienced recently.

Observed Environmental Conditions—environmental conditions in both fresh and marine waters inhabited by the southern DPS of eulachon are influenced, in large part, by two ocean-basin scale drivers, the Pacific Decadal Oscillation (PDO; Mantua et al. 1997) and the El Niño-Southern Oscillation (ENSO). Here, we briefly describe these features as they affect the marine environment.

Pacific Decadal Oscillation—the PDO describes the most prominent mode of variability in the North Pacific sea surface temperature field (Mantua et al. 1997). Positive values are characterized by warm SSTs along the West Coast of North America and cold SSTs in the central North Pacific, while negative values have the opposite pattern (cold along the coast and warm in the central North Pacific). The PDO also influences freshwater habitats, especially during winter. Positive PDO values are associated with warm and dry Pacific Northwest winters and therefore low snowpack, while negative values are associated with cold wet winters (high snowpack) (Mantua et al. 1997).

Because the PDO is a measure of SSTs and the eastern North Pacific Ocean has been extremely warm, the PDO has been positive since January 2014. It reached the highest monthly levels ever observed during December 2014 (+2.51), and January (+2.45) and February (+2.3) 2015 (Fig. 24). As long as marine water remains warm along the West Coast, the PDO will remain positive. Current forecasts of global water temperatures (from the NOAA NCEP coupled forecast system model version 2[1]) indicate SSTs along the West Coast will remain 0.5-1°C above average through the period of forecast (March–May 2016). If this occurs, the PDO will remain positive at least through spring 2016. Model predictions that take into account persistence of the past year's PDO index value and a prediction of the next year's El Niño status, also indicate the PDO will remain strongly positive until at least June 2016[2].

El Niño-Southern Oscillation—El Niño-Southern Oscillation (ENSO) is a tropical phenomenon that influences climate patterns around the globe. Much like the PDO, the warm phase (El Niño) is characterized by warm SSTs along the West Coast of North America, while negative values (La Niña) produce cold SSTs along the coast. Like the PDO, ENSO also influences terrestrial environments, and Pacific Northwest winter snowpack is low during warm El Niño events and high during cool La Niña years.

The Oceanic Niño Index (ONI) is the three-month running-mean SST departures in the Niño 3.4 region (http://www.cpc.ncep.noaa.gov/; Fig. 25). El Niño events are defined as positive ONIs greater than or equal to +0.5ºC, while La Niña events have a negative ONI less than or equal to -0.5ºC. These thresholds must be exceeded for a period of at least 5 consecutive overlapping 3-month seasons. The ONI first exceeded +0.5 ºC during the September–October–November period,

[1] http://www.cpc.ncep.noaa.gov/products/CFSv2/CFSv2seasonal.shtml.
[2] Nate Mantua, SWFSC, NMFS. Personal communication with Rick Gustafson, NWFSC, 6 October 2015.

and has remained above 0.5 ºC since then. Based on this criterion, a weak El Niño was declared in April 2015.

The current prediction (as of 21 September 2015) is a high probability (≥ 95%) that El Niño conditions will continue through winter 2015/2016, gradually weakening through spring 2016. How strong this El Niño event will be is difficult to predict, but the latest ENSO forecasts point to a strong to very strong El Niño persisting into spring 2016, with some predicting that this event will be comparable to the exceptional 1997/98 event[3].

El Niño Events—the biological effects at higher trophic levels of large El Niño events in the California Current are less predictable and poorly understood than changes in the PDO. This occurs because large El Niño events are relatively infrequent (the last two large events occurred in 1982/83 and 1997/98), and El Niño events are tropical phenomena with variable impacts on extra-tropical systems such as the California Current (Huyer et al. 2002). That said, the typical El Niño year impacts in the California Current are similar to those associated with the warm phases of the PDO, and in some extreme cases much more dramatic (like those associated with the extreme 1982/83 and 1997/98 El Niño events).

Several important biological impacts were noted during the last two extreme El Niño events. During both events, there were dramatic increases in poleward flow, elevated temperatures to 200 m depth, and reduced upwelling and greatly reduced nutrient levels (Pearcy and Schoener 1987, Huyer et al. 2002). The biological impact of these conditions resulted in changes throughout the ecosystem. During the 1982/83 event, primary and secondary production was greatly reduced from southern California to Vancouver Island, especially in 1983 (Pearcy and Schoener 1987). During the 1997/98 event, the copepod assemblage along the Newport Hydrographic (NH) line became dominated by southern and offshore species starting in late summer 1997, while normally dominant boreal species had almost completely disappeared; the overall abundance of copepods was also greatly reduced. These changes to the copepod assemblage persisted for roughly a year, although some boreal species did not recover to normal levels until the summer of 1999 (Peterson et al. 2002).

Changes were also observed at higher trophic levels during both strong El Niño events. There were unusual sightings of a variety of subtropical (and largely predatory) fishes along the Coast of Oregon, including Dorado (*Coryphaena hippurus*), Yellowtail (*Seriola lalandi*), California barracuda (*Sphyraena argentea*), and striped marlin (*Tetrapturus audux*), many of which were range extensions (Pearcy and Schoener 1987, Pearcy 2002). The 1997/98 event was also the first time Humboldt squid (*Dosidicus gigas*) had been observed so far north, although it has since been found as far north as Sitka, Alaska (Wing 2006, Litz et al. 2011). Like the influx of warm water fishes to the Oregon Coast, there was also influx of warm-water cetaceans to Monterey Bay during

[3] Nate Mantua, SWFSC, NMFS. Personal communication with Rick Gustafson, NWFSC, 6 October 2015.

1997 and concurrent decline of cold-water cetaceans during the El Niño (Benson et al. 2002). Sea bird numbers were also negatively impacted by the 1983 El Niño (Pearcy and Schoener 1987).

The impacts of these strong El Niño events on the southern DPS of eulachon are difficult to evaluate in retrospect, because there was no monitoring of eulachon population abundance at the time of the 1982/83 event and the only population undergoing monitoring during the 1997/98 event was the Fraser River subpopulation. In addition, the general decline of eulachon began in 1993 in the Columbia River, and abundance and fisheries collapsed in the mid 2000's in the Fraser River and in Central and Northern British Columbia rivers (JCRMS 2014). These declines apparently occurred independently of the various El Niño events.

As noted above, Pacific Northwest ocean conditions became unusually warm early in 2014, and are currently at or near record warm temperatures for much of the northeast Pacific Ocean. There is an abundance of evidence highlighting impacts on coastal marine ecosystems, including sea bird die offs, range shifts for subtropical fish and plankton, etc. Eulachon entering the coastal ocean in 2015 may have experienced especially poor ocean conditions. The expected impacts of the 2015/16 El Niño include intense winter downwelling, increased northward moving currents, increased upper ocean stratification, and overall reduced productivity. These conditions will likely prime the Pacific Northwest's coastal ocean for very poor productivity in spring 2016. Combining the expected El Niño effects over the next 6 to 8 months with existing warm ocean conditions will likely lead to poor or perhaps very poor early marine survival for eulachon going to sea in spring 2016[4].

