National Marine Fisheries Service Endangered Species Act (ESA)
Section 7(a)(2) Biological Opinion and
Magnuson-Stevens Act
Essential Fish Habitat (EFH) Consultation

Consultation on the implementation of the Area 2A (U.S. West Coast)
Pacific halibut catch sharing plan

NMFS Consultation Number: WCR-2017-8426

Action Agency: National Marine Fisheries Service (NMFS)

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

FOR Barry A. Thom
Regional Administrator

Date: March 21, 2018

Affected Species and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound/Georgia Basin (PS/GB) bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	No	No
PS/GB yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	No	No
Southern green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No	No
Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) [1/]	Threatened	Yes	No	No	No
Lower Columbia River Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No	No
Lower Columbia River coho salmon (*Oncorhynchus kisutch*)	Threatened	Yes	No	No	No
Snake River fall Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	No	No

Southern Resident killer whales (*Orcinus orca*)	Threatened	No	No	No	No
Leatherback sea turtles (*Dermochelys coriacea*)	Endangered	No	No	No	No
Humpback whales (*Megaptera novaeangliae*) Central American	Endangered	No	No	N/A	N/A
Humpback whales (*Megaptera novaeangliae*) Mexico	Threatened	No	No	N/A	N/A
Blue whales (*Balaenoptera musculus*)	Endangered	No	No	N/A	N/A
Fin whales (*Balaenoptera physalus*)	Endangered	No	No	N/A	N/A
Guadalupe fur seals (*Arctocephalus townsendi*)	Threatened	No	No	N/A	N/A
North Pacific right whales (*Eubalaena japonica*)	Endangered	No	No	N/A	N/A
Sei whales (*Balaenoptera borealis*)	Endangered	No	No	N/A	N/A
Sperm whales (*Physeter macrocephalus*)	Endangered	No	No	N/A	N/A
Western North Pacific gray whales (*Eschrichtius robustus*)	Endangered	No	No	N/A	N/A
Green sea turtles (*Chelonia mydas)*	Endangered	No	No	N/A	N/A
Loggerhead sea turtles (*Caretta caretta)*	Threatened	No	No	N/A	N/A
Olive ridley sea turtles (*Lepidochelys olivacea*)	Endangered	No	No	N/A	N/A

[1] Other salmon and steelhead species potentially affected but not likely to be adversely affected are listed in Table 2-32.

Fishery Management Plan That Describes EFH in the Project Area	**Does Action Have an Adverse Effect on EFH?**	**Are EFH Conservation Recommendations Provided?**
Pacific Coast Salmon	No	No
Pacific Coast Groundfish	Yes	Yes
Coastal Pelagic Species	No	No

Table of Contents

1. INTRODUCTION

This section provides information relevant to the other sections of this document and is incorporated by reference into Section 2, Endangered Species Act: Biological Opinion and Incidental Take Statement, and Section 3, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response.

1.1. Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. §§ 1531 *et seq*.), and implementing regulations at 50 C.F.R. § 402. It is based on information provided in published and unpublished scientific material on the biology and ecology of listed species in the action area, and other sources of information.

This opinion considers impacts of the Proposed Action on the two Puget Sound/Georgia Basin rockfish Distinct Population Segments (DPSs), Southern Green Sturgeon DPS, the Puget Sound Chinook Salmon Evolutionarily Significant Unit (ESU), the Lower Columbia River Chinook Salmon ESU, the Lower Columbia River Coho Salmon ESU, and the Snake River Fall Chinook Salmon ESU under the ESA. NMFS concluded that the Proposed Action is not likely to adversely affect listed marine mammal and sea turtle species or other salmon ESUs or steelhead DPSs potentially occurring in the area, as described in Section 2.11, "Not Likely to Adversely Affect" Determinations.

We also completed an Essential Fish Habitat (EFH) consultation. It was prepared in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. §§ 1801 *et seq*.) and implementing regulations at 50 C.F.R. § 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS's Public Consultation Tracking System (WCR-2017-8426). A complete record of this consultation is on file at NMFS Protected Resources Division and Sustainable Fisheries Division in Seattle, Washington.

1.2. Consultation History

Previous biological opinions for the U.S. West Coast Pacific Halibut Catch Sharing Plan (CSP or Plan) in 2014 and 2017 (NMFS 2014a; NMFS 2017a) concluded that the continuing implementation of the CSP was likely to adversely affect, but not likely to jeopardize, Puget Sound/Georgia basin bocaccio, yelloweye rockfish, southern green sturgeon, lower Columbia River Chinook salmon, and Puget Sound Chinook salmon. Those opinions also determined that continued implementation of the CSP was not likely to adversely affect other ESA-listed species or their critical habitat was not likely to be adversely modified. The 2017 opinion expired on December 31, 2017.

This biological opinion is based on information provided by NMFS's West Coast Region (WCR) Sustainable Fisheries Division (SFD) to WCR Protected Resources Division (PRD) on November 29, 2017. NMFS sent data request letters to the Washington Department of Fish and Wildlife (WDFW), Oregon Department of Fish and Wildlife (ODFW), California Department of Fish and Wildlife (CDFW), International Pacific Halibut Commission (IPHC), and Northwest Indian Fisheries Commission (NWIFC) to inform this opinion (Table 1-1). The letters requested information on the recreational and commercial halibut fisheries in the areas managed by these organizations and the bycatch of non-halibut listed species in those fisheries. NMFS received responses, had discussions at meetings, and deemed there was sufficient information to consult on the Proposed Action. Information in responses are summarized in Table 1-1.

Table 1-1. Summary of key correspondence and meetings between co-managers and NMFS regarding a request for existing and new information on the potential impacts of halibut fisheries on ESA-listed species, critical habitat, and EFH.

Date	From	To	Subject
August 1, 2017	Ryan Wulff, NMFS, SFD, Acting Assistant Regional Administrator (ARA)	Dr. David Wilson, IPHC, Executive Director; Justin Parker, NWIFC, Executive Director; Chuck Bonham, CDFW, Director; Dr. Caren Braby, ODFW, Director; Dr. Jim Unsworth WDFW, Director;	Request for assistance in characterizing Pacific halibut Area 2A fishery impacts on ESA-listed species; finalized 2016 and preliminary 2017 fishery data.
August 16, 2017	Lynn Mattes, Halibut Project leader, ODFW	Ryan Wulff, NMFS, SFD, Acting ARA	Response to August 1, 2017 letter; assistance in characterizing non-treaty Pacific halibut Area 2A fishery impacts on ESA-listed species.
August 24, 2017	Michele Culver, Intergovernmental Policy Manager, WDFW	Ryan Wulff, NMFS, SFD, Acting ARA	Response to August 1, 2017 letter; assistance in characterizing non-treaty Pacific halibut Area 2A fishery impacts on ESA-listed species.
August 25, 2017	Dr. David Wilson, IPHC, Executive Director	Ryan Wulff, NMFS, SFD, Acting ARA	Response to August 1, 2017 letter; non-treaty Pacific halibut fisheries and surveys in Area 2A; Excel spreadsheet of "other species" on stock assessment survey and survey notes.
September 7, 2017	Justin Parker, NWIFC, Executive Director	Ryan Wulff, NMFS, SFD, Acting ARA	Response to August 1, 2017 letter; tribal Pacific halibut fisheries and surveys in Area 2A
September 11-18, 2017			Pacific Fishery Management Council Meeting; scoping of changes to the 2018 CSP
November 14-20, 2017			Pacific Fishery Management Council Meeting; finalized changes to the 2018 CSP

November 28-29, 2017			IPHC interim meeting; recommended TAC based on stock assessment presented
January 22-26, 2018			IPHC annual meeting; 2A TAC determined

1.3. Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 C.F.R. § 402.02). For EFH consultation, a federal action means any action authorized, funded, or undertaken, or proposed to be authorized funded or undertaken, by a federal agency (50 C.F.R. § 600.910).

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 C.F.R. § 402.02). The IPHC conducts a stock assessment set line survey annually. This survey is an interrelated or interdependent activity with the implementation of the Area 2A CSP—this survey is described later in this subsection, and its effects are included in the analysis of section 2.5. No other interdependent or interrelated actions are associated with this Proposed Action.

The Proposed Action is the ongoing domestic management of the Pacific halibut fishery off the U.S. West Coast (Washington, Oregon, and California) through a catch sharing plan and approval of domestic management measures. This consultation evaluates the effects of this continued fishery beginning with the 2018 fishing season for five years through 2022. Information will be obtained annually from agencies and evaluated to determine if reinitiation of consultation is necessary.

The Pacific halibut fishery generally is managed by the IPHC according to the Pacific Halibut Treaty with Canada, described in more detail below. The IPHC sets the Pacific halibut total constant exploitation yield and resulting fishing constant exploitation yield, equivalent to total allowable catch (TAC), for each of its areas annually and adopts regulations governing the fishery. The U.S. West Coast is Area 2A under the IPHC's management scheme (Figure 1-1). Under the Halibut Act of 1982 (16 U.S.C. § 773), the Pacific Fishery Management Council is authorized to develop, and NMFS is authorized to approve and implement, domestic regulations for the Area 2A fishery that are consistent with the IPHC's regulations. The Pacific Fishery Management Council (PFMC) has developed, and NMFS has annually approved, a Pacific Halibut Catch Sharing Plan (CSP) for Area 2A that allocates the Area 2A TAC to the tribal, sport, and commercial fisheries within Area 2A, and includes additional management measures for the sport fisheries. NMFS implements the CSP through annual management measures promulgated as regulations consistent with the TAC and regulations adopted by the IPHC. The TAC only applies to the total catch of halibut, and is not dependent on other species caught incidentally. The Proposed Action for this consultation is NMFS's approval and implementation of the CSP for Area 2A. The PFMC typically recommends changes to the CSP and NMFS adopts regulations for the fishery on an annual basis. More information on changes to the CSP can be found in Section 1.3.5.

This action may affect some ESA-listed species and their critical habitat. We describe fisheries governed by the CSP in Sections 1.3.1 through 1.3.4 of this document to provide context for assessing the direct and indirect effects on ESA-listed species and critical habitat that may result from implementation of the federal actions covered by this consultation. The discussion focuses on those attributes of the Pacific halibut fisheries that influence the exposure of ESA-listed species to the fishery and potential outcomes, including:

- Seasonality and Geographic Extent – When and where the gear is deployed for comparison with the distribution of ESA-listed species and their critical habitat
- Fishing Effort – The amount of fishing effort, particularly in areas of overlap with ESA-listed species and their critical habitat
- Catch – Indirect effects of fishery catch and bycatch on the prey base of ESA-listed species and their critical habitat
- Gear Type/Use and Target Species – Configuration of gear, and methods of deployment and retrieval, including the potential for direct interaction with ESA-listed species and their critical habitat
- Monitoring strategies, data sources, and management jurisdiction

1.3.1. Overview of the Halibut Fishery, Regulations, and Catch Sharing Plan Annual Implementation

The Northern Pacific Halibut Act (Halibut Act) of 1982, 16 U.S.C. §§ 773-773K, gives the Secretary of Commerce (Secretary) general responsibility for implementing the provisions of the Halibut Convention between the United States and Canada (Halibut Convention) (16 U.S.C. § 773c). The Halibut Act requires the Secretary to adopt regulations as may be necessary to carry out the purposes and objectives of the Halibut Convention and the Halibut Act. Section 773c of the Halibut Act also authorizes the regional fishery management councils to develop regulations in addition to, but not in conflict with, regulations of the IPHC to govern the Pacific halibut catch in their corresponding U.S. Convention waters. The TAC is set by the IPHC[1] according to the Halibut Convention, and the Secretary has authority only to approve or disapprove the IPHC's recommended regulations.

The Council, through the CSP, allocates halibut among groups of fishermen in Area 2A, off the coasts of Washington, Oregon, and California (Figure 1-1). Between 1988 and 1995, the Council developed annual CSPs; since then, a long-term Plan has undergone minor revisions to account for the needs of the fisheries. The Council, with input from industry, the states, and the tribes, may consider and recommend changes to the Plan for the upcoming year at its September and November meetings. NMFS considers approval of any changes recommended by the Council and implements the CSP, including these revisions, through annual rulemaking. The domestic management measures for Area 2A are in addition to the IPHC regulations and are effective until superseded by new implementing regulations.

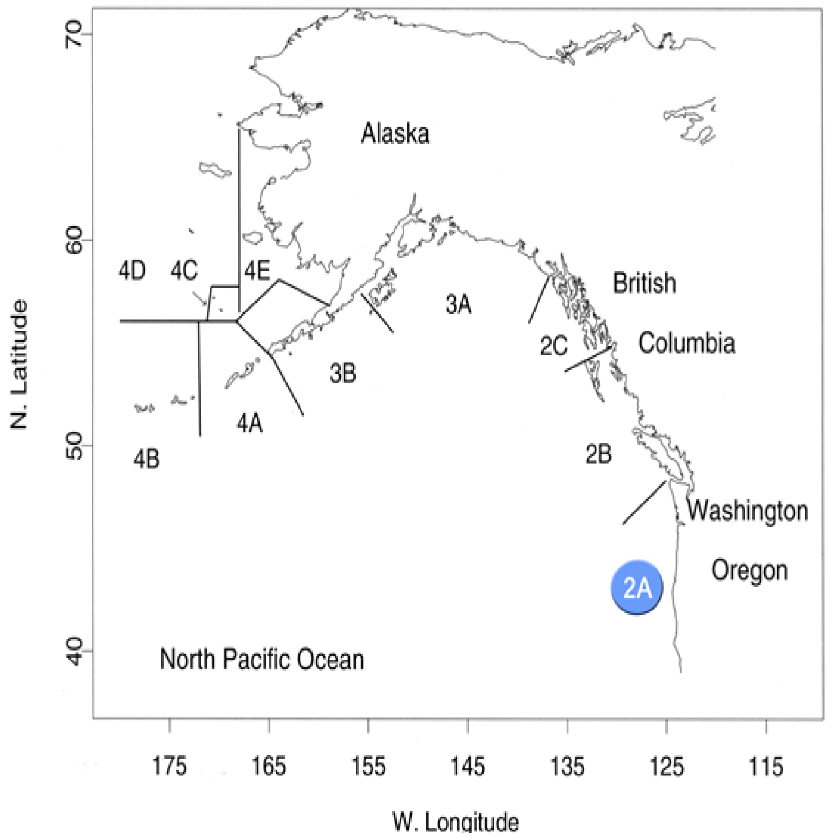

Figure 1-1. IPHC Regulatory Areas. Area 2A extends from the U.S/Canada border to the U.S./Mexico border.

To implement the Plan, NMFS applies the CSP framework to the annual Area 2A TAC approved by the IPHC each January[1]. For non-tribal fisheries, the CSP governs allocations of the TAC

[1]At the 2018 IPHC annual meeting, the Commissioners did not reach agreement on specific catch-limit recommendations for any of the IPHC Regulatory Areas for 2018, allowing 2017 catch limits to carry over to 2018

between components of the commercial and recreational fisheries, which vary annually depending on the amount of Pacific halibut TAC and thresholds in the CSP. Aspects of Area 2A's directed commercial fishery are governed by the IPHC regulations rather than the domestic regulations under the CSP: the commercial fishery opening date(s), duration, and vessel trip limits to ensure that the quota for the non-tribal commercial fisheries is not exceeded. This opinion evaluates the effects of these regulations on ESA-listed species beginning with the 2018 fishery.

In this opinion, we will consider the effects of the Area 2A fishery under the various actions expected to occur during annual management in the commercial and recreational fisheries for the duration of this opinion, 2018 through 2022.

1.3.2. Halibut Fishery Sectors, Seasonality, and Geographic Extent

Halibut is harvested coast-wide in state and federal waters from Washington to California. Various federal and state closed areas are used in the recreational and non-tribal commercial fisheries to protect overfished species such as yelloweye rockfish. Because groundfish species are the primary bycatch in the halibut fishery, most of the closed areas applied to the halibut fisheries are designed to minimize the catch of overfished groundfish species. Additionally, some nearshore areas are designated in the Washington, Oregon, and Columbia River subareas, with separate open days and quotas, restricting fishing to those areas.