NWFSC Ocean Indicators—the NWFSC has been using of a suite of physical and biological ocean indicators to describe the conditions experienced by juvenile salmon entering marine waters in the Northern California Current. These indicators—both individually and collectively—have been shown to influence juvenile salmon growth and survival (see Peterson et al. 2014a). While these indicators were selected specifically for juvenile salmon, a recent analysis suggests they capture ecosystem variation important to the recruitment of non-salmonid species, including sablefish, rockfish and sardines (Peterson et al. 2014b). These indicators include physical processes or conditions at ocean-basin scales (PDO, ONI), and regional/local scales (water temperature and salinity at surface and depth), and biological conditions (copepod composition, winter ichthyoplankton) (Peterson et al. 2014a).

The copepod community on the Newport Hydrographic (NH) line has received particular emphasis in the NWFSC indicators because copepods are planktonic and drift with the ocean currents. Therefore, the type of copepods found on the NH line reflects the type of water being transported into the Northern California Current: the presence of subtropical (southern) species off Oregon indicates transport of subtropical water from the south, while subarctic (northern) species indicates

[4] Nate Mantua, SWFSC, NMFS. Personal communication with Rick Gustafson, NWFSC, 6 October 2015.

transport of coastal, subarctic waters from the north. Southern copepods typically dominate the winter copepod community and northern copepods dominate the summer community, with the "biological spring transition" index defining when it switches from one to the other. Northern copepods have much higher lipid levels than southern copepods (Peterson et al. 2014a), and therefore likely produce food webs that promote high growth and survival in eulachon.

During winter/spring of 2015, 17 species of copepods were caught within 25 miles of shore on the NH line that had never been observed on the line in 20 years of biweekly sampling. These species were all subtropical or pelagic species, suggesting that subtropical offshore water was present on the continental shelf. Unusual copepods were also observed on the NH line during the 1997/98 El Niño, but the observations in 2015 far surpass the 1997/98 El Niño event. The biological transition in spring 2015 was also extremely late (late June), and the abundance of northern copepods was extremely low during summer 2015, suggesting a poor base for the food chain.

State of the California Current Report—many of the ocean indicators used by NWFSC are also described in the annual State of the California Current Report (SCCR), which is focused on the entire California Current, from the US-Canada border to the US-Mexico border (CCIEAT 2015). The SCCR also describes the current state of additional indicators, including the North Pacific Gyre Oscillation (NPGO), upwelling, dissolved oxygen levels, and ocean acidification, and abundances of forage fish, salmon, groundfish, marine mammals, and seabirds. Notable changes in these indicators during 2014 were a decrease in the NPGO index and weaker than normal downwelling during winter 2014 and a late physical spring transition (when the slope of cumulative upwelling becomes positive) at 45°N. Both the decline in the NPGO and the late timing of the spring transition are associated with reduced productivity.

State of Pacific Canadian Marine Ecosystems Report—many of the unusual conditions in the California current described above were also present in Canadian waters off the west coast of British Columbia (Chandler et al. 2015). This includes reduced nutrient levels in offshore waters, rapid rise in SSTs as the warm water mass moved onshore, and unusually high abundances of southern copepods during summer 2014. At higher trophic levels, harvest of ocean shrimp off the WCVI was nearly twice as high as the previous maximum, and estimated herring biomass was higher in 2014 than 2013, although there was a marked absence of Pacific sardine in Canadian waters for a second year in a row (Chandler et al. 2015). The warm water was also the likely cause for the extremely high diversion rate of sockeye salmon bound for the Fraser River in 2014, which returned around the north end of Vancouver Island via Johnstone Strait (vs. around the south end via Strait of Juan de Fuca) at the highest rate ever recorded.

In contrast to unusual conditions observed off the West Coast of British Columbia, conditions within the Strait of Georgia were not particularly unusual. For example, salinity and temperature of water within the Strait of Georgia was fairly typical to other years during most of 2014, the timing of the phytoplankton bloom was also normal, and juvenile salmon survival was comparable to other recent years. One notable difference was that waters of the Strait of Juan de Fuca were warmer than normal in September and October, reflecting the influence of warm coastal waters off Vancouver Island.

Biological Consequences of Marine Environmental Conditions

Eulachon are a cold water species, therefore current elevated temperatures in both freshwater and marine habitats are expected to be detrimental to their growth and survival. In marine environments, however, environmental conditions also have large indirect effects on eulachon. This occurs because temperature changes are typically associated with different parcels of water, which come with their own planktonic ecosystem, including eulachon prey and predators.

Expectations for Eulachon

All the above documented changes will likely influence the growth, productivity, survival, and migration of eulachon. Larval and juvenile eulachon are planktivorous and are likely adapted to feed on a northern or boreal suite of copepods during the critical larval/juvenile transition. Warmer ocean conditions may be expected to contribute to a mismatch between eulachon life history and preferred prey species. These conditions would likely have significant negative impacts on marine survival rates of eulachon, and recruitment failure of eulachon may be traced to mortality during this critical period. Eulachon returns to spawning rivers in the southern DPS were poor during the previous period of unfavorable ocean conditions from 2004 to 2008 (JCRMS 2008) and may portend how eulachon will respond to the recent warming ocean conditions.

Pacific hake undergo seasonal migrations from their winter spawning 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 the dominant prey of both small Pacific hake and eulachon are euphausiids (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 likely to result in an altered distribution of both predators on eulachon and competitors for food resources.

Climate Change Impacts on Freshwater Environments

Sea surface temperatures across the Northeast Pacific Ocean are anomalously warm due to persistent high pressure off the Pacific Northwest coast and weak winds and a lack of upwelling off the Pacific Southwest coast. This warm water offshore has contributed to above average terrestrial temperatures in the Pacific Northwest (Bond et al. 2015). Mean air temperatures for Washington, Oregon, and Idaho were the warmest on record for the 24 month period ending in August 2015 (from a 120 year record starting in 1895). These exceptionally warm air temperatures were most pronounced during the second half of 2014 (warmest July–December 2014 on record), and the first half of 2015 (warmest January–August 2015), and less extreme during the first half of 2014 (15th warmest during January–June 2014). However, June 2015 was the warmest on record for the three state area, 8°F above the long term average and 2.6°F above the previous warm year. In contrast, precipitation in the Pacific Northwest was slightly above average during 2014, ranking 31st and 32nd wettest during January–June and July–December, respectively. Since January 2015, however, precipitation has been below average and the 8 month period from January to August was the 11th driest on record.

The exceptionally warm air during the winter of 2014/2015 and below average precipitation from January–April resulted in anomalously low snow pack conditions in the Olympic and Cascade Mountains, with most areas having less than 25% of average snow pack in April 2015 (compared to the 1981–2010 record). Many areas—especially in the southern Oregon Cascades and Sierra Nevada—that typically have continuous snow coverage during the winter had no measurable snow. Consequently, by June 2015, most basins in Washington, Idaho, Oregon, California and Nevada had 0% of normal snow pack.