The Pacific halibut fisheries in Area 2A are allocated a small percentage, generally less than 2 percent, of the coast-wide TAC. Washington treaty Indian tribes are allocated 35 percent of the Area 2A TAC. The allocation to non-tribal fisheries is divided into four shares: a commercial fishery (30.7 percent) and recreational fisheries in Washington (35.6 percent), Oregon (29.7 percent), and California (4.0 percent) (Figure 1-2). The CSP further subdivides the recreational fisheries into six geographic areas, each with separate allocations and seasons. These are described in detail below.

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unless superseded. NMFS published interim final rules setting catch limits in Alaska and Area 2A more restrictive than 2017.

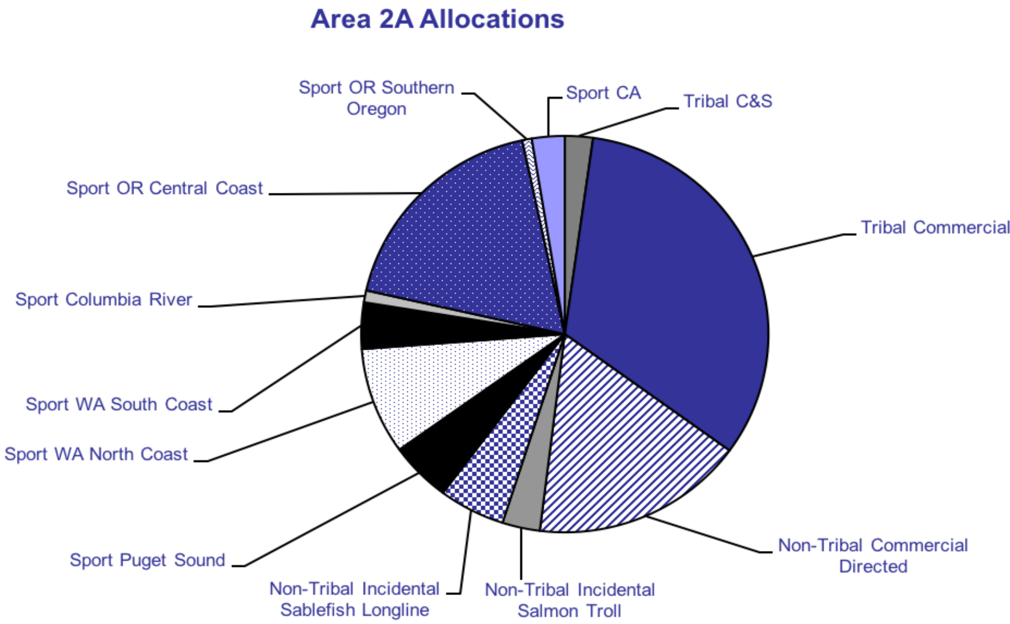

Figure 1-2. 2017 Area 2A Catch Sharing Plan allocations.

1.3.2.1. Non-tribal Commercial Fishery

The CSP allocates the 30.7 percent of the non-tribal 2A TAC to halibut in three separate non-tribal commercial halibut fisheries: the directed commercial fishery, the salmon troll fishery, and the sablefish fishery north of Point Chehalis, Washington. Vessels fishing commercially in Area 2A apply for licenses from the IPHC, which are required to participate in any non-tribal commercial Pacific halibut fishery. There are three types of commercial halibut licenses in Area 2A: (1) a license for the directed commercial fishery, (2) a license for the sablefish primary fishery north of Pt. Chehalis, Washington, and (3) an incidental commercial salmon troll license. Participants in the directed halibut fishery may retain groundfish species but must comply with groundfish open access fishery regulations. Vessels participating in the incidental sablefish fishery may also participate in the directed commercial fishery.

The directed (longline) commercial fishery is allocated 85 percent of the 30.7 percent non-tribal 2A TAC for halibut (26.95 percent of the non-tribal harvest). The troll salmon commercial fishery, in which halibut are caught incidentally, is allocated 15 percent of the 30.7 percent (4.75 percent of the non-tribal harvest) (Figure 1-2). The incidental sablefish allocation occurs when the Washington recreational fishery allocation is 214,110 pounds or greater, and longline vessels participating in the sablefish primary fishery north of Pt. Chehalis are allocated up to 50,000 pounds of halibut taken incidentally in that fishery; a 2A TAC above 1.5 million pounds results in an allocation of up to 70,000 pounds of halibut to the sablefish fishery. There has been sufficient Area 2A TAC to allocate halibut to the sablefish primary fishery each year from 2000 to 2009 and 2012 to 2017. Any unharvested quota in this fishery is nontransferable. Regulations for the retention of halibut in the sablefish primary fishery are promulgated through the groundfish regulations, and incidental take of non-target species is covered by the biological opinion on the groundfish fishery, with more detail in Section 2.4, Environmental Baseline (NMFS 2012a; NMFS 2017b).

Seasonality
The non-tribal directed commercial fishery is a derby-style fishery open for 10 hours per open period until the quota is taken or there is not enough quota to open the fishery for another open period. Because of the level of effort and amount of the Area 2A TAC over the last 5 years, the fishery has been open 2 to 3 days for the season (Table 1-2). This fishery typically opens the last week of June and is open every other Wednesday until the quota is taken. A change to this fishery structure to create a longer season is being discussed by the Council and IPHC (more detail in Section 1.3.5, Changes to the Catch Sharing Plan).

Table 1-2. **Non-tribal directed commercial fishery season length by year.**

	2013	2014	2015	2016	2017
Days open	2	2	2	3	3

Geographic Extent
Since 2003, non-tribal commercial vessels operating in the directed fishery and vessels participating in the primary sablefish fishery and catching halibut incidentally have been required to fish offshore of a mandatory, depth-based closed area known as the Rockfish Conservation Area (RCA). This area extends along the coast from the U.S./Canada border south to 40°10' N. lat. The RCA boundaries are eastern and western boundary lines created by drawing straight lines between a series of latitude/longitude coordinates, which may be found on the NMFS West Coast Region website. This large RCA was implemented to protect certain overfished groundfish species.

Additionally, since 2002, participants in the non-tribal commercial fishery (including the sablefish and salmon troll fisheries with incidental halibut catch) have been voluntarily fishing outside of a closure off the northern coast of Washington to protect yelloweye rockfish. This area is known as the C-shaped North Coast Recreational Yelloweye Rockfish Conservation Area (YRCA).

The directed longline halibut fishery is permitted only south of Pt. Chehalis, Washington, and along the coasts of Oregon and California. Most directed halibut fishing operates seaward of the RCA in waters up to 150 fathoms; however, if fishermen are also fishing for sablefish during the directed halibut fishery they will typically fish deeper in the 300 fathom areas.

The IPHC defines statistical areas for use in analyzing catch data, biological and biometric data, and the migration data from tagging experiments (IPHC 2004). Regulatory areas, such as Area 2A discussed in this opinion, are larger regional units. Statistical area data are combined for use at the regulatory area level. Figure 1-3 shows the statistical areas within Area 2A. Between 2011 and 2015, the majority of commercial vessels landed into statistical areas 10 and 20 in central Oregon. No landings were made south of statistical area 6 between 2011 and 2015 (IPHC 2017-1026). The southern boundary of statistical area 06 is 40°26'24" N. lat.

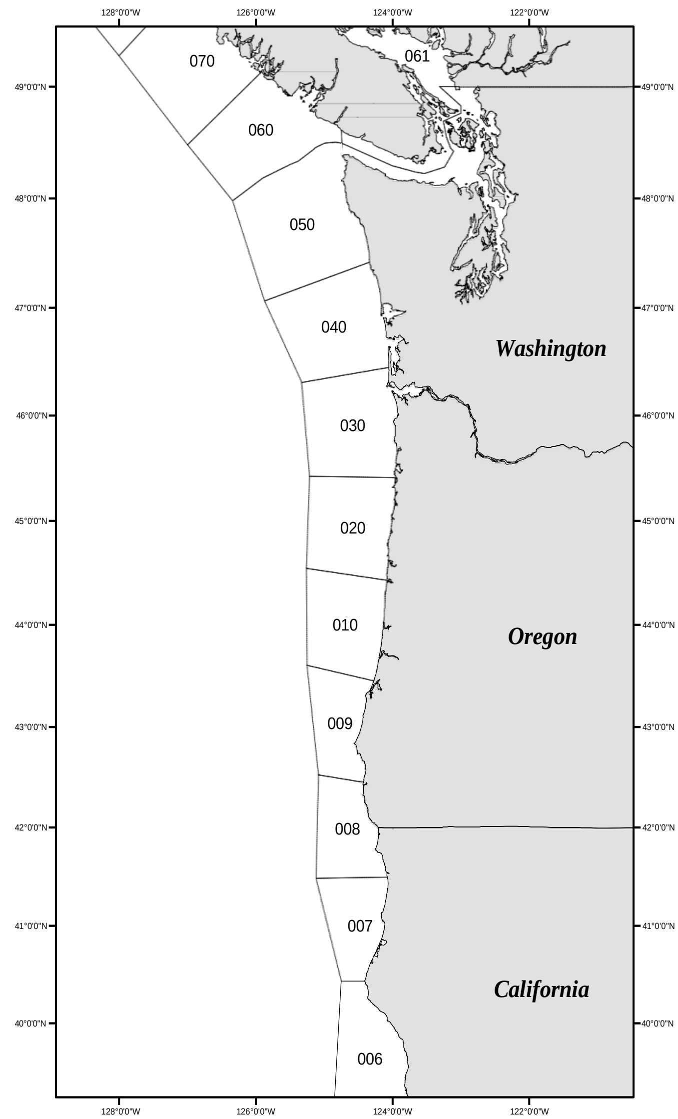

Figure 1-3. Map of IPHC statistical areas in regulatory Area 2A (IPHC 2004).

1.3.2.2. Tribal Fisheries

Thirteen western Washington tribes possess and exercise treaty fishing rights to halibut, including the four tribes that possess treaty fishing rights to groundfish. The tribes are the Hoh, Jamestown S'Klallam, Lower Elwha S'Klallam, Lummi, Makah, Nooksack, Port Gamble S'Klallam, Quileute, Quinault, Skokomish, Suquamish, Swinomish, and Tulalip. Tribal allocations have been included in the CSP since 1995.

The CSP currently allocates 35 percent of the Area 2A TAC to the treaty Indian tribes in subarea 2A-1, which includes that portion of Area 2A north of Point Chehalis, Washington (46°53.30' N. lat.) and east of 125°44.00' W. long. (Figure 1-4). The treaty Indian allocation is to provide for a tribal commercial fishery and a ceremonial and subsistence fishery (C&S). These two fisheries are managed separately. Each tribe manages its fisheries through its own regulations and in compliance with the applicable court orders and court-approved agreement. Data is collated by the Northwest Indian Fisheries Commission (NWIFC).

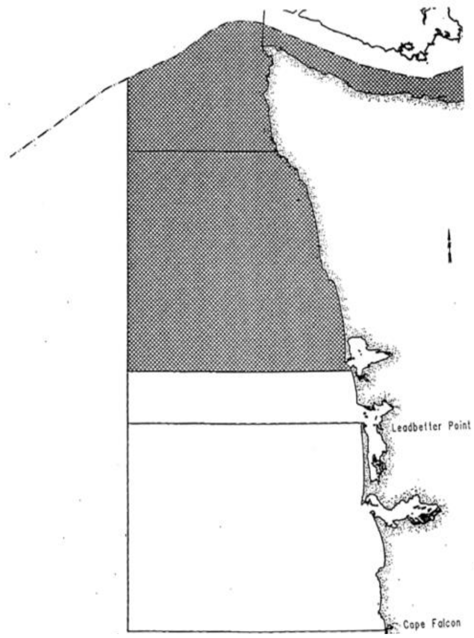

Figure 1-4. Map of Area 2A-1. Shaded area represents the usual and accustomed area, which extends into Puget Sound (Area 2A-1) (PFMC 1994).

In general, management of the tribal fishery has involved four fishery components: (1) unrestricted, (2) restricted, (3) late season, and (4) C&S. The tribes' 2017 plan (separate from the CSP) divided the tribal commercial allocation as follows: 46.5 percent to the unrestricted fishery (with no landing limits), 19 percent to the restricted fishery (with landing limits), and 34.5 percent to the late season (mop-up) fishery. The commercial allocation is the tribal allocation minus C&S, and the C&S allocation is based on the previous year's catch estimate. These allocations are not further subdivided by individual tribe; rather, all the tribes participating in each commercial fishery manage collectively. The tribal halibut fishery number of landings and pounds of halibut harvested for the past 5 years for the four components are shown in Table 1-3.

Table 1-3. Annual tribal halibut fishery data.[1]

	Puget Sound Tribes		**Coastal Tribes**	
Year	Landings	Pounds	Landings	Pounds
2013	550	150,211	111	155,746
2014	569	163,241	102	145,743
2015	505	143,765	104	171,908
2016	568	156,592	188	203,400
2017[2]	443	127,828	222	304,655
Average:	527	153,494	118	174,644

[1] Data provided by Sandy Zeiner at NWIFC; last updated October 6, 2017.
[2] 2017 data are preliminary.

For 2017, the tribes estimated that 29,600 pounds would be used for C&S fisheries and the remaining 435,900 pounds were allocated to the commercial fishery.

Geographic Extent

Tribal fishing occurs off the coast of Washington and in Puget Sound. Each tribe has Usual and Accustomed (U&A) areas designated in federal regulations at 50 C.F.R. § 300.64; however, some of the designations do not list the coordinates for the U&A, but simply describe the area.

Table 1-4 lists the areas fished by the tribes. The area numbers listed correspond to the areas, as applicable to any tribe, in Figure 1-5.

Table 1-4. Commercial and C&S halibut areas fished by each tribe.

Treaty Tribe	Areas Fished
Hoh	South from the line running west from the mouth of the Quillayute River (47 deg. 154'18" N. lat.) south to the line running west from the mouth of the Quinault River (47 deg. 121'00" N. lat.)
Jamestown	Areas 20B, 22A, 23A, 23B, 23C, 23D, 25A, 25B, 25C, 25D, 25E, 27A, 27B, 29
Lower Elwha	Areas 20B, 22A, 23A, 23B, 23C, 23D, 25A, 25B, 25C, 25D, 25E, 27A, 27B, 29
Lummi	Marine areas of northern Puget Sound from the Canadian boundary south to the environs of Seattle, including areas 20A, 20B, 21A, 21B, 22A, 22B, and 23B, 23A north of the line from Trial Island off Victoria to the flashing horn buoy between Dungeness Spit and Hein Bank, area 25A north of the line from the previous point to Point Wilson, all of area 25B and 26A.
Makah	North of Norwegian Memorial (48 deg. 02'15" N. lat.), east of 125 deg. 44" west and west of Tongue Point (123 deg. 42'30" west)
Nooksack	Areas 20A, 20B, 21A, 21B, 22A, and 22B
Port Gamble	Areas 20B, 22A, 23A, 23B, 23C, 23D, 25A, 25B, 25C, 25D, 25E, 27A, 27B, 29
Quileute	Sand Point (48 deg. 07'36" N. lat.) to Queets River (47 deg. 31'42" N. lat.)
Quinault	Pacific Ocean between Point Chehalis (46 deg. 53'18" N. lat.) and Destruction Island (47 deg. 40'06" N. lat.)
Skokomish	Marine areas 27C, 27B, 27A and 25C (south of the line from Olele Point to Foulweather Bluff excluding Port Gamble Bay).
Suquamish	Marine areas 20A, 20B, 21A, 21B, 22A, 22B, 23A, 23B, 24B, 24D, 25A, 25B, 26A
Swinomish	Marine areas 20A, 20B, 21A, 21B, 22A, 22B, 23A, 23B, 24A, 24C, 24D, 25A, 25B, 26A
Tulalip	20A, 20B, 21A (west of a line from Vendovi Island to the northern most tip of Guemes Island, along the eastern shore of Guemes Island to Clark Point to March Point); 23A (northeast of a line from Trial Island light to Protection Island); 23B, 24B, 24C (south of a line extended due west of Camano City to Whidbey Island); 24D, 25A (north and east of a line from Trial Island light to Protection Island to McCurdy Point); 25B (Point Monroe and excluding that portion of area 26B east of a line from Meadow Point to West Point to Alki Point).