This lack of snowpack and anomalously low precipitation from January to August had large impacts on river discharge throughout the Pacific Northwest. Stream flow in June 2015 in most small and large Washington and Oregon rivers was below average. During June, the Columbia River near Quincy, WA (USGS Station 14246900) was flowing at roughly 70% of its normal rate (230 KCFS vs the long term average of 330 KCFS). These low flow rates throughout the Northwest are expected to remain below normal through fall 2015.

The combined effects of low flows and high air temperatures are expected to result in higher than normal stream temperatures, although the extent to which this is true is not presently known because most water temperature time series formerly available from the USGS have been terminated. In June 2015, when larval eulachon may still have been out-migrating, the Columbia River at The Dalles Dam was 3.6°C above normal (19.1°C vs. 15.3°C) and the Willamette River at Portland (USGS Station 14211720) was 5.3°C above average.

It is likely that current anomalously warm marine and freshwater conditions have been and will be unfavorable in the future for the southern DPS of eulachon. How extreme the effects will be is difficult to predict, although decreased productivity and abundance of the southern DPS of eulachon observed during prior warm periods provide a useful guide.

How long the current conditions will last is also unknown, but NOAA's coupled forecast system model (CFS version 2) suggests that the warm conditions associated with the strengthening El Niño will persist at least through spring 2016. The model currently predicts temperature anomalies during the March–April–May 2016 period will exceed 2°C at the equator and 0.5–2°C in the NE Pacific. Unfortunately, longer forecasts are not available.

However, following the extreme El Niño period of 1997/98 the entire eastern Pacific (Northeast and tropical) went cold for multiple years and there were also relative increases in eulachon fishery landings in the Columbia River and in Fraser River SSB estimates following those sequential cold year periods. The expected effects of the tropical El Niño are likely to favor a more coastally-oriented warming of the North East Pacific this fall and winter that will persist into spring 2016. Next spring's ocean migrants will likely encounter an ocean strongly influenced by (if not dominated by) a subtropical food-web that favors poor early marine survival for the southern-distributed ocean migrants.

Eulachon are a cold water species: they flourish in cold and productive marine ecosystems, such as those present in the early 2010s, resulting in increased abundance in the Columbia River. The exceptionally warm marine waters in 2014 and 2015 were likely unfavorable for high marine survival. The overall effects of these environmental conditions will not be known until adults begin returning in late winter of 2015/2016 and early spring of 2016, and continuing for the next few years.

Recommended Future Actions

- Ensure there are adequate monitoring programs in place to detect significant changes in eulachon habitat due to climate change (by monitoring changes in marine and freshwater survival at all life stages), and evaluate ocean survival for eulachon for each year in order to signal the need for enhanced conservation measures when survival is poor.

- To assess the effects of natural climate variability and anthropogenic-forced climate change on the inter-annual variability of eulachon abundance and distribution in the marine environment, develop a research and monitoring plan to collect and analyze data on large-scale oceanographic conditions in the California Current Ecosystem.

- Develop and research and monitoring plan to analyze shifts in planktonic assemblages in the California Current related to shifts in ocean conditions to assess how these shifts may affect eulachon larval survival in the nearshore environment.

- Develop a plume-nearshore oceanographic model to assess the relationship and significance of plume and nearshore ocean environments on eulachon survival, especially larval eulachon, during the freshwater-ocean transition period.

- Develop an oceanographic survival indicator model to determine the relationship between eulachon and short-term and long-term variability in ocean conditions in the California Current.

- Develop a research and monitoring plan to analyze how shifts in water temperature and flow from climate change will potentially affect spawn timing, location, and success.

- Conduct a cross-evaluation of restoration projects in Washington, Oregon, and California to assess how they might contribute to the recovery of eulachon.

- Develop a life-cycle model for eulachon to help evaluate effects of habitat restoration and how they contribute to eulachon recovery.

- Develop a research and monitoring plan to monitor and evaluate the causal mechanisms, e.g., shifts in the timing, magnitude, and duration of the hydrograph of the Columbia River caused by the hydropower system, and their effects on the migration and behavioral characteristics and effects on larval eulachon during their first weeks in the plume-ocean environment.

Listing Factor A Conclusion

We conclude that the risk to the species' persistence remains unchanged since the last status review.

Listing Factor B: Overutilization for commercial, recreational, scientific, or educational purposes

In 2014–2016, WDFW and ODFW reinstated a reduced Level-I eulachon fishery in the Columbia River, and select tributaries of the Columbia River. It was expected that a limited eulachon fishery would benefit eulachon recovery efforts by:

(1) Providing essential context for interpreting historical harvest data to better understand trends and variability in eulachon abundance
(2) Filling critical information gaps such as the length and age structure of spawning eulachon, as well as the temporal and spatial distribution of the run
(3) Supporting the cultural traditions of Northwest tribes who relied on eulachon as a seasonally important food source and valuable trade item
(4) Providing a limited public and commercial opportunity for eulachon harvest to maintain a connection between people and the eulachon resource. This connection is important to sustaining public engagement in eulachon conservation and recovery.

A commercial gill-net fishery opening occurred in the mainstem Columbia River on Mondays and Thursdays for seven hours each day from 10 February to 6 March in 2014, from 2–26 February in 2015, and from 1–25 February in 2016, for a total opening each year of 56 h (JCRMS 2014, ODFW 2015, 2016). Approximately 8.4, 7.5, and 2.2 metric tons of eulachon were commercially harvested in 2014, 2015, and 2016, respectively (ODFW 2014, 2015, 2016). Recreational sport fisheries were also permitted on the Cowlitz and Sandy rivers in 2014, which harvested an estimated 89.7 and 2.7 metric tons (Gustafson et al. 2016), respectively. Likewise, recreational dip-net fisheries operated on the Cowlitz and Sandy rivers in 2015. The Cowlitz River recreational dip-net fishery, which was open for two Saturdays in February 2015, harvested an estimated 131.4 mt of eulachon (ODFW 2015). Less than 100 pounds of eulachon were reported as taken in the recreational dip-net fishery in the Sandy River during 2015. Although landings are preliminary, recreational harvest was estimated at about 64 mt in the single day opening of the sport or recreational fishery on the Cowlitz River in 2016. A decision on opening a sport fishery on the Sandy River in 2016 is still pending as of 7 March 2016. Catch records were not maintained for eulachon recreational fisheries in the Columbia River Basin prior to 2014, although in the past it had been estimated at times to equal the historical commercial catch (WDFW and ODFW 2001).

The current California Code of Regulations for fishing in inland waters states that "Candlefish or Eulachon may not be taken or possessed."