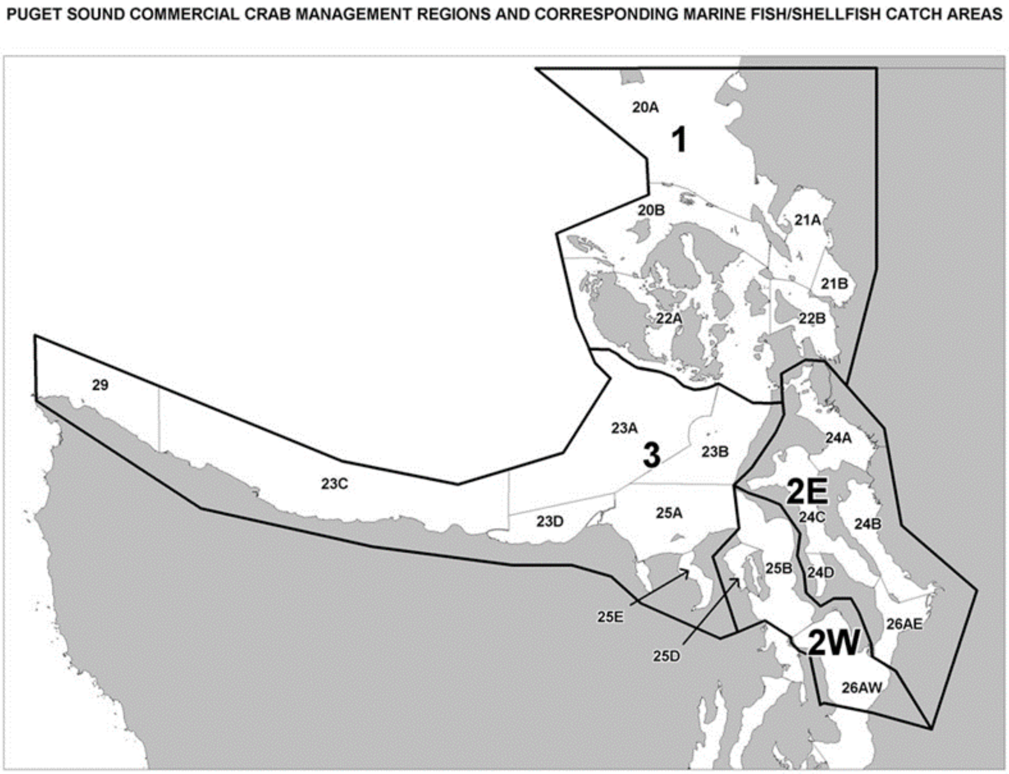

Figure 1-5. Map of Washington State fishing areas in Puget Sound. Numbers from this figure are listed in Table 1-4 and identify Usual and Accustomed areas of Puget Sound treaty tribes.

Seasonality

The C&S fishery is open intermittently throughout the year; however, the timing of the fisheries varies from year to year and each tribe issues its own regulations. Typical regulations include a maximum landing limit per vessel per day, with landings totaling between 25,000 and 35,000 pounds each year.

The structure of the tribal fishery has changed over the years and is affected by ongoing litigation. Table 1-5 shows the dates, and in some cases the number of hours, that each of these fisheries was open from 2012 to 2017.

In 2017, the unrestricted fishery was open March 20 (11 hours) and April 15 to 16 (39 hours). The unrestricted fishery landed 264,005 pounds in 306 landings. The restricted fishery was open May 1 to 2 (35 hours), with a 500 pounds/vessel/day limit. The restricted fishery landed 41,608 pounds in 172 landings. The first late-season fishery was open 34 hours on both May 19 to 20 and 22 to 23 with a landing limit of 2,500 pounds/vessel/day. The first late-season fishery landed 92,401 pounds in 133 landings. The second late-season fishery was open 34 hours on both June 18 to 19 and July 2122 with a landing limit of 1,000 pounds/vessel/day. The second late-season fishery landed 34,469 pounds in 54 landings. Therefore, the total landings for all fisheries are 432,483 pounds, which is 3,417 pounds under the tribal commercial allocation. The C&S fishery is managed throughout the year with landing limits by each tribe. Typically, this fishery is closed while the commercial fishery is open.

Table 1-5. Year, type of fishery, dates and number of days, and participating tribes in halibut fisheries from 2012 to 2017.

Year	Fishery	Dates Open
2017	Unrestricted	March 20 (11 hours) and April 15-16 (39 hours)
	Restricted	May 1-2 (35 hours)
	Mop up	May 19-20 & 22-23 (34 hours); June 18-19 & July 21-22 (34 hours)
	C&S	Jan. 1 - Dec. 31 (365 days)
2016	Unrestricted	March 19-21, 20-21 and 21-23 (39 hrs.)
	Restricted	April 1-2 (28 hr)
	Mop up	May 1-2 & 11-12 (24 hr); May 18-Aug. 15; July 25-Aug. 2; and Sept. 12-Nov. 15
	C&S	Jan. 1 - Dec. 31 (365 days)
2015	Unrestricted	March 16-18 (48 hr)
	Restricted	April 1-2 (30 hr)
	Mop up	None
	C&S	Jan. 1 - Dec. 31 (365 days)
2014	Unrestricted	March 11-13 (48 hr)
	Restricted	March 20-21 (30 hr),
	Mop up	May 8 (10 hr)
	C&S	Jan. 1 - Dec. 31 (365 days)
2013	Unrestricted	March 23-25 (48 hr)
	Restricted	April 3 (36 hr) and April 15 (36 hr)
	Mop up	May 8 (12 hr), June 6 (12 hr), July 13 (12 hr)
	C&S	Jan. 1 - Dec. 31 (365 days)
2012	Unrestricted	March 24-26 (48 hr.)
	Restricted	March 17-19 (55 hr.)
	Mop up	May 1 (13 hr.)
	C&S	Jan. 1 - Dec. 31 (365 days)

1.3.2.3. Recreational Fisheries

The halibut recreational fisheries include individual anglers and charter boats. Recreational halibut fisheries occur in Washington, Oregon, and northern California, with catches generally occurring north of Shelter Cove, California. Each state has varying time and area closures implemented through annual changes to the CSP (Table 1-6).

Table 1-6. Area 2A subareas opening info**.**

Area	Opener	Length	2017 days open
Washington			
Inside Waters/Puget Sound	Early May	2 days/week	9
North Coast	Early May	2 days/week	9
South Coast	Early May	2 days/week	5

South Coast nearshore	Early May	7 days/week	0
Columbia River all-depth	Early May	Thursday-Sunday[1]	14
Columbia River nearshore	Early May	Monday-Wednesday	31
Oregon			
Central Coast spring	Early May	Thursday-Saturday	18
Central Coast summer	Early August	Friday-Saturday	8
Central Coast nearshore	June 1	7 days/week	122
Southern Oregon	May 1	7 days/week	170
California	Early May	7 days/ week, closed periods	86

[1] 2018 Season changed to Thursday, Friday, and Sunday at November 2017 Council meeting.

Washington

Recreational fishing for halibut in Washington is allocated 35.6 percent of the non-tribal recreational TAC and is divided into four subareas for management and catch allocation purposes: Washington Inside Waters (Puget Sound) subarea, Washington North Coast subarea, Washington South Coast subarea, and Columbia River subarea (shared with Oregon). These boundaries correspond to WDFW marine catch areas (MCAs). Beginning in 2010, WDFW closed fishing for bottom fish in all waters deeper than 120 feet and closed several commercial fishing activities west of the ESA-listed rockfish DPSs' boundary to Cape Flattery.

Groundfish species such as lingcod or various species of rockfish are often encountered while targeting halibut. All such directed halibut fishing is part of the current Proposed Action.

<u>Washington Inside Waters (Puget Sound) Subarea</u>

Puget Sound is allocated 23.5 percent of the first 130,845 pounds (59.4 mt) allocated to the Washington recreational fishery, and 32 percent of the Washington recreational fishery allocation between 130,845 pounds (59.4 mt) and 224,110 pounds (101.7 mt). The Washington Inside Waters subarea includes all waters east of the Sekiu River mouth and includes Puget Sound, most of the Strait of Juan De Fuca, the San Juan Islands area, Hood Canal, and Admiralty Inlet. There are eleven MCAs in the Puget Sound region, including Area 4, which spans both ocean and inside waters (Figure 1-6). This fishery occurs in Washington MCAs 5 through 10. Washington MCAs 11, 12, and 13 are closed to recreational halibut fishing. Most of the Washington Inside Waters subarea's recreational catch of halibut is taken in the Strait of Juan de Fuca and in MCAs 5, 6, 7, and 9.

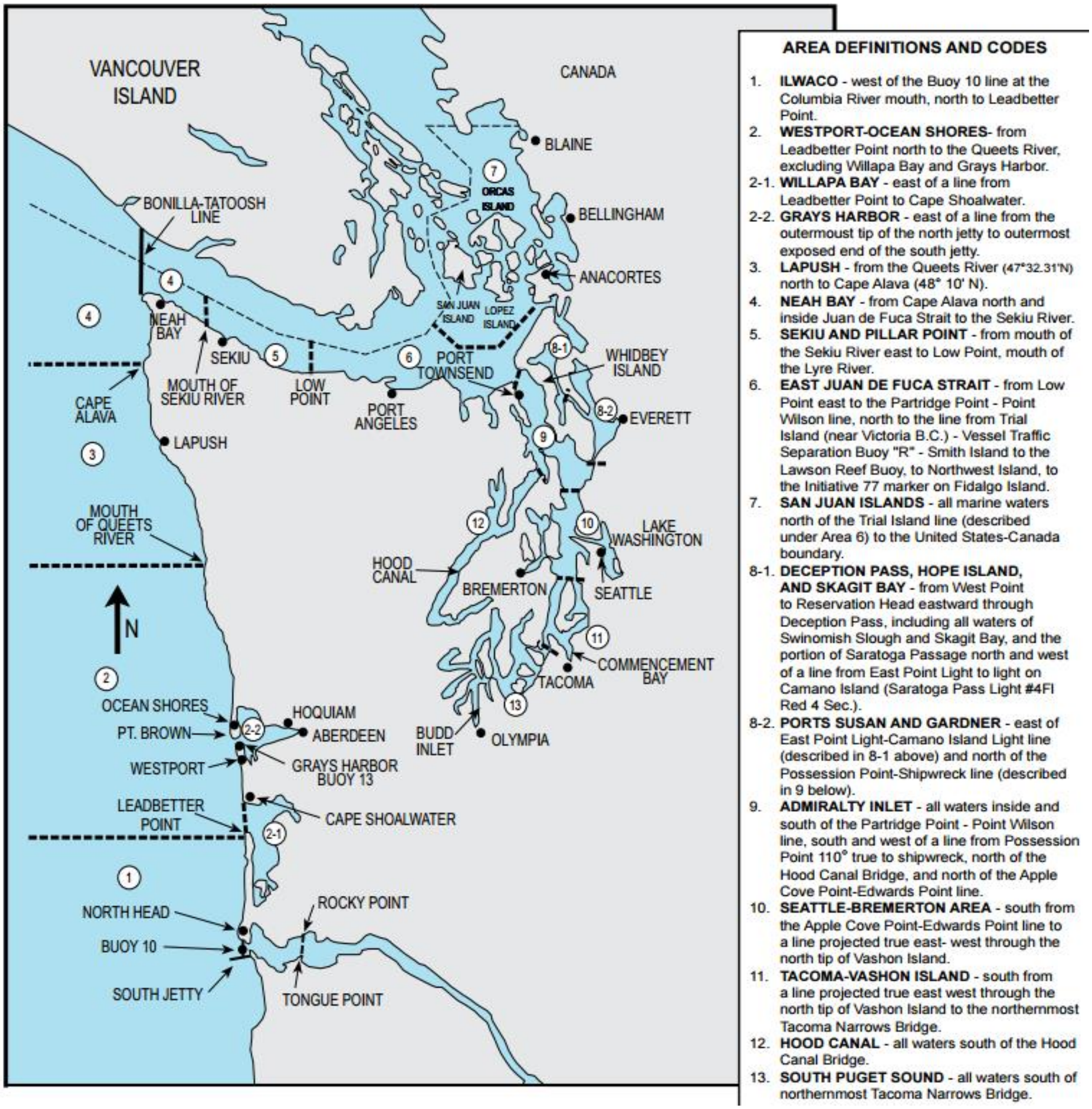

Figure 1-6. Washington marine catch area definitions and codes. From WDFW 2015 Recreational Fishing Regulation Pamphlet (http://wdfw.wa.gov/fishing/regulations/).

<u>Washington North Coast Subarea</u>

Recreational fishing for halibut along the North Coast is allocated 62.2 percent of the first 130,845 pounds (59.4 mt) to the Washington recreational fishery, and 32 percent of the Washington recreational allocation between 130,845 pounds (59.4 mt) and 224,110 pounds (101.7 mt). This area is defined as all U.S. waters west of the mouth of the Sekiu River and north of the Queets River (47°31.70' N. lat.), Washington MCAs 3 and 4 (Figure 1-6), including the portion inside the Strait of Juan de Fuca. This area includes a C-shaped YRCA, which is closed to halibut fishing, though much of the fishing in this area occurs in the deepwater areas along the edges of this closure (M. Culver, WDFW, letter to Ryan Wulff, NMFS WCR, August 24, 2017, regarding recreational halibut fisheries, port sampling data, and bycatch data).

Washington South Coast Subarea

This area is allocated 12.3 percent of the first 130,845 pounds (59.4 mt) to the Washington recreational fishery, and 32 percent of the Washington recreational allocation between 130,845 pounds (59.4 mt) and 224,110 pounds (101.7 mt). This subarea is defined as waters south of the Queets River (47°31.70' N. lat.) and north of Leadbetter Point (46°38.17' N. lat.), in Washington MCA 2 (Figure 1-6). This area includes two closed YRCAs. Fishing generally occurs in the deep water on the shelf.

The South Coast subarea has two components: an offshore fishery and a nearshore fishery. The nearshore fishery operates east of a boundary line approximating the 30-fathom depth contour and is allocated 10 percent of the subarea quota or 2,000 pounds, whichever is smaller. In recent years, the nearshore fishery has been allocated 2,000 pounds, rather than 10 percent, of the subarea quota. Overages in the primary fishery may cause the nearshore fishery not to open. Participants in the offshore (seaward of the 30 fathom line) recreational halibut fishery are allowed to keep incidentally caught lingcod in accordance with groundfish regulations.

Seasonality

The four Washington recreational fishing areas have the same open dates statewide, spreading the effort across subareas. Beginning in early May, the fishery is open 2 days per week (one week day and one weekend day) and extends into June if sufficient quota remains. Subareas close as quota is attained, and additional open days may be added. If quota sufficient to open remains, the nearshore South Coast fishery opens the Saturday after the closure of the all-depth and typically runs 7 days per week until quota attainment.

Table 1-7. Number of individual anglers per day in each Washington subarea in 2017.

<table>
<tr><th>Date</th><th>Puget Sound</th><th>North Coast</th><th>South Coast</th><th>Columbia River</th></tr>
<tr><td>May 4</td><td>5,211</td><td>2,316</td><td>1,067</td><td>82</td></tr>
<tr><td>May 6</td><td>4,601</td><td>1,961</td><td>940</td><td>85</td></tr>
<tr><td>May 11</td><td>2,170</td><td>786</td><td>750</td><td>34</td></tr>
<tr><td>May 21</td><td>3,345</td><td>1,071</td><td>1,116</td><td>44</td></tr>
<tr><td>May 25</td><td>1,479</td><td>287</td><td rowspan="4">Closed</td><td>22</td></tr>
<tr><td>Jun 1</td><td>1,326</td><td>441</td><td rowspan="3">Closed</td></tr>
<tr><td>Jun 4</td><td>1,366</td><td>420</td></tr>
<tr><td>Jun 10</td><td>1,237</td><td>539</td></tr>
<tr><td>Jun 17</td><td>1,074</td><td>627</td><td>681</td><td>169</td></tr>
</table>

Columbia River Subarea

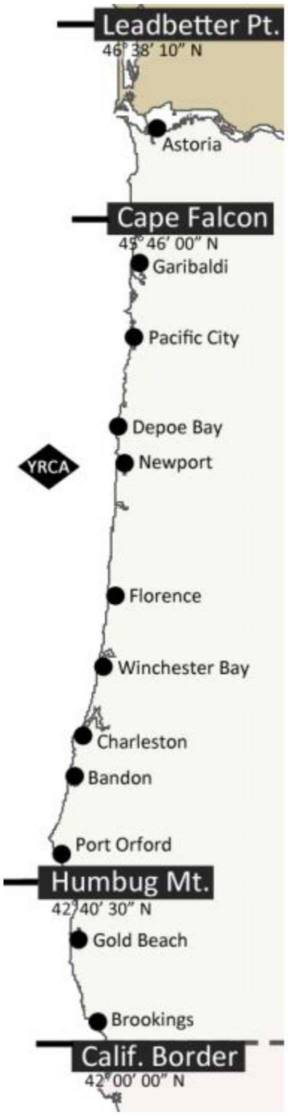

Figure 1-7. Map of Oregon Coast subarea and coordinates for subarea definitions.

The Columbia River recreational fishery subarea is allocated 2.0 percent of the first 130,845 pounds (59.4 mt) to the Washington recreational fishery, and 4.0 percent of the Washington recreational allocation between 130,845 pounds (59.4 mt) and 224,110 pounds (101.7 mt). This subarea is also allotted 2.3 percent of the Oregon recreational allocation. The Columbia River subarea is defined as waters south of Leadbetter Point, Washington (46°38.17' N. lat.) and north of Cape Falcon, Oregon (45°46.00' N. lat.) (Figure 1-7). This subarea is MCA 1 in Washington to the Washington/Oregon border. It was established in 1995; before that time, it was part of the Washington South Coast subarea. To date, most of the recreational catch in this subarea is landed into Ilwaco, Washington. The current CSP allocates 500 pounds to a nearshore fishery and the remainder is allocated to an all-depth fishery. There are no closed areas within this subarea. There are no restrictions on fishing for halibut into the estuary; however, halibut have a low tolerance for low salinity, so it is unlikely they would be encountered in the estuary.

Seasonality

The Columbia River nearshore fishery is typically open Monday through Wednesday starting in May. The all-depth season opening is Thursday, Friday, and Sunday starting in May. The entire subarea is open through September 30 or until quota attainment, whichever happens first. The Columbia River subarea was open 66 days in 2013, 87 days in 2014, and 19 days each year in 2015 and 2016. In 2017, the all-depth area was open 14 days and the nearshore 31 days.

Oregon

Recreational fishing for halibut in Oregon is allocated 29.7 percent of the non-tribal recreational TAC and is divided into three subareas for management and catch allocation purposes: the Columbia River subarea (see above), Central Coast subarea, and Southern Oregon (Figure 1-7). Most fishing effort in Oregon occurs between 10 to 150 fathoms, with concentrated effort between 20 to 30 fathoms and between 80 to 100 fathoms. The peak between 20 and 30 fathoms is primarily from anglers participating in the nearshore fishery; however, there is some effort in those depths during all-depth openings. The effort in the 80 to 100 fathom range is from the all-depth seasons (Williams, S., ODFW, letter to Frank Lockhart, NMFS WCR, June 21, 2012, regarding halibut fishery data request). The most popular fishing areas occur in the Central Coast subarea (Figure 1-). The Stonewall Bank YRCA is closed to recreational groundfish and halibut fishing off Oregon's central coast.

The Oregon Central Coast subarea is allocated 93.79 percent of the Oregon recreational allocation. This fishery consists of a nearshore and an all-depth component that operates from Cape Falcon to Humbug Mountain. The nearshore fishery operates inside of the 40-fathom depth contour and is allocated 12 percent of the subarea allocation when the TAC is above 700,000 pounds and 25 percent when the TAC is below 700,000 pounds. There are no federal closed areas within the nearshore area. There are state marine reserves in the nearshore area that do not allow halibut fishing, but those are not in areas where halibut are generally targeted. There is a closed area in the all-depth fishery near Stonewall Bank off Newport that is closed to recreational halibut fishing.

The Southern Oregon subarea is allocated 3.91 percent of the Oregon recreational allocation. This fishery operates in the area from Humbug Mountain, Oregon, to the Oregon/California border.

Figure 1-8. Map of popular recreational Pacific halibut fishing locations (pers. comm. Mattes. Aug. 16, 2017).

Seasonality

The Central Coast subarea is divided into three components: spring, summer, and nearshore. The spring season opens in mid-May and has typically closed in June or July for quota attainment. The summer season opens in early August and is generally open only a few days. The nearshore fishery opens June 1 and is open 7 days per week until October 31 or until the quota has been taken. The nearshore fishery has seen an increase in effort in the last few years and has not remained open for the entire May through October period because of quota attainment. To provide more opportunity in areas with high effort, quota may be transferred from one subarea with low attainment to another, typically later in the season when ODFW is reasonably sure the quota would otherwise go unharvested.

California
The California subarea is defined as all waters off California and is allocated 4 percent of the non-tribal recreational TAC. Since the 2014 creation of a California recreational fishery subarea, the allocation has been 25,220 pounds in 2015, 29,640 pounds in 2016, and 34,580 pounds in 2017. In California, the catch of Pacific halibut occurs in the northern portion of the state from the Oregon/California border south to Sonoma County (Figure 1-), with most of the effort occurring in Humboldt and Del Norte counties in the summer months. There are several state marine protected areas (MPAs) that are closed to halibut fishing in this subarea.

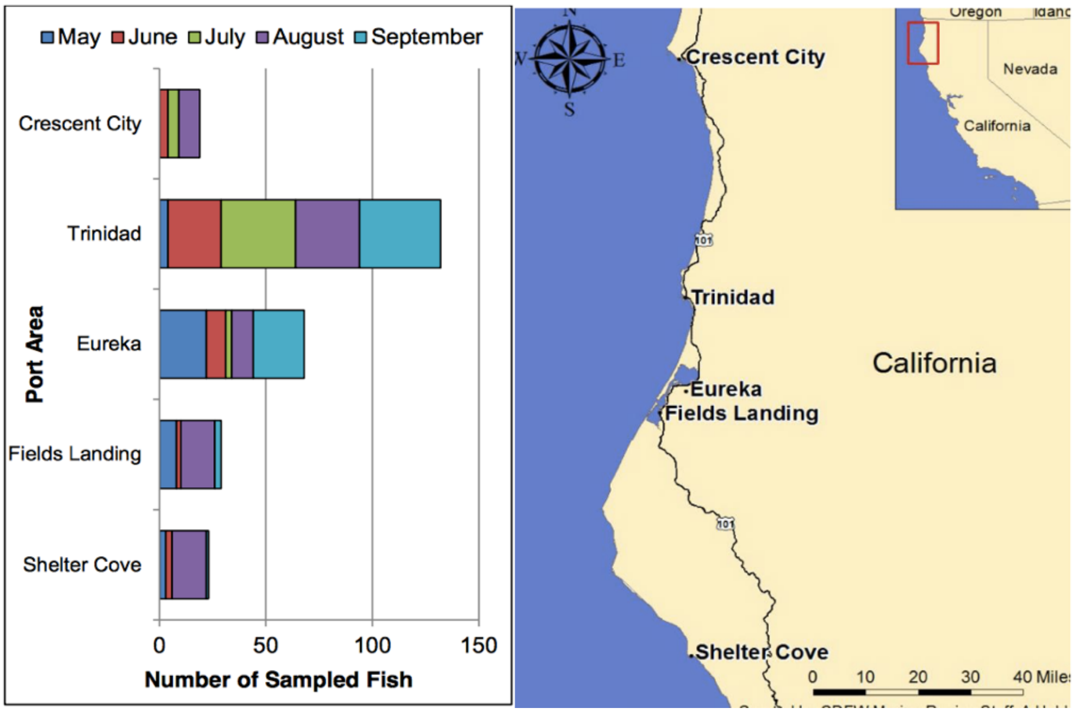

Figure 1-9. Distribution of halibut encountered in California by month in 2016. CDFW report on 2016 fishery to IPHC.

<u>Seasonality</u>
The California subarea is open 7 days a week May through October or until the quota is taken. There may also be additional closed periods during this season determined after the TAC is set. In 2017, the fishery was open May 1 to June 15, July 1 through 15, August 1 through 15, and September 1 through 10.

1.3.3. Gear Fished in the Halibut Fishery

1.3.3.1. Commercial Fishery

The directed non-tribal fishery is restricted to the use of longline (or set-line gear, as it is called in IPHC regulations). Figure 1-10 shows a typical gear configuration. Typical longline gear consists of a “skate,” which is made up of a mainline, gangions, and hooks. Typical bait is herring, octopus, salmon, or some combination of the three. The gangions are approximately 3 to

4 feet long with a hook attached to the end. Hooks are typically size 16/0. The typical gear set up has a 1,800-foot skate with 100 size 16/0 hooks at an 18-foot spacing (IPHC 2014). Several skates may be connected depending on many factors, including size of the fishing ground and the likelihood of snagging on the bottom (IPHC 2014). The number of hooks per skate for the commercial tribal fishery varies. The skates are tied together in sets of 4 to 12 skates each. The baited skates are set over a chute at the stern of the vessel. The gear is retrieved by a power-driven wheel, the "gurdy," on the side of the vessel.

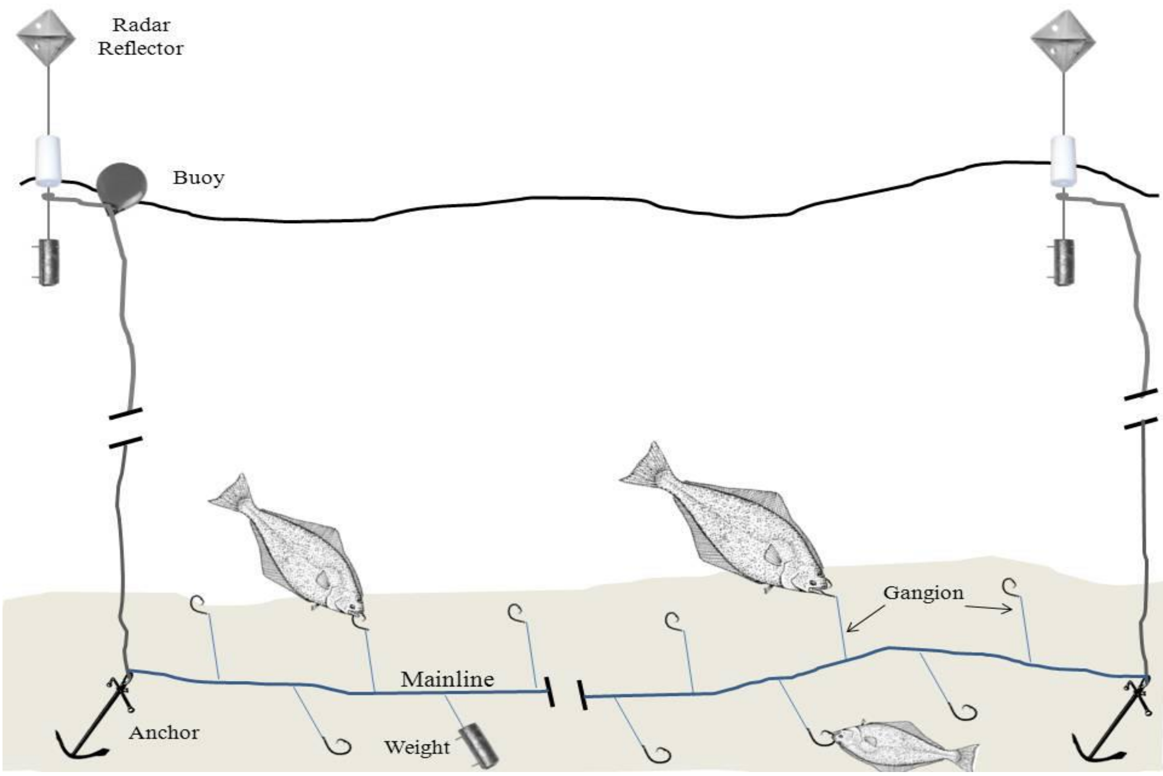

Figure 1-10. Schematic of halibut longline gear set-up (Williams 2012).

1.3.3.2. Tribal Fisheries

Gear used in the tribal fisheries include:

- Hook-and-line (rod and reel, no more than two hooks)
- Hand line (no more than two hooks)
- Longline, snap gear only
- Bottom troll (no more than six lines)

Bait is typically the same as the non-tribal directed commercial fishery: salmon, herring, octopus, and sometimes Pacific cod.

1.3.3.3. Recreational Fisheries

Recreational gear in all of Area 2A is restricted to a single heavy line with no more than two hooks attached, or to spear fishing. Anglers use large jigs, and bait may be artificial worms, herring, tuna bellies, or salmon bellies while targeting halibut (Olander 1991; Martinis 2015;

Mattes, L. ODFW, letter to Gretchen Hanshew, NMFS WCR, August 16, 2017, regarding recreational halibut fisheries, port sampling data, and bycatch data). Hooks are usually circle hooks or “J” hooks with a single point (M. Culver, WDFW, letter to Ryan Wulff, NMFS WCR, August 24, 2017, regarding recreational halibut fisheries, port sampling data, and bycatch data). There are no depth restrictions for the recreational fishery, and gear is fished on or near the bottom.

Rockfish caught incidentally to the halibut fishery may suffer from barotrauma, and state regulations require or recommend the use of descending devices, discussed in more detail in Section 2.5.1.1, Puget Sound/Georgia Basin Rockfish. WDFW recently adopted a new fishing regulation that requires anglers have a descending device rigged for use on board the fishing vessel during all recreational bottom fish and halibut fisheries. As of April 21, 2017, descending devices are mandatory on vessels participating in the recreational halibut fishery outside of the 30-fathom curve off the coast of Oregon. Descending devices are strongly recommended but not required when fishing for halibut in California.

1.3.4. Catch Monitoring, Accounting, and Enforcement

Catch monitoring, accounting, and enforcement are accomplished through coordination among WDFW, ODFW, CDFW, IPHC, NMFS, and the individual tribes. A description of the relevant data systems used to monitor total catch in commercial and recreational halibut sectors follows.

1.3.4.1. IPHC Stock Assessment Set Line Survey

The IPHC conducts standardized assessment surveys to collect information on the halibut stock such as growth, distribution, area-wide biomass, age composition, sexual maturity, and relative abundance of bycatch species. Another objective of the survey is to log marine mammal and seabird occurrence and interactions with fishing gear.