British Columbia—the Fraser River commercial fishery for eulachon has essentially been closed since 1997, opening only briefly in 2002 and 2004, when 5.76 and 0.44 mt were landed, respectively (Gustafson et al. 2010). In regards to eulachon fishing opportunities on the Fraser River, DFO (2013, p. 28) stated that:

> First Nation Fisheries: First Nations access to eulachon for food, social and ceremonial (FSC) purposes is managed through a communal Aboriginal fishing licence on the Fraser River. In 2012, harvest opportunities targeting 50 pounds per Band on a case by case basis were provided for up to eight Bands. However, the target of 400 pounds total was exceeded; the total eulachon harvest in 2012 was 1,037 pounds.
>
> Recreational Fisheries: There were no recreational fisheries for eulachon on the Fraser River in 2012 [–2015].
>
> Commercial Fisheries: There were no commercial fisheries for eulachon on the Fraser River in 2012 [–2015].
>
> New Westminster Test Fishery: The New Westminster test fishery was not conducted in 2012 [–2015].
>
> Furthermore, DFO (2013, p. 28) stated that:
>
> Due to conservation concerns and the recovery process, only limited Fraser River FSC [food, social, and ceremonial] fisheries for eulachon will be considered on a case by case basis by the Lower Fraser area office for 2013.
>
> The Department is managing the LFA [lower Fraser area] eulachon fisheries to ensure harvests do not exceed 800 pounds in 2013. This limited harvest will provide access to First Nations for FSC purposes while maintaining conservation objectives.

Additional landings and effort statistics for most First Nations fisheries within the southern DPS of eulachon are unavailable. Recreational fishing for eulachon with dip nets, gillnets, minnow nets, or cast nets in fresh water, is prohibited throughout British Columbia.

Recommended Future Action

- Minimize impacts related to a directed fishery on eulachon by developing and implementing a biologically-based fishery management plan linked to subpopulation-specific viability criteria for the Klamath River and Columbia River subpopulations.

Listing Factor B Conclusion

We conclude that the risk to the species' persistence remains unchanged since the last status review.

Listing Factor C: Disease or Predation

Disease

Disease rates over the past five years are believed to be consistent with the previous review.

Predation

Status of Pinnipeds Populations in Oregon and Washington

Pinniped predation continues to remain a concern for listed species in Oregon and Washington due to a general increase in pinniped populations along the West Coast. For example, California sea lions have increased at a rate of 5.4% per year between 1975 and 2011 (NMFS 2015b), Steller sea lions have increased at a rate of 4.18% per year between 1979 and 2010 (Allen and Angliss 2014), and harbor seals likely remain at or near carrying capacity in Washington and Oregon (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014).[5]

Columbia River Basin—in the Columbia River Basin, there has been a steady influx of pinnipeds (Figure 2), especially California sea lions, over the past 5 years with sharp increases in California sea lion presence in 2013 of 750 animals, 1,420 animals in 2014,[6] and 2,340 animals in 2015.[7]

As pinniped numbers have increased in the Columbia River Basin over the past 13 years (2002 through 2014 this steady influx of pinnipeds into the Columbia River may also represent a shift in

[5] The last population estimates of harbor seals in Washington (coastal population) and Oregon was in 2003 and 2005 (Jefferies et al. 2003, Brown et al. 2005, respectively, as cited in NMFS 2014), when the population growth rate was estimated at 7% (NMFS 2014).
[6] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.
[7] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.

the severity of predation to eulachon. For example, in 2015 WDFW[8] estimated, based on biomass reconstruction for eulachon consumption, that harbor seals were consuming an estimated 2,700,000 eulachon per day in the Columbia River estuary.

The information available since the last status review clearly indicates that predation by pinnipeds on eulachon has increased since the last status review.

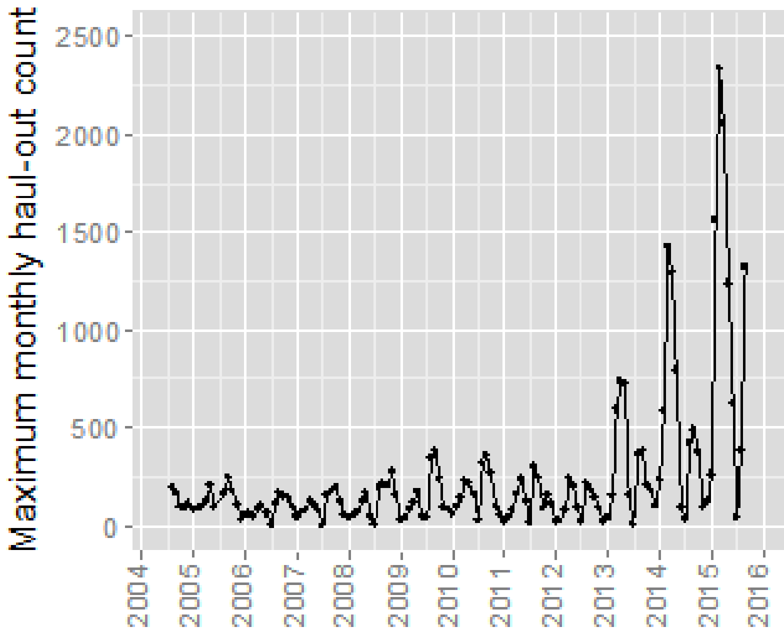

Figure 2. Estimated peak counts (spring and fall) of California sea lions in the East Mooring Basin in Astoria, Oregon, 2004 through 2015.[9]

Puget Sound—in Puget Sound, there has been a steady influx of pinnipeds, especially harbor seals (NMFS 2014), and Steller sea lions (Wiles 2015) over the past 5 years. Current information on abundance estimates of harbor seals (coastal and inland waters populations) are 32,000 animals (Jefferies 2013),[10] with approximately 11,036 of these animals in Puget Sound (inland waters population), compared to an estimated 8,949 animals in 1999 (Jefferies et al. 2003). The most recent population estimates of Steller sea lions indicate that the overall population was at 70,174 animals in 2010 (Wiles 2015), up from 18,313 animals in 1979. The effects of predation by marine mammals on the productivity and abundance of Puget Sound listed salmon and steelhead stocks has not been quantitatively assessed since 2003 (Scordino 2010).

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[8] E-mail (forwarded) to Robert Anderson, NMFS, from Brent Norberg, NMFS, on February 19, 2015, from Steven Jefferies, WDFW, regarding sea lion counts in Astoria, Oregon.
[9] E-mail to Robert Anderson, NMFS, from Bryan Wright, ODFW, October 28, 2015.
[10] E-mail to Robert Anderson, NMFS, from Steven Jefferies, WDFW, October 26, 2015.

Recommended Future Actions

- Expand monitoring efforts in the Columbia River to assess predator-prey interactions between pinnipeds and eulachon.
- Complete life-cycle/extinction risk modeling to quantify predation rates by predatory pinnipeds on eulachon in the Columbia River.
- Expand research efforts in the Columbia River estuary on survival and run timing for adult eulachon migrating through the lower Columbia River.
- Expand monitoring efforts in Puget Sound to assess predator-prey interactions between pinnipeds and eulachon.

Listing Factor C Conclusions

Disease—we conclude that the risk to the species' persistence remains unchanged since the last status review.

Predation—we conclude that the risk to the species' persistence remains unchanged since the last status review.

Listing Factor D: Adequacy and Inadequacy of Regulatory Mechanisms and Protective Efforts

The BRT identified bycatch of eulachon in commercial fisheries as a moderate threat to all four populations in the Southern DPS. See Listing Factor E: Other Natural or Manmade Factors Affecting its Continued Existence for a detailed discussion regarding bycatch.

The only regulatory mechanism related to eulachon since the last status review are regulations issued by the California Department of Fish and Wildlife prohibiting the taking or possession of eulachon in California.