Each survey region consists of a regular distribution of stations on a 10 by 10 nautical mile grid, where a single coordinate indicates the center of the set (IPHC 2017b). The center of each station is within the survey depth range of 20 to 275 fathoms. The ends of some sets may extend shallower or deeper than the standard range to cover data gaps (10 to 20 fathoms or 275 to 400 fathoms). The survey is conducted in the summer, between May 28 and August 31 for 2017, and has used the same 10 nautical mile grid sampling method since 1993. Sampling areas may change from year to year.

For 2017, the Commissioners recommended a denser survey grid off the north coast of Washington, adding 26 stations. Northern California expanded to 44 stations (up from 27) (IPHC 2017b). Constituents hypothesized that the standard 10 by 10 nautical mile sampling grid was too large to accurately detect the relatively patchy distribution of Pacific halibut in Area 2A and that increasing the density of sampling stations would yield more representative estimates of Pacific halibut abundance at the southern end of its range (Figure 1-11).

The IPHC survey collects extensive data on distribution of halibut and the occurrence of bycatch in Area 2A. This survey informs the IPHC’s decision on the TAC and provides data that the Council and NMFS may consider when managing the Area 2A fishery. NMFS therefore considers the survey to be an interrelated or interdependent activity with the implementation of the Area 2A CSP. In 2018, the survey will again include stations in Puget Sound and for the first time include the inside waters of the Georgia Strait in Canada.

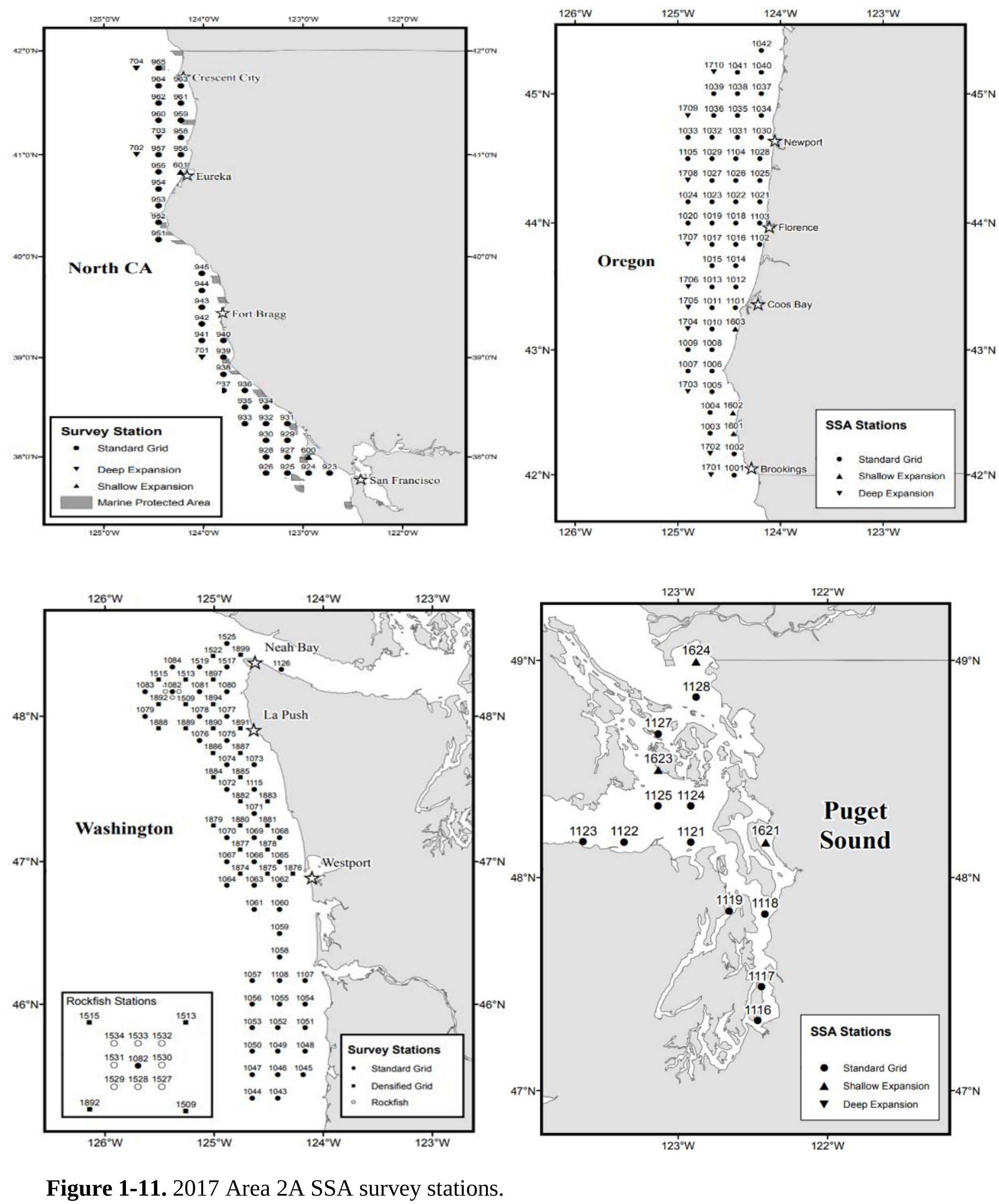

Figure 1-11. 2017 Area 2A SSA survey stations.

1.3.4.2. Data Collection Programs: Non-tribal Commercial Fisheries

The three non-tribal commercial fisheries are monitored inseason relative to their halibut quota. Catch of halibut in the sablefish fishery is monitored by WDFW; catch of halibut in the salmon troll fisheries is monitored by WDFW, ODFW, and CDFW and reported to NMFS and IPHC inseason; and catch of halibut in the directed fishery is monitored by IPHC and is reported to NMFS inseason. All three fisheries are adjusted inseason, if necessary, depending on fishery performance and available quota. U.S. vessels participating in any commercial fisheries that are 26 feet or greater in overall length are required to maintain logbooks.

Area 2A had NMFS-trained observers on board directed commercial vessels for the first time in 2017, where catch data was collected for 22 trips. Normally, the previous year's observer reports will likely not be available until the September Council meeting. Data collected include take and interactions with prohibited species, length and viability for halibut, and fishing effort and bycatch information (NWFSC 2017). Boats in the directed halibut fishery retaining incidentally caught groundfish and boats participating in the sablefish primary fishery north of Pt. Chehalis, Washington, that retain incidentally caught halibut are subject to the observer requirements under groundfish regulations and may have observers on board depending on observer coverage requirements in the groundfish regulations[2].

During the Area 2A directed commercial fishery, the IPHC sends port samplers to Newport, Oregon, to collect logbook data and biological samples. Newport is the only port covered because it typically receives the most pounds landed. The IPHC does not hire port samplers for this fishery and instead Seattle office staff are deployed to cover the openings. When boats offload at different plants in Newport, the skippers are interviewed, logbook data are collected, and halibut fork length measurements and otoliths are taken. The logbook and biological data are later used for stock assessment purposes. The port sampler stationed in Bellingham, Washington mainly collects data from halibut caught incidentally in the sablefish fishery (IPHC 2017c).

Following an opening, IPHC and ODFW staff contact the different fish processing plants along the west coast to obtain fish ticket information. The total pounds landed are tallied. IPHC staff, in conjunction with ODFW and NMFS staff, decide whether there is sufficient poundage remaining to reopen the fishery.

1.3.4.3. Data Collection Programs: Tribal Fisheries

Data collection programs vary among the treaty tribes; however, IPHC regulations require all U.S. vessels (tribal and non-tribal) 26 feet or greater in overall length to maintain logbooks. A majority of the vessels in the tribal fishery are under 26 feet. Logbooks were obtained from 137 tribal vessels in 2015 and 161 in 2016 (IPHC 2017c). Generally, logbook data are used by the IPHC for stock assessment purposes and not for inseason monitoring or tracking. The IPHC logbook requirements are the same for all commercial (tribal and non-tribal) halibut fishing occurring in Area 2A, and are required to contain the following information:

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[2] NMFS is currently developing regulations to allow for electronic monitoring in place of observers. This may impact the type and amount of information collected in the future.

- The name of the vessel and the state and/or tribal vessel number
- The date(s) upon which the fishing gear is set or retrieved
- The latitude and longitude coordinates or a direction and distance from a point of land for each set or day
- The number of skates deployed or retrieved, and number of skates lost
- The total weight or number of halibut retained for each set or day (IPHC logbooks do not require information on species other than halibut)

For tribal fisheries, fishery regulations, catch monitoring, and enforcement are the responsibility of each individual tribe. Each tribe has slightly different regulations regarding what information is required on their fish tickets; however, all landed catch (both halibut and other non-target species) is required to be reported on fish tickets. Catch that is not landed, considered to be minimal, is not required to be reported on tribal fish tickets. Data from fish tickets is transmitted to the NWIFC that collects and distributes the data for use by the treaty tribes for collective inseason management according to the management plan.

Each December, NWIFC compiles individual tribal catch data and sends a report to NMFS of ESA-listed species caught incidental to the halibut fishery.

1.3.4.4. Data Collection Programs: Recreational Sectors

Washington

WDFW monitors the catch of halibut through a sampling program in both the Puget Sound region and the coastal region. Under the sampling approach described below, halibut catch and effort estimates are available on a weekly basis.

WDFW's Ocean Sampling Program (OSP) produces estimates for salmon, groundfish, Pacific halibut, tuna, and sturgeon to meet state and federal needs. This includes weekly estimates of catch (number of fish) and effort (angler trips) by species and management area for inseason management of quota-managed species. Beginning in 2015 and expanded in 2017, the Puget Sound Sampling Program (PSSP) implemented an intensive sampling program that also provides weekly estimates of catch and effort for inseason management of the Pacific halibut fishery.

Bycatch data on non-targeted released species for the coastal area are collected through WDFW's dockside sampling programs, but data on the condition of the released fish (including listed species) is not collected. There have not been takes of salmon, sea turtles, green sturgeon, or eulachon, and no interactions with marine mammals in Puget Sound or on the coast in the last 15 years (M. Culver, WDFW, letter to Ryan Wulff, NMFS WCR, August 24, 2017, regarding recreational halibut fisheries, port sampling data, and bycatch data). This is expected to continue, since there have only been minor changes to the fishery over this time period, and monitoring in Puget Sound has improved.

In 2016, WDFW staff onboard aircraft collected location data of all recreational fishing vessels throughout Puget Sound on days the halibut season was open. Additionally, during the recreational halibut fishery, WDFW enforcement conducts on-the-water patrols. Exit/entrance numbers are counted (by boat type) either leaving the port (4:30 a.m. through end of the day) or entering the port (approximately 8:00 a.m. through dusk) to give total counts of charter and private boats for the day. Interviews are systematically conducted as boats return to port.

Angler interviews include:

- Primary target species (“trip type”)
- Number of anglers
- Management area fished
- Number of released fish by species
- Depth at which most rockfish were caught
- Non-fishing trips (recorded as such and expanded)
- Examination of catch; retained catch is counted and species identified by the sampler. Salmon are electronically checked for coded wire tags (CWT), and other biological data are collected.

Sampling rates and schedules:

- MCAs 6, 7, and 9 had sampling rates of 41 to 49 percent in 2016. Marine Area 8 was unreported.
- Sampling rates vary by port and boat type. Generally, where there are fewer than 30 boats, the goal is 100 percent coverage. The sampling rate goal decreases as boat count increases.
- Boats are selected systematically for sampling; a consistent sample rate is maintained throughout the day.
- Overall sampling rates average approximately 50 percent coastwide through the season.
- Sampling schedules for weekdays/weekend days are stratified in all ports except the Columbia River north jetty (land-based fishery). Usually, both weekend days and a random 3 of 5 weekdays are sampled.

Oregon

The recreational Pacific halibut fishery off the Oregon coast is sampled by the Oregon Recreational Boat Survey (ORBS) program as part of the overall sampling program. There is not a halibut-specific sampling program. However, during the all-depth openings in the Central Oregon Coast subarea, additional staff are scheduled at the busiest ports, such as Garibaldi and Newport, to reflect the additional effort.

The ocean recreational catch of Pacific halibut in Oregon is estimated weekly by multiplying average catch per boat (obtained from interviews) by the total effort for each port. In each port, separate catch estimates are made by boat type (charter, private) and trip type (target species such as bottom fish, salmon, or halibut, for example).

- <u>Private Boat Effort:</u> In most ports, ODFW personnel tally private boats as they cross the bar to enter the ocean. Boat counts are made most days, beginning at dawn and usually ending 5 to 6 hours later. Interviews at the docks are used to determine the proportions of boats by trip type (bottom fish or halibut, for example).

- Charter Boat Effort: Charter offices are the primary source for charter boat counts by trip type. Charter boats are also counted as they leave the harbor.

- Average Catch per Boat: Dockside interviews are used to determine average catch per ocean boat by trip type and boat type.

Sampling procedures specify that interviews be conducted randomly and representatively throughout the week. Port samplers do not focus on certain trip types or catch. The overall sampling rate goal is 20 percent, to meet salmon CWT expansion requirements; however, in most ports and for most fisheries, the sampling rate is often higher.

For halibut trips, effort, and harvest in the Central Oregon Coast subarea, the data are further divided into the nearshore and all-depth fisheries, based on the day of the week. All halibut trips and landings occurring on days that the all-depth fishery is open are assigned to the all-depth fishery, regardless of actual depth of fishing or harvest. For the Oregon portions of the halibut estimates in the Columbia River and south of Humbug Mountain subareas, this is not an issue because there is only one season/fishery at a time. Landings estimates from all ports in a subarea and fishery are then combined for the weekly total for that subarea.

Bycatch estimates are reported from ORBS to RecFIN and include a combination of landed and released dead fish from halibut-targeted trips. Bycatch species (including green sturgeon) are reported by the ORBS program.

California

The CDFW recreational sampling program (known as the California Recreational Fisheries Survey (CRFS)), began collecting recreational catch information in 2004. CRFS provides a comprehensive approach to recreational fishery data collection throughout the state, and the information is used to estimate total marine recreational catch and effort in California. It is a coordinated sampling survey designed to gather information for all finfish species, including Pacific halibut, from anglers in all modes of recreational fishing (CDFW 2017). The sampling program provides 20 percent coverage for primary sample sites and 10 percent to secondary sites. One part of the program uses a telephone survey to collect effort data, another part looks at commercial passenger fishing vessel logs, and the last part is field sampling. CRFS samplers intercept anglers on the water or on shore to collect fishing information. Samplers collect data on fishing location and bottom depth during interviews at the dock or onboard the vessel. Samplers record the number, length, and weight (if possible) of fish observed in the catch, along with the angler’s demographic and fishing activity information. In addition, the species, number, and condition of discarded fish (alive or dead), including non-target species, is reported by anglers and recorded.

1.3.4.5. Fishery Enforcement Monitoring

Vessel Monitoring System (VMS) units are a tool used to monitor the location and speed of participants in commercial fisheries along the west coast. Currently, VMS units are required for participants in groundfish fisheries and for boats participating in the directed halibut fishery and salmon troll fishery only if those boats are also retaining federally managed groundfish species.

Enforcement of tribal fishing is conducted by each tribe and generally happens through dockside monitoring of catch. Periodically, the U.S. Coast Guard will use air patrols with a NMFS enforcement officer before a scheduled tribal fishery to monitor activity before the fishery opens.

1.3.5. Changes to the Catch Sharing Plan

As previously mentioned in Section 1.3.1, the long-term CSP framework has been in place since 1995. While there have been annual updates, these changes have been relatively minor. Since 2014, new subareas have been created and allocations reapportioned, and openings changed from dates to days of the week. Other changes include retention of groundfish bycatch species and changes to openings based on inseason management. These are indicative of the types of changes made on an annual basis.

In 2014, new subareas for California and southern Oregon were created, reallocating 2 percent of the Oregon spring all-depth fishery to the Southern Oregon subarea. The 2 percent was increased to 4 percent in 2015 and readjusted to 3.91 percent in 2016, accounting for when Oregon's portion of the Columbia River allocation was removed (in 2015, the Columbia River allocation was removed before the 4 percent allocation to the southern Oregon subarea). California was allocated 1 percent of the non-tribal allocation in 2014, which was increased to 4 percent in 2015 to respond to effort and greater halibut biomass from surveys than in previous years. Three fisheries were created for the Columbia River subarea in 2014: nearshore, an all-depth spring, and an all-depth summer. A 1,500 pound limit or 10 percent of the subarea allocation was set for the nearshore fishery. In 2015, the nearshore limit was lowered to 500 pounds and the early and late season all-depth fisheries were removed in favor of one season. In 2014, California had a set season of May 1 through July 31 and September 1 through October 31, which was changed in 2015 at the introduction of an inseason management program. Also in 2014, the Washington North Coast subarea reworded the opening for the third week of fishing, to be "closed until open" to tally catch and prevent overages. In 2016, the Oregon Central Coast nearshore fishery moved its opening day from July 1 to June 1. Also in 2016, the Washington North Coast subarea was changed from opening on Thursday between May 9 and May 15 to opening on the first Saturday in May. In 2016, retention of some groundfish bycatch was allowed, even in areas closed to groundfish fishing. Oregon modified the wording of the CSP to allow inseason modifications in response to yelloweye rockfish bycatch.

For 2018, there have been several suggested changes (PFMC 2017). Proposed changes to the Plan in 2018 include:

- Keeping the same season days for all Washington subareas and allowing the transfer of quota between the subareas, and for any quota left after the pre-set season has concluded, distributing quota following the CSP allocation structure.
- Splitting the Central Oregon subarea into two subareas, each with its own allocation.
- Revising the amount of incidental halibut allocation caught in the sablefish fishery from 70,000 to 50,000 pounds when the TAC is less than 1.5 million pounds.

A change to the structure of the derby-directed commercial fishery to create a longer season is being discussed by the Council and IPHC for implementation in 2019 or beyond. This change could take many forms, from decreased vessel limits, to caps on number of licenses distributed, to individual or vessel fishing quotas. For reference, the quota fisheries in Alaska and British Columbia, Canada, were open from March 11 to November 7, 2017, with around 50 percent of each region's catch limits landed between late May and mid-September (IPHC 2017d; IPHC 2017e). This potential change has been considered in this opinion.

Changes to the dates or days do not influence the timing of the fishery, and shifts in subarea allocations, incidental retention, or the structure of the directed fishery are not likely to result in shifts in the effort or harvest of halibut, because monitoring of the stock is performed on a weekly basis by state agencies, and its progress discussed by IPHC and NMFS. These types of changes made annually do not compromise the status of ESA-listed species because the effects of these changes do not increase encounters or takes. Information will be obtained annually from agencies and evaluated to determine if reinitiation of consultation is necessary. This biological opinion is in effect for the next 5 years (through the year 2022), or will be reinitiated if new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously consideredin this opinion before the 5-year period has ended.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, federal action agencies consult with NMFS, and section 7(b)(3) requires that at the conclusion of consultation NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

NMFS has determined that the Proposed Action will have no effect on southern eulachon or its critical habitats.[3] The proposed action is also not likely to adversely affect marine mammals, sea turtles, or their critical habitats, nor is it likely to adversely affect green sturgeon critical habitat. These determinations are documented in Section 2.12, "Not Likely to Adversely Affect" Determinations.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 C.F.R. § 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214, February 11, 2016).

The designations of critical habitat for the species listed above use the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414, February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

[3] The action area of the proposed action does not overlap with designated critical habitat of eulachon, and eulachon are not encountered in recreational or commercial fisheries that target halibut.

We use the following approach to determine whether a Proposed Action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.
- Analyze the effects of the Proposed Action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat, and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the Proposed Action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the Proposed Action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 C.F.R. § 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

2.2.1. Status of Listed Species

As discussed in more detail in section 2.12, "Not Likely to Adversely Affect Determinations," NMFS concludes that the salmon ESUs likely to be adversely affected by the Proposed Action are Puget Sound Chinook salmon, LCR Chinook salmon, LCR coho salmon, and Snake River fall Chinook salmon. The discussion of the species status and subsequent sections for salmon is therefore limited to those four ESUs.

For Pacific salmon and steelhead, NMFS commonly uses four parameters to assess the viability of the populations that, together, constitute the species: spatial structure, diversity, abundance, and productivity (McElhany et al. 2000). These "viable salmonid population" (VSP) criteria therefore encompass the species' "reproduction, numbers, or distribution" as described in 50 C.F.R. § 402.02. When these parameters are collectively at appropriate levels, they maintain a population's capacity to adapt to various environmental conditions and allow it to sustain itself in the natural environment. These attributes are influenced by survival, behavior, and experiences throughout a species' entire life cycle, and these characteristics, in turn, are influenced by habitat and other environmental conditions.

"Spatial structure" refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. A population's spatial structure depends fundamentally on habitat quality and spatial configuration and the dynamics and dispersal characteristics of individuals in the population.

"Diversity" refers to the distribution of traits within and among populations. These range in scale from DNA sequence variation at single genes to complex life history traits (McElhany et al. 2000).

"Abundance" generally refers to the number of naturally produced adults (i.e., the progeny of naturally spawning parents) in the natural environment (e.g., on spawning grounds).

"Productivity," as applied to viability factors, refers to the entire life cycle or portions of a life cycle; i.e., the number of progeny or naturally spawning adults produced per parent. When progeny replace or exceed the number of parents, a population is stable or increasing. When progeny fail to replace the number of parents over a period of time (e.g., a generation), the population is declining. McElhany et al. (2000) use the terms "population growth rate" and "productivity" interchangeably when referring to production over the entire life cycle. They also refer to "trend in abundance," which is the manifestation of long-term population growth rate.

For species with multiple populations, once the biological status of a species' populations has been determined, NMFS assesses the status of the entire species using criteria for groups of populations, as described in recovery plans, guidance documents from technical recovery teams, and regional guidance. Considerations for species viability include having multiple populations that are viable, ensuring that populations with unique life histories and phenotypes are viable, and that some viable populations are both widespread to avoid concurrent extinctions from mass catastrophes and spatially close to allow functioning as metapopulations (McElhany et al. 2000).

One factor affecting the status of salmonids, rockfish, and aquatic habitat at large is climate change. The following section describes climate change and other ecosystem effects on the action area.

Climate Change and Other Ecosystem Effects

Changes in global climate affect ESA-listed stocks occurring in the action area. This section is summarized, and more detail can be found in, the 2017 halibut biological opinion (NMFS 2017a). Anthropogenic influences on climate as well as projections of climate change over the next century are anticipated to continue. Recent warming bears the signature of rising concentrations of greenhouse gas emissions and it is anticipated that the 30-year average temperature in the Northern Hemisphere is now higher than it has been over the past 1,400 years (IPCC 2013; Melillo et al. 2014). In addition, there is high certainty that ocean acidity has increased with a drop in pH of 0.1 (NWFSC 2015).

Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distributions and abundances of marine and anadromous fishes, including federally listed species considered in this opinion. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state of

Washington (Battin et al. 2007; ISAB 2007). While the intensity of effects will vary by region (ISAB 2007), climate change is generally expected to alter aquatic habitat (water yield, peak flows, and stream temperature). As climate change alters the structure and distribution of rainfall, snowpack, and glaciations, each factor will in turn alter riverine hydrographs. Given the increasing certainty that climate change is occurring and is accelerating (Battin et al. 2007), NMFS anticipates salmonid habitats will be affected and this in turn is likely to affect the distribution and productivity of salmon populations in the region (Beechie et al. 2006). Climate and hydrology models project substantial reductions in both total snow pack and low-elevation snow pack in the Pacific Northwest over the next 50 years (Mote and Salathé 2009)—changes that will shrink the extent of the snowmelt-dominated habitat available to salmon. Changes may restrict our ability to conserve diverse salmon and steelhead life histories and make recovery targets for these salmon populations more difficult to achieve.

The potential for climate change to increase water temperatures and impact flow rates in freshwater, estuarine, and ocean habitats could affect green sturgeon's spawning and recruitment success, depending on the magnitude and timing of the potential changes. Similar to other sturgeon species, water temperatures and flow rates are important factors influencing green sturgeon spawning and recruitment success. Subadult and adult Southern DPS green sturgeon use ocean habitats for migration and potentially for feeding. Based on their use of coastal bay and estuarine habitats, subadults and adults can occupy habitats with a wide range of temperature, salinity, and dissolved oxygen levels (Kelly et al. 2007; Moser and Lindley 2007). Thus, it is not clear how changing ocean conditions because of climate change may affect Southern DPS green sturgeon and its habitat.

The impact of climate change on Puget Sound yelloweye and bocaccio rockfish is discussed in detail below.

2.2.1.1. Status of Puget Sound/Georgia Basin Rockfish

Detailed assessments of yelloweye rockfish and bocaccio can be found in the recovery plan (NMFS 2017c) and the 5-year status review (Tonnes et al. 2016), and are summarized here. We describe the status of yelloweye rockfish and bocaccio with nomenclature referring to specific areas of Puget Sound. Puget Sound is the second largest estuary in the United States, located in northwest Washington State and covering an area of about 900 square miles (2,330 square km), including 2,500 miles (4,000 km) of shoreline. Puget Sound is part of a larger inland waterway, the Georgia Basin, situated between southern Vancouver Island, British Columbia, Canada, and the mainland coast of Washington State. We subdivide the Puget Sound into five interconnected basins because of the presence of shallow areas called sills: (1) the San Juan/Strait of Juan de Fuca Basin (also referred to as "North Sound"), (2) Main Basin, (3) Whidbey Basin, (4) South Sound, and (5) Hood Canal. We use the term "Puget Sound proper" to refer to all of these basins except the San Juan/Strait of Juan de Fuca Basin.

The Puget Sound/Georgia Basin Distinct Population Segments (DPS) of yelloweye rockfish is listed under the ESA as threatened, and bocaccio are listed as endangered (75 FR 22276, April 28, 2010). On January 23, 2017, we issued a final rule to remove the Puget Sound/Georgia Basin canary rockfish (*Sebastes pinniger*) DPS from the Federal List of Threatened and Endangered Species and remove its critical habitat designation. We proposed these actions based on newly obtained samples and genetic analysis that demonstrates that the Puget Sound/Georgia Basin canary rockfish population does not meet the DPS criteria and therefore does not qualify for listing under the Endangered Species Act. Within the same rule, we extended the yelloweye rockfish DPS area further north in the Johnstone Strait area of Canada, as reflected in Figure 2-1. This extension was also the result of new genetic analysis of yelloweye rockfish. The final rule was effective March 24, 2017.

The DPSs include all yelloweye rockfish and bocaccio found in waters of Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill (Figure 2-1 and Figure 2-2). Yelloweye rockfish and bocaccio are 2 of 28 species of rockfish in Puget Sound (Palsson et al. 2009).

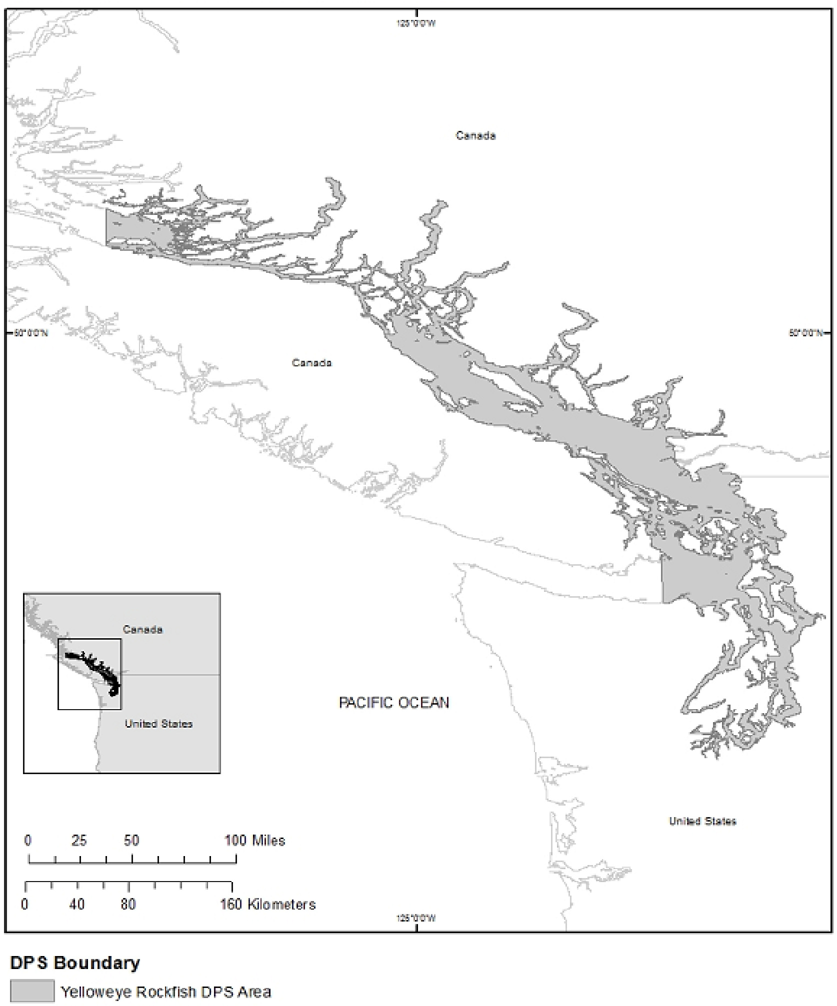

Figure 2-1. Yelloweye rockfish DPS area.

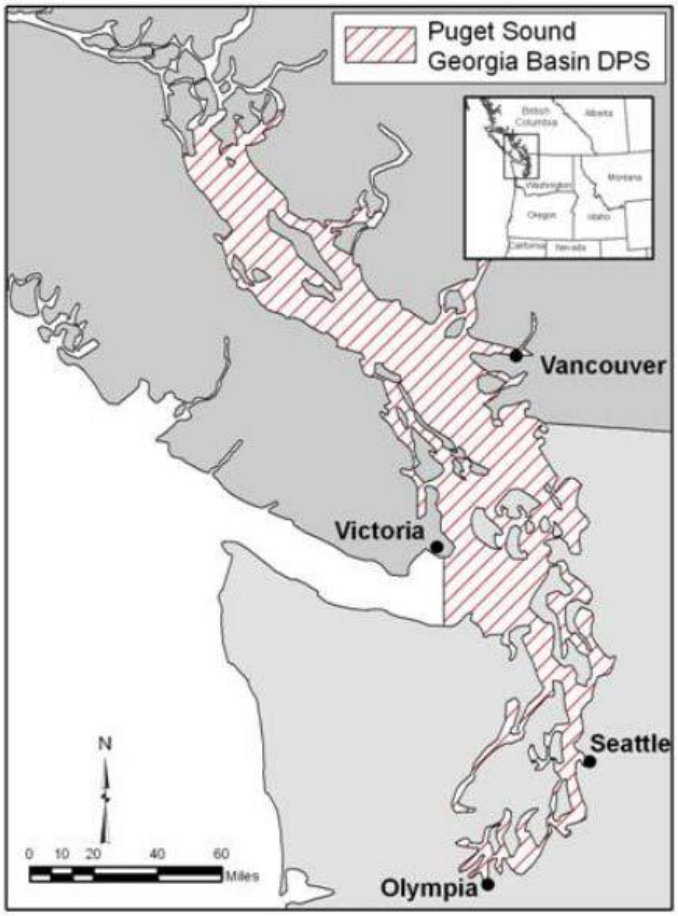

Figure 2-2. Bocaccio DPS area.