Recommended Future Action

Ensure appropriate and effective regulatory, response, restoration, and enforcement mechanisms are in place domestically and internationally for both planned and unplanned impacts. For planned impacts, project planning should ensure no net loss of eulachon critical habitat. Where natural or anthropogenic impacts do occur, an effective and complete response plan, including appropriate compensatory and site restoration, is executed.

Listing Factor D Conclusion

We conclude that the risk to the species' persistence remains unchanged since the last status review.

Listing Factor E: Other Natural or Manmade Factors Affecting its Continued Existence

Eulachon Bycatch—for additional information on bycatch see *Gustafson 2016 et al. Status Review Update of Eulachon (Thaleichthys pacificus) Listed under the Endangered Species Act: Southern Distinct Population Segment.*

Eulachon Bycatch in Ocean Shrimp Trawl Fisheries 2004–2014

Offshore trawl fisheries for ocean shrimp (*Pandalus jordani*) occur off the west coast of North America from the west coast of Vancouver Island (WCVI) to Cape Mendocino, California (Hannah and Jones 2007) and in British Columbia, Canada. *Pandalus jordani* is known as the smooth pink shrimp in British Columbia, ocean pink shrimp or smooth pink shrimp in Washington, pink shrimp in Oregon, and Pacific Ocean shrimp in California. Herein we use the common name "ocean shrimp" in reference to *P. jordani* as suggested by the American Fisheries Society (McLaughlin et al. 2005). The common name "pink shrimp" has been assigned by the American Fisheries Society to *Farfantepenaeus duorarum*, a commercial species in the South Atlantic and Gulf of Mexico (McLaughlin et al. 2005). Numerous publications have documented eulachon bycatch levels in shrimp trawl fisheries off the coasts of Washington, Oregon, California, and British Columbia (Hay et al. 1999a, b; Olsen et al. 2000; NWFSC 2008, 2009, 2010; Bellman et al. 2011; Al-Humaidhi et al. 2012; Gustafson et al. 2015a, b).

Canada—following recognition that large numbers of eulachon were occurring as bycatch in Queen Charlotte Sound shrimp fisheries (Hay and McCarter 2000, Olsen et al. 2000) and of a concurrent decline in central coast British Columbia eulachon stocks, DFO closed the Queen Charlotte Sound shrimp trawl fishery in 1999, which has remained closed (DFO 2014).

Washington, Oregon, and California—ocean shrimp fisheries began in California in 1952 and expanded into Oregon and Washington by the mid- to late-1950s (Frimodig et al. 2009). Ocean shrimp in commercial quantities are found from Point Arguello, California north to Queen Charlotte Sound, British Columbia, typically over well-defined beds of green mud or green mud and sand (Frimodig et al. 2009). Because ocean shrimp undergo a vertical diel migration, dispersing into surface waters during nighttime hours and returning to near-bottom aggregations in the daytime (Zirges and Robinson 1980, Frimodig et al. 2009), ocean shrimp vessels generally trawl in depths ranging from 91–256 m (50 to 140 fathoms) during daylight hours. Vessels that currently operate in the state-permitted ocean shrimp trawl fisheries in Washington, Oregon, and California range in size from 11.6–32 m (38–105 feet), with an average length of 19.9 m (65 feet), and can use single or double-rigged shrimp trawl gear.

The ocean shrimp season is open 1 April through 31 October in Washington, Oregon, and California and vessels deliver catch to shore-based processors. Total coastwide ocean shrimp landings have ranged from a low of 1,888 mt in 1957 to a high of 41,418 mt in 2014 (Gustafson et al. 2015b). The portion of the bycatch that is not marketable or for which regulations prohibit landing is discarded at-sea and all discarded eulachon in this fishery results in 100% mortality.

Currently, ocean shrimp vessels are required to use bycatch reduction devices (BRDs) that serve as deflecting grids to guide fin-fish towards an escape opening, which is usually on the top of the net. The primary goal of mandatory BRDs is to reduce bycatch of groundfish species, and more recently, protected species such as eulachon. BRDs became mandatory in California in 2002

(Frimodig 2008, Frimodig et al. 2009) and in Washington and Oregon in 2003. Current 2014–2015 regulations in Washington and Oregon, adopted by both states in 2012, require ocean shrimp trawl fishery BRDs to consist of a rigid panel or grate of narrowly spaced bars (usually constructed of aluminum) with no gaps between the bars exceeding 0.75 inches (19.1 mm). Approved BRDs for use in the ocean shrimp fishery in California include: (1) rigid- or semi-rigid grate excluders consisting of vertical bars with no gaps between the bars exceeding 2 inches (50.8 mm); (2) soft-panel excluders, usually made of a soft mesh material "with individual meshes no large than 6 inches;" and (3) fisheye excluders, which have a forward facing escape opening that is maintained by a rigid frame.

Gustafson et al. (2015b) reported observed and estimated bycatch of eulachon in ocean shrimp trawl fisheries for the years 2004, 2005, and 2007–2013. The observed tows were in waters shallower than 250 m and deeper than 80 m. The ocean shrimp trawl fishery did not carry WCGOP observers in 2006. Data sources and bycatch estimation methods for eulachon bycatch in west coast ocean shrimp fisheries in 2004–2013 are detailed in Gustafson et al. (2015b).

The WCGOP began observing eulachon bycatch in the Washington ocean shrimp fishery in 2010 and the estimated bycatch in terms of weight and numbers of eulachon has increased in each year up to 2013, while the percentage of total shrimp landings observed has fluctuated between just less than 10% to nearly 15% (Gustafson et al. 2015b). Total estimated bycatch of eulachon in the Washington ocean shrimp fisheries ranged from a low of over 64 thousand (95% CI; 23,361–132,532) fish in 2010 to a high of over 17.2 million (95% CI; 12,077,308–21,444,581) fish in 2013 (Gustafson et al. 2015b). Mean estimated total biomass of eulachon bycatch in the Washington fishery during this time period (2010–2013) ranged from 2.1–203.7 metric tons (mt) (Gustafson et al. 2015b).

Eulachon bycatch in the Oregon ocean shrimp fishery was estimated at well under a million individual fish (range of 146–845 thousand) from 2004–2011 (the fishery was not observed in 2006); however, estimated bycatch expanded dramatically in 2012 and 2013 to over 28.1 million (95% CI; 17,948,671–39,302,622 million) and 35.1 million (95% CI; 20,316,467–52,991,571), respectively (Gustafson et al. 2015b). Similarly, total weight of estimated eulachon bycatch in Oregon increased from 20.5 mt (95% CI; ~14.7–27.4 mt) in 2011 to nearly 428 mt (95% CI; ~285–588 mt) in 2012 and to over 540 mt (95% CI; ~348–759 mt) in 2013.

Bycatch ratios, measured as both kg of eulachon and numbers of fish, per metric ton of ocean shrimp observed also increased dramatically in both the Washington and Oregon ocean shrimp fisheries from 2011 to 2012, and remained high in 2013 (Gustafson et al. 2015b). Bycatch ratios were higher in Washington than in the Oregon fishery in both 2012 and 2013 (Gustafson et al. 2015b).