The life histories of yelloweye rockfish and bocaccio include a larval/pelagic juvenile stage followed by a juvenile stage, and subadult and adult stages. Much of the life history and habitat use for these two species is similar, with important differences noted below. Rockfish fertilize their eggs internally and the young are extruded as larvae. Individual mature female yelloweye rockfish and bocaccio produce from several thousand to over a million eggs each breeding cycle (Love et al. 2002). Larvae can make small local movements to pursue food immediately after birth (Tagal et al. 2002), but are likely initially passively distributed with prevailing currents until they are large enough to progress toward preferred habitats. Larvae are observed under free-floating algae, seagrass, and detached kelp (Love et al. 2002; Shaffer et al. 1995), but are also distributed throughout the water column (Weis 2004). Unique oceanographic conditions within Puget Sound proper likely result in most larvae staying within the basin where they are released (e.g., the South Sound) rather than being broadly dispersed (Drake et al. 2010).

When bocaccio reach sizes of 1 to 3.5 inches (3 to 9 centimeters (cm)) (approximately 3 to 6 months old), they settle onto shallow nearshore waters in rocky or cobble substrates with or without kelp (Love et al. 1991, 2002). These habitat features offer a beneficial mix of warmer temperatures, food, and refuge from predators (Love et al. 1991). Areas with floating and submerged kelp species support the highest densities of most juvenile rockfish (Carr 1983; Halderson and Richards 1987; Hayden-Spear 2006; Matthews 1989). Unlike bocaccio, juvenile yelloweye rockfish do not typically occupy intertidal waters (Love et al. 1991; Studebaker et al. 2009), but settle in 98 to 131 feet (30 to 40 m) of water near the upper depth range of adults (Yamanaka and Lacko 2001).

Subadult and adult yelloweye rockfish and bocaccio typically utilize habitats with moderate to extreme steepness, complex bathymetry, and rock and boulder-cobble complexes (Love et al. 2002). Within Puget Sound proper, each species has been documented in areas of high relief rocky and non-rocky substrates such as sand, mud, and other unconsolidated sediments (Miller and Borton 1980; Washington 1977). Yelloweye rockfish remain near the bottom and have small home ranges, while bocaccio have larger home ranges, move long distances, and spend time suspended in the water column (Love et al. 2002). Adults of each species are most commonly found between 131 to 820 feet (40 to 250 m) (Love et al. 2002; Orr et al. 2000).

Yelloweye rockfish are one of the longest-lived of the rockfishes, with some individuals reaching more than 100 years of age. They reach 50 percent maturity at sizes around 16 to 20 inches (40 to 50 cm) and ages of 15 to 20 years (Rosenthal et al. 1982; Yamanaka and Kronlund 1997). The maximum age of bocaccio is unknown, but may exceed 50 years, and they reach reproductive maturity near age 6 (FishBase 2010).

In the following section, we summarize the condition of yelloweye rockfish and bocaccio at the DPS level according to the following demographic viability criteria: abundance and productivity, spatial structure/connectivity, and diversity. These viability criteria are outlined in McElhaney et al. (2000) and reflect concepts that are well founded in conservation biology and are generally applicable to a wide variety of species. These criteria describe demographic risks that individually and collectively provide strong indicators of extinction risk (Drake et al. 2010). There are several common risk factors detailed below at the introduction of each of the viability criteria for each listed rockfish species. Habitat and species limiting factors can affect abundance, spatial structure and diversity parameters, and are described.

Abundance and Productivity

There is no single reliable historical or contemporary population estimate for the yelloweye rockfish or bocaccio within the full range of the Puget Sound/Georgia Basin DPSs (Drake et al. 2010). Despite this limitation, there is clear evidence each species' abundance has declined dramatically (Drake et al. 2010). Analysis of SCUBA surveys, recreational catch, and WDFW trawl surveys indicated total rockfish populations in the Puget Sound region are estimated to have declined between 3.1 and 3.8 percent per year for the past several decades, which corresponds to a 69 to 76 percent decline from 1977 to 2014 (Tonnes et al. 2016).

Catches of yelloweye rockfish and bocaccio have declined as a proportion of the overall rockfish catch (Drake et al. 2010; Palsson et al. 2009). Yelloweye rockfish were 2.4 percent of the harvest in North Sound during the 1960s, occurred in 2.1 percent of the harvest during the 1980s, but then decreased to an average of 1 percent from 1996 to 2002 (Palsson et al. 2009). In Puget Sound proper, yelloweye rockfish were 4.4 percent of the harvest during the 1960s, only 0.4 percent during the 1980s, and 1.4 percent from 1996 to 2002 (Palsson et al. 2009).

Bocaccio consisted of 8 to 9 percent of the overall rockfish catch in the late 1970s and declined in frequency, relative to other species of rockfish, from the 1970s to the 1990s (Drake et al. 2010). From 1975 to 1979, bocaccio averaged 4.6 percent of the catch. From 1980 to 1989, they were 0.2 percent of the 8,430 rockfish identified (Palsson et al. 2009). In the 1990s and early 2000s, bocaccio were not observed by WDFW in the dockside surveys of the recreational catches (Drake et al. 2010).

Productivity is the measurement of a population's growth rate through all or a portion of its life cycle. Life history traits of yelloweye rockfish and bocaccio suggest generally low levels of inherent productivity because they are long-lived, mature slowly, and have sporadic episodes of successful reproduction (Drake et al. 2010; Tolimieri and Levin 2005). Overfishing can have dramatic impacts on the size or age structure of the population, with effects that can influence ongoing productivity. When the size and age of females decline, there are negative impacts on reproductive success. These impacts, termed maternal effects, are evident in a number of traits. Larger and older females of various rockfish species have a higher weight-specific fecundity (number of larvae per unit of female weight) (Bobko and Berkeley 2004; Boehlert et al. 1982; Sogard et al. 2008). A consistent maternal effect in rockfishes relates to the timing of parturition. The timing of larval birth can be crucial in terms of corresponding with favorable oceanographic conditions because most larvae are released typically once annually, with a few exceptions in southern coastal populations and in yelloweye rockfish in Puget Sound (Washington et al. 1978). Several studies of rockfish species have shown that larger or older females release larvae earlier in the season compared to smaller or younger females (Nichol and Pikitch 1994; Sogard et al. 2008). Larger or older females provide more nutrients to larvae by developing a larger oil globule released at parturition, which provides energy to the developing larvae (Berkeley et al. 2004; Fisher et al. 2007), and in black rockfish enhances early growth rates (Berkeley et al. 2004).

Contaminants such as polychlorinated biphenyls (PCBs), polybrominated diphenyl ethers (PBDEs), and chlorinated pesticides appear in rockfish collected in urban areas (Palsson et al. 2009). While the highest levels of contamination occur in urban areas, toxins can be found in the tissues of fish throughout Puget Sound (West et al. 2001). Although few studies have investigated the effects of toxins on rockfish ecology or physiology, other fish in the Puget Sound region that have been studied do show a substantial impact, including reproductive dysfunction of some sole species (Landahl et al. 1997). Reproductive function of rockfish is also likely affected by contaminants (Palsson et al. 2009) and other life history stages may be affected as well (Drake et al. 2010).

Future climate-induced changes to rockfish habitat could alter their productivity (Drake et al. 2010). Harvey (2005) created a generic bioenergetic model for rockfish, showing that their productivity is highly influenced by climate conditions. For instance, El Niño-like conditions generally lowered growth rates and increased generation time. The negative effect of the warm water conditions associated with El Niño appear to be common across rockfishes (Moser et al. 2000). Recruitment of all species of rockfish appears to be correlated at large scales. Field and Ralston (2005) hypothesized that such synchrony was the result of large-scale climate forcing. Exactly how climate influences rockfish in Puget Sound is unknown; however, given the general importance of climate to rockfish recruitment, it is likely that climate strongly influences the dynamics of listed rockfish population viability (Drake et al. 2010), although the consequences of climate change to rockfish productivity during the course of the Proposed Action will likely be small.

Yelloweye Rockfish Abundance and Productivity

Yelloweye rockfish within the Puget Sound/Georgia Basin (in U.S. waters) are very likely the most abundant within the San Juan Basin. The San Juan Basin has the most suitable rocky benthic habitat (Palsson et al. 2009) and historically was the area of greatest numbers of angler catches (Moulton and Miller 1987; Olander 1991).

Productivity for yelloweye rockfish is influenced by long generation times that reflect intrinsically low annual reproductive success. Natural mortality rates have been estimated from 2 to 4.6 percent (Yamanaka and Kronlund 1997; Wallace 2007). Productivity may also be particularly impacted by Allee effects, which occur as adults are removed by fishing and the density and proximity of mature fish decreases. Adult yelloweye rockfish typically occupy relatively small ranges (Love et al. 2002) and it is unknown the extent they may move to find suitable mates.

In Canada, yelloweye rockfish biomass is estimated to be 12 percent of the unfished stock size on the inside waters of Vancouver Island (DFO 2011). There are no analogous biomass estimates in the U.S. portion of the yelloweye rockfish DPS. However, WDFW has generated several population estimates of yelloweye rockfish in recent years. Remotely Operated Vehicle (ROV) surveys in the San Juan Island region in 2008 (focused on rocky substrate) and 2010 (across all habitat types) estimated a population of 47,407±11,761 and 114,494±31,036 individuals, respectively. A 2015 ROV survey of that portion of the DPSs south of the entrance to Admiralty Inlet encountered 35 yelloweye rockfish, producing a preliminary population estimate of 66,998±7,370 individuals (final video review is still under way) (WDFW 2017).

Bocaccio Abundance and Productivity

Bocaccio in the Puget Sound/Georgia Basin were historically most common within the South Sound and Main Basin (Drake et al. 2010). Though bocaccio were never a predominant segment of the multi-species rockfish abundance within the Puget Sound/Georgia Basin (Drake et al. 2010), their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Bocaccio abundance may be very low in large segments of the Puget Sound/Georgia Basin. Productivity is driven by high fecundity and episodic recruitment events, largely correlated with environmental conditions. Thus, bocaccio populations do not follow consistent growth trajectories and sporadic recruitment drives population structure (Drake et al. 2010).

Natural annual mortality is approximately 8 percent (Palsson et. al 2009). Tolimieri and Levin (2005) found that the bocaccio population growth rate is around 1.01, indicating a very low intrinsic growth rate for this species. Demographically, this species demonstrates some of the highest recruitment variability among rockfish species, with many years of failed recruitment being the norm (Tolimieri and Levin 2005). Given their severely reduced abundance, Allee effects may be particularly acute for bocaccio, even considering the propensity of some individuals to move long distances and potentially find mates.

In Canada, the median estimate of bocaccio biomass is 3.5 percent of its unfished stock size (though this included Canadian waters outside of the DPS's area) (Stanley et al. 2012). There are no analogous biomass estimates in the U.S. portion of the bocaccio DPS. However, The ROV survey of the San Juan Islands in 2008 estimated a population of 4,606±4,606 (based on four fish observed along a single transect), but no estimate could be obtained in the 2010 ROV survey because this species was not encountered. A single bocaccio encountered in the 2015 ROV survey produced a statistically invalid population estimate for that portion of the DPS lying south of the entrance to Admiralty Inlet and east of Deception Pass. Several bocaccio have been caught in genetic surveys and by recreational anglers in Puget Sound proper in the past several years.

In summary, though abundance and productivity data for yelloweye rockfish and bocaccio is relatively imprecise, both abundance and productivity have been reduced largely by fishery removals within the range of each Puget Sound/Georgia Basin DPSs.

Spatial Structure and Connectivity

Spatial structure consists of a population's geographical distribution and the processes that generate that distribution (McElhaney et al. 2000). A population's spatial structure depends on habitat quality, spatial configuration, and dynamics as well as dispersal characteristics of individuals within the population (McElhaney et al. 2000). Prior to contemporary fishery removals, each of the major basins in the range of the DPSs likely hosted relatively large populations of yelloweye rockfish and bocaccio (Moulton and Miller 1987; Washington 1977; Washington et al. 1978). This distribution allowed each species to utilize the full suite of available habitats to maximize their abundance and demographic characteristics, thereby enhancing their resilience (Hamilton 2008). This distribution also enabled each species to potentially exploit ephemerally good habitat conditions, or in turn receive protection from smaller-scale and negative environmental fluctuations. These types of fluctuations may change prey abundance for various life stages and/or may change environmental characteristics that influence the number of annual recruits. Spatial distribution also provides a measure of protection from larger scale anthropogenic changes that damage habitat suitability, such as oil spills or hypoxia that can occur within one basin but not necessarily the other basins. Rockfish population resilience is sensitive to changes in connectivity among various groups of fish (Hamilton 2008). Hydrologic connectivity of the basins of Puget Sound is naturally restricted by relatively shallow sills located at Deception Pass, Admiralty Inlet, the Tacoma Narrows, and in Hood Canal (Burns 1985). The Victoria Sill bisects the Strait of Juan de Fuca and runs from east of Port Angeles north to Victoria, and regulates water exchange (Drake et al. 2010). These sills regulate water exchange from one basin to the next, and thus likely moderate the movement of rockfish larvae (Drake et al. 2010). When localized depletion of rockfish occurs, it can reduce stock resiliency (Hamilton 2008; Hilborn et al. 2003). The effects of localized depletions of rockfish are likely exacerbated by the natural hydrologic constrictions within Puget Sound.

Yelloweye Rockfish Spatial Structure and Connectivity

Yelloweye rockfish spatial structure and connectivity is threatened by the reduction of fish within each basin. This reduction is likely most acute within the basins of Puget Sound proper.

Yelloweye rockfish are probably most abundant within the San Juan Basin, but the likelihood of juvenile recruitment from this basin to the adjacent basins of Puget Sound proper is naturally low because of the generally retentive circulation patterns that occur within each of the major basins of Puget Sound proper.

Bocaccio Spatial Structure and Connectivity

Most bocaccio may have been historically spatially limited to several basins. They were historically most abundant in the Main Basin and South Sound (Drake et al. 2010) with no documented occurrences in the San Juan Basin until 2008 (WDFW 2011a). Positive signs for spatial structure and connectivity come from the propensity of some adults and pelagic juveniles to migrate long distances, which could re-establish aggregations of fish in formerly occupied habitat (Drake et al. 2010). The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further impairment in the historically spatially limited distribution of bocaccio, and adds risk to the viability of the DPS.

In summary, spatial structure and connectivity for each species have been adversely impacted, mostly by fishery removals. These impacts on species viability are likely most acute for yelloweye rockfish because of their sedentary nature as adults.

Diversity

Characteristics of diversity for rockfish include fecundity, timing of the release of larvae and their condition, morphology, age at reproductive maturity, physiology, and molecular genetic characteristics. In spatially and temporally varying environments, there are three general reasons why diversity is important for species and population viability: (1) diversity allows a species to use a wider array of environments, (2) diversity protects a species against short-term spatial and temporal changes in the environment, and (3) genetic diversity provides the raw material for surviving long-term environmental changes.

Yelloweye Rockfish Diversity

Yelloweye rockfish size and age distributions have been truncated (Figure 2-3). Recreationally caught yelloweye rockfish in the 1970s spanned a broad range of sizes. By the 2000s, there was some evidence of fewer older fish in the population (Drake et al. 2010). No adult yelloweye rockfish have been observed within the WDFW ROV surveys and all observed fish in 2008 in the San Juan Basin were less than 8 inches long (20 cm) (Pacunski et al 2013). Since these fish were observed several years ago, they are likely bigger (Pacunski et al. (2013) did not report a precise size for these fish; thus, we are unable to provide a precise estimate of their likely size now). As a result, the reproductive burden may be shifted to younger and smaller fish. This shift could alter the timing and condition of larval release, which may be mismatched with habitat conditions within the range of the DPS, potentially reducing the viability of offspring (Drake et al. 2010). Recent genetic information for yelloweye rockfish further confirmed the existence of fish genetically differentiated within the Puget Sound/Georgia Basin compared to the outer coast (NMFS 2016a) and that yelloweye rockfish in Hood Canal are genetically divergent from the rest of the DPS. Yelloweye rockfish in Hood Canal are addressed as a separate population in the recovery plan (NMFS 2017c).