Eulachon bycatch in the California ocean shrimp fishery has followed a very different trajectory from that observed in Washington and Oregon during the last three years (2011–2013) of available data. Eulachon bycatch in California remained below 25,000 fish prior to 2008 (the fishery was not observed in 2006), rose dramatically in 2010 to over 267,000 (95% CI; 40,040–714,661) fish; fell to its lowest observed level of just 471 (95% CI; 197–826) fish in 2011, increased again dramatically in 2012 to over 337,000 (95% CI; 151,822–616,148) fish, and then fell to just over 16,000 (95% CI; 3,768–33,610) fish in 2013 (Gustafson et al. 2015b). Biomass of eulachon bycatch and bycatch ratios have shown similar fluctuations over the time period from 2010–2013 (Gustafson et al. 2015b). The tonnage of observed ocean shrimp and of fleet-wide landings were relatively stable over the last three to four years, indicating that yearly differences in eulachon distribution, or in the catchability of eulachon, likely contributed to the extreme fluctuations in eulachon bycatch in the California ocean shrimp fishery.

Combined WCGOP estimates of the weight and number of eulachon caught in the Oregon and California ocean shrimp trawl fishery as bycatch from 2004–2013 (except for 2006 when these fisheries were not observed) and in Washington from 2010–2013 are presented Gustafson et al. 2015b. Total estimated bycatch of eulachon in the Oregon and California ocean shrimp fisheries ranged from nearly 158,000 fish (95% CI; 11,642–492,844) in 2004 to a high of over 959,000 (95% CI; 238,075–2,147,772) fish in 2009. Estimated eulachon bycatch in the Washington ocean shrimp fishery in 2010 (its first year of observation) was nearly 65,000 fish and the total 2010 estimated eulachon bycatch for all three states combined was over 1,072,000 (95% CI; 532,268–1,891,424). Total three-state eulachon bycatch decreased to about 602,000 (95% CI; 394,343–875,107) fish in 2011. However, as seen earlier, eulachon bycatch increased dramatically in all three states in 2012, topping out at over 42.8 million (95% CI; ~26.9–59.1 million) individual eulachon. Bycatch increased again in Washington and Oregon, but not California in 2013 resulting in an estimated total eulachon bycatch for all three states combined of over 52.3 million (95% CI; ~32.4–74.5 million) fish. Estimated weight of these bycaught eulachon in 2013 was over 744 mt (95% CI; ~498–1,008 mt).

Recently, the WCGOP released updated data on observed bycatch of eulachon in Washington, Oregon, and California ocean shrimp trawl fisheries for 2014[11]. Approximately, 7.1%, 9.7%, and 15.5% of ocean shrimp landings were observed in the Washington, Oregon, and California sectors

[11] NWFSC, FRAM Division, Fisheries Observation Science, Annual Tables of Observed Bycatch of Protected Species, Eulachon observed bycatch (2002-2014). Available at: http://www.nwfsc.noaa.gov/research/divisions/fram/observation/data_products/protected_species.cfm

of this fishery during 2014. Over the past three years (2012–2014), the bycatch ratio (measured as the number of eulachon caught per mt of observed ocean shrimp), and the number of eulachon caught in this fishery, have declined in Washington, increased in Oregon, and fluctuated up and down in California. During 2014, approximately 968; 2,322; and 159 eulachon were caught per mt of observed ocean shrimp landings in Washington, Oregon, and California, respectively.

Ward et al. (2015) applied spatiotemporal models to both fishery-dependent observations of eulachon bycatch and eulachon fisheries-independent survey data to 1) estimate population trends of eulachon, 2) understand eulachon bycatch risk in shrimp fisheries, and 3) identify persistent bycatch hotspots that may be used in future management actions to reduce eulachon bycatch rates. Two spatial data sets for the period from 2007–2012 were examined: WCGOP catch data of shrimp and eulachon in the California, Oregon, and Washington ocean shrimp trawl fisheries and fishery-independent incidental eulachon catch in the WCBTS (Ward et al. 2015). Ward et al. (2015) found support for a greater than 40% annual increase in eulachon density based on the bycatch dataset and a greater than 55% annual increase based on the fisheries-independent survey dataset over the duration of the datasets. The later dataset also suggested that eulachon density was “substantially higher in 2012 than in any recent period” (Ward et al. 2015). These data also imply “that increases in bycatch [are] not due to an increase in incidental targeting of eulachon by fishing vessels, but because of an increasing population size of eulachon.” Ward et al. (2015, their figures 4–5) also presented mapped representations of both the spatial distribution of eulachon bycatch risk and areas of highest bycatch encounters.

Ward et al. (2015) found that the coastal areas just south of Coos Bay, Oregon; between the Columbia River and Grays Harbor, Washington; and just south of La Push, Washington were consistent hotspots of eulachon bycatch across years.

The previously depressed and currently increasing abundance of the southern DPS of eulachon (James et al. 2014) are likely contributing to the increased levels of eulachon bycatch reported for 2012–2014. The dramatic increases in the level of eulachon bycatch in both the Washington and Oregon ocean shrimp trawl fisheries in 2012 and 2013 occurred in spite of regulations, enacted in 2012, requiring the use of BRDs with a minimum 19 mm (0.75 inch) bar spacing. It is unclear why bycatch ratios were highest in the Washington, intermediate in the Oregon, and lowest in the California sectors of the ocean shrimp trawl fishery in 2012 and 2013. However, the bycatch ratio increased in Oregon and decreased in Washington in 2014 compared to the previous two year period.

Although speculative, it may be that BRDs in the ocean shrimp trawl fisheries operate at greatly reduced efficiency when eulachon reach high densities. Winger et al. (2012, p. 91) stated that:

> Fish density is also expected to affect the performance of BRDs installed within the net. When large pulses of fish are encountered, devices such as selection windows, sorting grids, or separator panels may be temporarily masked by neighboring

> conspecifics. This reduces the probability of fish encountering the devices and thus reduces the potential sorting efficiency.

The Washington ocean shrimp fishery was also observed separately in 2011 and 2012 by a team of state-deployed fishery bycatch observers (Wargo et al. 2014). Wargo et al. (2014) reported a fleet-wide eulachon bycatch in the Washington state ocean shrimp fishery of "7.8 mt (17,132 pounds) for 2011 and 171 mt (378,011 pounds) for 2012." These bycatch estimates are approximately 30% and 10% greater than the estimates for the Washington ocean shrimp fishery as reported in the present document of 5.5 and 156.8 mt in 2011 and 2012, respectively. In the 2011 Washington ocean shrimp trawl fishery 24% of trips were observed by the state observers (Wargo et al. 2014), whereas the WCGOP observed 16.6% of the total ocean shrimp landings (Gustafson et al. 2015b). In 2012, 16% of trips were observed by the state observer program (Wargo et al. 2014) and 14.8% of shrimp landings were observed by the WCGOP (Gustafson et al. 2015b).

Prior to the mandated use of bycatch reduction devices (BRDs), 32–61% of the total catch in the Oregon ocean shrimp fishery consisted of non-shrimp biomass, including various species of smelt (Hannah and Jones 2007). Krutzikowsky (2001, p. 2) evaluated bycatch in this fishery and stated that:

> Bycatch discards in this fishery can range from relatively low to very high levels that can affect the efficiency and, possibly, the value of the fishery. Bycatch of Pacific whiting, *Merluccius productus*, in particular, can become high enough on the shrimp grounds to preclude efficient shrimping. … The majority of bycatch is discarded, such as … smelt Osmeridae sp. …

Reducing bycatch in this fishery has long been an active field of research (Hannah et al. 1996, 2003, 2011; Hannah and Jones 2000, 2003, 2007, 2012; Frimodig et al. 2009) and great progress has been made in reducing bycatch, particularly of larger-bodied fishes. Use of BRDs in offshore shrimp trawl fisheries, which was mandated beginning in 2002 in California and 2003 in Washington and Oregon has substantially reduced bycatch of fin fish in these fisheries (Hannah and Jones 2007, Frimodig et al. 2009). As of 2005, following required implementation of BRDs, the total bycatch by weight had been reduced to about 7.5% of the total catch and osmerid smelt bycatch was reduced to an estimated average of 0.73% of the total catch across all BRD types (Hannah and Jones 2007).

Although data on survivability of BRDs by small pelagic fishes such as eulachon are scarce, many studies on trawl net escape mortality for other fishes indicate that "among some species groups, such as small-sized pelagic fish, mortality may be high" and "the smallest escapees often appear the most vulnerable" (Suuronen 2005, p. 13–14). A recent workshop (Pickard and Marmorek 2007, p. 31–33) to determine research priorities for eulachon in Canada recommended the need to research the effectiveness of BRDs and the need to estimate mortality, not just bycatch. Partly in response to these concerns, Hannah and Jones (2012) used underwater video technology to examine behavior of eulachon when encountering rigid-grate BRDs in an ocean shrimp trawl net. The purpose of this research was to determine fish condition and survival following exclusion by the BRDs and the effectiveness of these types of BRDs at reducing mortality rates. Hannah and Jones (2012) stated that:

> Almost 80% of the large eulachon maintained an upright vertical orientation throughout their escape and exited the trawl in a forward-swimming orientation. Large eulachon maintained distance from the deflecting grid better than the other species encountered ($P < 0.001$) and typically showed no contact or only minimal contact with it (63%). Only about 20–30% of the large eulachon showed behaviors indicating fatigue, such as laying on or sliding along the grid.

Hannah and Jones (2012) concluded that:

> … data on behavior of large eulachon escaping from a shrimp trawl show that most have enough residual swimming ability to minimize their physical contact with the deflecting grid, maintain their vertical orientation and to continue actively swimming in a forward direction as they exit. This suggests that the use of deflecting grids in the ocean shrimp fishery is likely reducing eulachon mortality rates, as well as bycatch.

Hannah and Jones (2012) also noted that large eulachon are excluded at a higher efficiency than are small eulachon and behavior of eulachon in this study, both large and small, may have been influenced by the use of artificial video lighting.

In 2014 the ODFW conducted research on eulachon using light emitting diode (LED) lights attached to fishing gear (pink shrimp fishery) to assess the potential to reduce bycatch of eulachon associated with the ocean shrimp fishery. Researchers compared bycatch levels over 42 paired trials between lighted and unlighted trawl nets using double-rigged vessels that could tow paired shrimp trawl nets. When 10 green LED lights were placed along the trawl fishing line of ocean shrimp trawl nets with rigid-grate BRDs with 0.75 inch (19.1 mm) bar spacing installed and then were compared with identical trawls nets without lights, the bycatch of eulachon was reduced by 91%.

Summary on Bycatch

Although the use of bycatch reduction devices clearly are beneficial to eulachon, without a better understanding of bycatch as a proportion of eulachon in the marine environment, and its impact on recruitment, it is impossible to quantify the benefit. Nonetheless, NMFS acknowledges that the use of bycatch reduction devices, especially LED lights, represents a significant step in bycatch reduction and the threat bycatch poses to the persistence of eulachon.

Recommended Future Actions

- Develop and implement a biologically-based analysis on the long-term effects of bycatch from the ocean shrimp fishery on eulachon recruitment.
- Develop and implement a research and monitoring plan to better understand the relationship between habitat types shared between eulachon and pink shrimp in the California Current.
- Develop and implement a monitoring plan to help quantify the benefits by-catch reduction methods.
- Expand the use of LED lights to reduce bycatch of eulachon throughout the West Coast ocean shrimp fishery.

Listing Factor E Conclusion

We conclude that the risk to the species' persistence, albeit unquantifiable, has decreased since the last status review.

Efforts Being Made to Protect the Species

When considering whether to list a species as threatened or endangered, section 4(b)(1)(A) of the ESA requires that NMFS take into account any efforts being made to protect that species. Below is a summary of significant actions taken since the last status review to reduce the severity of threats to eulachon and improve habitat conditions for eulachon.

Ocean Shrimp Fisheries – Effective December 2010, the state of Oregon required all shrimpers fishing within the Oregon Fisheries Conservation Zone are required to use rigid-grate bycatch reduction devices. The state of Washington adopted rigid-grate 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. Current 2014–2015 regulations in Washington and Oregon, adopted by both states in 2012, require ocean shrimp trawl fishery BRDs to consist of a rigid panel or grate of narrowly spaced bars (usually constructed of aluminum) with no gaps between the bars exceeding 0.75 inches (19.1 mm). Approved BRDs for use in the ocean shrimp fishery in California include: (1) rigid- or semi-rigid grate excluders consisting of vertical bars with no gaps between the bars exceeding 2 inches (50.8 mm); (2) soft-panel excluders, usually made of a soft mesh material "with individual meshes no large than 6 inches;" and (3) fisheye excluders, which have a forward facing escape opening that is maintained by a rigid frame.

Oregon Department of Fish and Wildlife - In 2014 the ODFW conducted research on eulachon using LED lights attached to fishing gear (pink shrimp fishery) to assess the potential to reduce bycatch of eulachon associated with the ocean shrimp fishery. Researchers compared bycatch levels over 42 paired trials between lighted and unlighted trawl nets using double-rigged vessels that could tow paired shrimp trawl nets. When 10 green LED lights were placed along the trawl fishing line of ocean shrimp trawl nets with rigid-grate BRDs with 0.75 inch (19.1 mm) bar spacing installed and then were compared with identical trawls nets without lights, the bycatch of eulachon was reduced by 91%, with little or no effect on shrimp catch. Hannah et al. (2015, p. 60) stated that "How the addition of artificial light is causing these changes in fish behavior and bycatch reduction is not known," but the authors speculated that illumination of the trawl fishing line may possibly allow the fish to see the approaching net sooner and react in time to avoid being entrained, and "likely encouraged some species to also move downwards, perhaps exploiting a natural tendency to move towards the seafloor when threatened" (Hannah et al. 2015, p. 66). In 2015, all vessels in the Oregon shrimp fishery fleet were using light emitting diode lights in the fishery.

<u>Department of Fisheries and Oceans, Canada</u> – Since 1995 DFO has suspended commercial eulachon fisheries in the Fraser River; closed the 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.

<u>Department of Fisheries and Oceans, Canada</u> – First Nations Fisheries: 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.

<u>Department of Fisheries and Oceans, Canada</u> – Recreational Fisheries: The recreational fishery for eulachon is closed in the Fraser River area. Recreational fishing for eulachon with dip nets, gillnets, minnow nets, or cast nets in fresh water, is prohibited throughout British Columbia due to conservation concerns.

<u>Department of Fisheries and Oceans, Canada</u> – Commercial Fisheries: The commercial eulachon fishery remains closed in the Fraser River. However, there are currently 16 gill net (introduced) eulachon license eligibilities.

<u>Elwha River</u> – In 2000, as part of a comprehensive restoration effort in the Elwha River basin, the Elwha and Glines Canyon dams were acquired by the federal government. In 2014, both dams were removed. These restoration actions likely have indirect benefits to eulachon, especially in the lower reach of the Elwha River via material influx that support spawning and incubation of eulachon.

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

<u>Habitat Restoration Projects</u> – While not specific to eulachon, significant habitat restoration and protection actions at the Federal, state, tribal, and local levels have been implemented to improve degraded habitat conditions for Pacific salmon and steelhead stocks in the Pacific Northwest and California. While these efforts have been substantial and are expected to improve freshwater and

estuarine habitat conditions for the targeted species, we do not yet have evidence demonstrating that these improvements in habitat conditions will yield similar benefits for eulachon. Nonetheless, these habitat restoration actions likely have yielded indirect benefits to eulachon, especially habitat restoration actions in estuarine habitats that provide material influx that support food web processes that may contribute to improvements in eulachon fitness and survival in estuarine and nearshore environments.

2.4 Synthesis

The ESA defines an endangered species as one that is in danger of extinction throughout all or a significant portion of its range, and a threatened species as one that is likely to become an endangered species in the foreseeable future throughout all or a significant portion of its range. Under ESA section 4(c)(2), we must review the listing classification of all listed species at least once every five years. While conducting these reviews, we apply the provisions of ESA section 4(a)(1) and NMFS's implementing regulations at 50 CFR part 424.

To determine if a reclassification is warranted, we review the status of the species and evaluate the five factors, as identified in ESA section 4(a)(1): (1) the present or threatened destruction, modification, or curtailment of its habitat or range; (2) overutilization for commercial, recreational, scientific, or educational purposes; (3) disease or predation; (4) inadequacy of existing regulatory mechanisms; and (5) other natural or man-made factors affecting a species continued existence. We then make a determination based solely on the best available scientific and commercial information, taking into account efforts by states and foreign governments to protect the species.

The updated status review indicates that although eulachon abundance in monitored populations has generally improved, especially in the 2013–2015 return years, recent poor ocean conditions and the likelihood that these conditions will persist into the near future suggest that population declines may be widespread in the upcoming return years. Therefore, it is too early to tell whether recent improvements in the southern DPS of eulachon will persist or whether a return to the severely depressed abundance years of the mid-late 1990s and late 2000s will reoccur. The Northwest Fisheries Science Center (Gustafson et al. 2016) concluded, after reviewing the available new information that the biological risk category for this DPS has not changed since the time of the last status review.

Our analysis of the ESA section 4(a)(1) factors indicates that the collective risk to the persistence of eulachon has not changed significantly since our final listing determination in 2010; however, predation from an increase in pinniped populations in the Columbia River remains a concern, as do the impacts that climate change on ocean conditions poses to long-term recovery.

After considering the available information of its ESA section 4(a)(1) factors, in addition to new information on eulachon abundance, we conclude that the status of the southern DPS of eulachon has not improved significantly since it was last reviewed in 2010.

2.4.1 DPS Delineation

NMFS found that no new information that has become available since the previous status review that would justify a change in boundaries for the southern DPS of eulachon.

2.4.2 DPS Viability and Statutory Listing Factors

The Northwest Fisheries Science Center's review of updated information does not indicate a change in the biological risk category of eulachon since the time of the last status review (Gustafson et al. 2016).

Our analysis of ESA section 4(a)(1) factors indicates that the collective risk to the eulachon's persistence has not changed significantly since our listing determination in 2010. The overall level of concern remains the same.

3 · Results

3.1 Classification

Listing Status:

Based on the information identified above, we recommend that the southern DPS of eulachon remain classified as a threatened species.

DPS Delineation:

NMFS found that no new information that has become available since the previous status review that would justify a change in boundaries for the southern DPS of eulachon.

3.2 New Recovery Priority Number

NMFS revised the southern DPS of eulachon recovery priority number from 7 (NMFS 2009) to a new recovery priority number of 11 (NMFS 2015b) as listed in Table 4 of this document.

4 · Recommendations for Future Actions

In our review of the listing factors, we identified several actions critical to improving the information requirements needed to inform our assessment regarding the status of eulachon. We are currently in the process of finalizing a recovery plan for eulachon that will identifying additional actions that address the factors contributing to the existing threats for each subpopulation.

We are directing our efforts at subpopulation-level recovery criteria, the best available scientific information concerning DPS status, limiting factors and threats, and the likelihood of action effectiveness to guide our recommendations for future actions. NMFS is coordinating with the Federal, state, tribal, international, and local implementing entities to ensure that priority actions identified in the recovery plan are addressed to the extent practicable.

Additional recommended actions include:

- Expand eulachon spawning stock biomass surveys.
- Develop biological viability criteria for each subpopulation of eulachon.
- Develop and implement a fisheries-independent method to estimate at-sea abundance of eulachon.
- Develop and implement a method to identify eulachon core spawning areas for the Columbia River and Klamath River subpopulations.

5· References

5.1 Federal Register Notices

June 15, 1990 (55 FR 24296). Notice: Endangered and Threatened Species; Listing and Recovery Priority Guidelines.

November 20, 1991 (56 FR 58612). Notice of Policy: Policy on Applying the Definition of Species Under the Endangered Species Act to Pacific Salmon.

February 7, 1996 (61 FR 4722). Notice of Policy: Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act.

March 18, 2010 (75 FR 13012). Final Rule. Threatened Status for Southern Distinct Population Segment of Eulachon.

October 20, 2011 (76 FR 65324). Final Rule. Critical Habitat for the Southern Distinct Population Segment of Eulachon.

June 21, 2013 (78 FR 40104). Notice of intent to prepare a recovery plan.

February 6, 2015 (80 FR 6695). Notice of Initiation of 5-year Reviews: Endangered and Threatened Species; Initiation of 5-Year Reviews for 32 Listed Species of Pacific Salmon and Steelhead, Puget Sound Rockfishes, and Eulachon.

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National Marine Fisheries Service
5-Year Review
Southern DPS Eulachon

Conclusion:
Based on the information identified above, we conclude:

- The southern DPS of eulachon should remain listed as threatened

REGIONAL OFFICE APPROVAL

West Coast Assistant Regional Administrator, Protected Resources Division

Approve:____Date: 1 April 2016

cc: Administrative File: 151412WCR2016PR00165