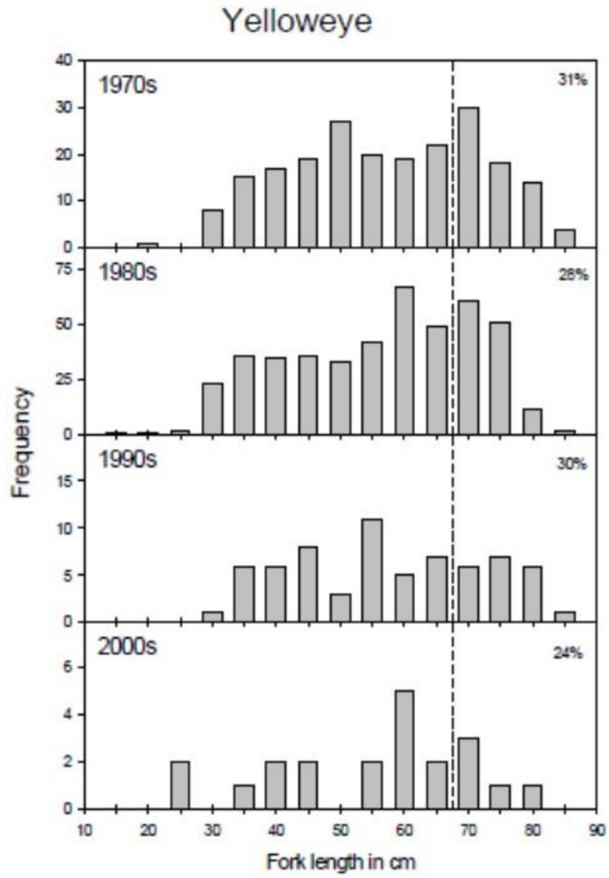

Figure 2-3. Yelloweye rockfish length frequency distributions (cm) binned within four decades.

Bocaccio Diversity

Size-frequency distributions for bocaccio in the 1970s indicate a wide range of sizes, with recreationally caught individuals from 9.8 to 33.5 inches (25 to 85 cm) (Figure 2-4). This broad size distribution suggests a spread of ages, with some successful recruitment over many years. A similar range of sizes is also evident in the 1980s' catch data. The temporal trend in size distributions for bocaccio also suggests size truncation of the population, with larger fish becoming less common over time. By the decade of the 2000s, no size distribution data for bocaccio were available. Bocaccio in the Puget Sound/Georgia Basin may have physiological or behavioral adaptations because of the unique habitat conditions in the range of the DPS. The potential loss of diversity in the bocaccio DPS, in combination with their relatively low productivity, may result in a mismatch with habitat conditions and further reduce population viability (Drake et al. 2010).

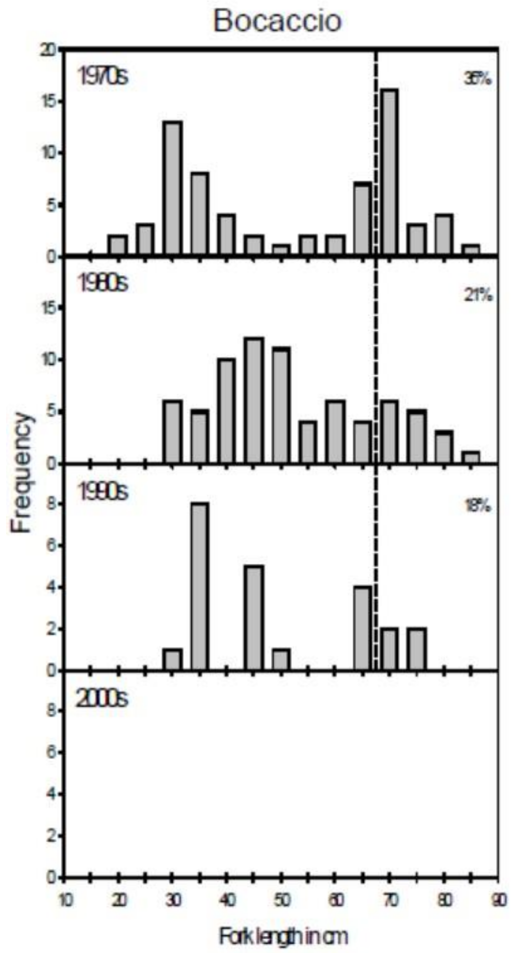

Figure 2-4. Bocaccio length frequency distributions (cm) within four decades. The vertical line depicts the size at which about 30 percent of the population comprised fish larger than the rest of the population in the 1970s, as a reference point for a later decade.

In summary, diversity for each species has likely been adversely impacted by fishery removals. In turn, the ability of each fish to utilize habitats within the action area may be compromised.

Limiting Factors

Climate Change and Other Ecosystem Effects

As reviewed in ISAB (2007), average annual Northwest air temperatures have increased by approximately 1.8°F (1°C) since 1900, which is nearly twice that for the previous 100 years, indicating an increasing rate of change. Summer temperatures, under the A1B emissions scenario (a "medium" warming scenario), are expected to increase 3°F (1.7°C) by the 2020s and 8.5°F (4.7°C) by 2080 relative to the 1980s in the Pacific Northwest (Mantua et al. 2010). This change in surface temperature has already modified, and is likely to continue to modify, marine habitats of listed rockfish. There is still a great deal of uncertainty associated with predicting specific changes in timing, location, and magnitude of future climate change.

As described in ISAB (2007), climate change effects that have, and will continue to, influence the habitat, include increased ocean temperature, increased stratification of the water column, and intensity and timing changes of coastal upwelling. These continuing changes will alter primary and secondary productivity, marine community structures, and in turn may alter listed rockfish growth, productivity, survival, and habitat usage. Increased concentration of CO2 (termed Ocean Acidification, or OA) reduces carbonate availability for shell-forming invertebrates. Ocean acidification will adversely affect calcification, or the precipitation of dissolved ions into solid calcium carbonate structures, for a number or marine organisms, which could alter trophic functions and the availability of prey (Feely et al. 2010). Further research is needed to understand the possible implications of OA on trophic functions in Puget Sound to understand how they may affect rockfish. Thus far, studies conducted in other areas have shown that the effects of OA will be variable (Ries et al. 2009) and species-specific (Miller et al. 2009).

There have been very few studies to date on the direct effect OA may have on rockfish. In a laboratory setting OA has been documented to affect rockfish behavior (Hamilton et al. 2014). Fish behavior changed markedly after juvenile Californian rockfish (*Sebastes diploproa*) spent one week in seawater with the OA conditions that are projected for the next century in the California shore. Researchers characterized the behavior as "anxiety" as the fish spent more time in unlighted environments compared to the control group. Research conducted to understand adaptive responses to OA on other marine organisms has shown that although some organisms may be able to adjust to OA to some extent, these adaptations may reduce the organism's overall fitness or survival (Wood et al. 2008). More research is needed to further understand rockfish-specific responses and possible adaptations to OA.

There are natural biological and physical functions in regions of Puget Sound, especially in Hood Canal and South Sound, that cause the water to be corrosive and hypoxic, such as restricted circulation and mixing, respiration, and strong stratification (Newton and Van Voorhis 2002; Feely et al. 2010). However, these natural conditions, typically driven by climate forcing, are exacerbated by anthropogenic sources such as OA, nutrient enrichment, and land-use changes (Feely et al. 2010). By the next century, OA will increasingly reduce pH and saturation states in Puget Sound (Feely et al. 2010). Areas in Puget Sound susceptible to naturally occurring hypoxic and corrosive conditions are also the same areas where low seawater pH occurs, compounding the conditions of these areas (Feely et al. 2010).

<u>Commercial and Recreational Bycatch</u>

Listed rockfish are caught in some recreational and commercial fisheries in Puget Sound. This bycatch is described in Section 2.4.4.1. In addition, NMFS permits limited take of listed rockfish for scientific research purposes. This take is also described in Section 2.7.1, Puget Sound/Georgia Basin Rockfish.

Other Limiting Factors

The yelloweye rockfish DPS abundance is much lower than it was historically. The fish face several threats, including bycatch in some commercial and recreational fisheries, non-native species introductions, and habitat degradation. NMFS has determined that this DPS is likely to be in danger of extinction in the foreseeable future throughout all of its range.

The bocaccio DPS exists at very low abundance and observations are relatively rare. Their low intrinsic productivity, combined with continuing threats from bycatch in commercial and recreational harvest, non-native species introductions, loss and degradation of habitat, and chemical contamination, increase the extinction risk. NMFS has determined that this DPS is currently in danger of extinction throughout all of its range.

In summary, despite some limitations on our knowledge of past abundance and specific current viability parameters, characterizing the viability of yelloweye rockfish and bocaccio includes their severely reduced abundance from historical times, which in turn hinders productivity and diversity. Spatial structure for each species has also likely been compromised because of a probable reduction of mature fish of each species distributed throughout their historical range within the DPSs (Drake et al. 2010).

2.2.1.2. Status of Southern DPS Green Sturgeon

NMFS listed the Southern DPS of North American green sturgeon (Southern DPS green sturgeon) as threatened under the ESA in 2006 (71 FR 17757, April 7, 2006). In this section, we summarize the status of Southern DPS green sturgeon throughout its range, based on the most recent 5-year status review (NMFS 2015a) and the draft recovery plan.

Because of the limited information available on the population's historical and current abundance, spatial structure, productivity, and diversity, there is a high level of uncertainty regarding the species' viability. However, the best available information indicates that Southern DPS green sturgeon are at moderate risk of extinction based on the low estimated adult abundance and restriction of spawning to one segment of the mainstem Sacramento River and lower Feather River (only a portion of the species' potential historical spawning habitat), which have likely also compromised the species' productivity and diversity.

Description and Geographic Range

The green sturgeon is an anadromous, long-lived, and bottom-oriented (demersal) fish species in the family Acipenseridae. The maximum age of adult green sturgeon is likely to range from 60 to 70 years, and adults may exceed 6.5 feet (2 m) in length and 198 pounds (90 kg) in weight.

Based on genetic analyses and spawning site fidelity (Adams et al. 2002; Israel et al. 2004), NMFS determined that the green sturgeon includes at least two DPSs: a northern DPS consisting of populations originating from coastal watersheds northward of and including the Eel River (Northern DPS green sturgeon), with spawning confirmed in the Klamath and Rogue River systems; and a southern DPS consisting of populations originating from coastal watersheds south of the Eel River (Southern DPS green sturgeon), with spawning confirmed in the Sacramento River system. Recent genetic analysis of samples from five non-juvenile green sturgeon collected in the Eel River confirms the Northern DPS assignment (Anderson et al. 2017). A recent study further suggests a spawning population in the Eel River (Stillwater Sciences and Wiyot Tribe Natural Resources Department 2017). In 2006, NMFS listed the Southern DPS green sturgeon as threatened under the ESA, but determined that ESA listing for Northern DPS green sturgeon was not warranted, maintaining the Northern DPS on the NMFS Species of Concern list instead. Because the ESA-listed entity (Southern DPS green sturgeon) and non-ESA listed entity (Northern DPS green sturgeon) co-occur throughout much of their range, most of the information presented here is general to green sturgeon. Where available, we provide information specific to Southern DPS green sturgeon.

Green sturgeon range from the Bering Sea, Alaska, to Ensenada, Mexico, use a diversity of habitat types at different life stages, and are one of the most marine-oriented sturgeons. Subadult green sturgeon (sexually immature fish that have entered coastal marine waters) spend several years at sea before reaching reproductive maturity and returning to fresh water to spawn for the first time (Nakamoto et al. 1995). After migrating out of their natal rivers, subadult green sturgeon move between coastal waters and various estuaries along the U.S. West Coast between San Francisco Bay, California, and Grays Harbor, Washington (Lindley et al. 2008; Lindley et al. 2011). Migration patterns differ among individuals within and among populations (Lindley et al. 2011). Green sturgeon form dense aggregations in multiple rivers and estuaries (e.g., lower Columbia River estuary, Willapa Bay, Grays Harbor) during summer months (Moser and Lindley 2007). Winter months are generally spent in the coastal ocean, with many green sturgeon migrating to northern waters in the fall. Green sturgeon occur in areas north of Vancouver Island in winter, with Queen Charlotte Sound and Hecate Strait likely destinations based on observed depth and temperature preferences and detections of acoustically tagged green sturgeon at the northern end of Vancouver Island (Lindley et al. 2008; Nelson et al. 2010). Peak migration rates exceeded 31 miles (50 km) per day during the spring southward migration (Lindley et al. 2008).

Relatively little is known about how green sturgeon use habitats in the coastal ocean and in estuaries, or the purpose of their episodic aggregations (Lindley et al. 2008; Lindley et al. 2011). Studies using pop-off archival tags (satellite tags) indicate that, while in the ocean, green sturgeon occur between 0- and 656-foot (0 and 200 m) depths, but spend most of their time between 65 to 262 feet (20 to 80 m) in water temperatures of 9.5 to 16.0°C (Erickson and Hightower 2007; Huff et al. 2011). They are generally demersal, but make occasional forays to surface waters, perhaps to assist their migration (Kelly et al. 2007). Telemetry data in coastal ocean habitats suggest that green sturgeon spent a longer duration in areas with high seafloor complexity, especially where a greater proportion of the substrate consists of boulders (Huff et al. 2011). However, while in estuaries where green sturgeon feed over the bottom on benthic invertebrates (Dumbauld et al. 2008), they do not appear to use hard substrates. Data from feeding pit mapping surveys conducted in Willapa Bay, Washington, showed densities were highest over shallow intertidal mud flats and lowest in subtidal areas over sand and in dense stands of non-indigenous seagrasses (Moser et al. 2017). Telemetry data indicates that, in their natal rivers, mature green sturgeon prefer deep pools, presumably for spawning and conserving/restoring energy (Erickson and Webb 2007; Heublein et al. 2009). Similar tracking studies involving juvenile green sturgeon are currently underway (Klimley et al. 2015a).

After maturity is reached at approximately 15 years of age and 150 cm total length, the Southern DPS typically spawns every 3 to 4 years (range 2 to 6 years) (Brown 2007; NMFS 2015a). Adult Southern DPS spawn in the Sacramento River primarily from April through early July, with peaks of activity likely influenced by factors including water flow and temperature (Heublein et al. 2009; Poytress et al. 2011, 2015). Southern DPS spawning primarily occurs in cool sections of the upper mainstem Sacramento River in deep pools containing small to medium sized gravel, cobble, or boulder substrate (Klimley et al. 2015b; Poytress et al. 2015). Eggs primarily adhere to gravel or cobble substrates, or settle into crevices (Van Eenennaam et al. 2001; Poytress et al. 2011). Eggs hatch after 6 to 8 days, and larval feeding begins 10 to 15 days post-hatch; larval development is completed within 45 days at 2.36 to 3.15 inches (60 to 80 mm) total length (TL) (Beamesderfer et al. 2007). After rearing in fresh water or the estuary of their natal river for 1 to 4 years, juvenile green sturgeon transition to the subadult stage and move from estuarine waters into coastal waters. Results from Klimley et al. (2015a) suggest that some individuals in the Southern DPS may enter the ocean and transition to the subadult life stage in their first year, but typical length of fish encountered in the ocean (>600-mm TL) suggests ocean entry occurs at a later age. Mature adults of the Northern DPS enter their natal rivers in the spring and typically leave the river during the subsequent autumn when water temperatures drop below 10°C and flows increase (Benson et al. 2007; Erickson and Webb 2007). Thereafter, they migrate among the coastal ocean and estuarine habitats before returning again to spawn 2 to 4 years later (Erickson and Webb 2007).

Genetic and acoustic tagging data indicate little migration between spawning areas of the Northern and Southern DPSs, although they co-occur in non-natal marine and estuarine habitats to varying degrees (Israel et al. 2009; Lindley et al. 2011). Southern DPS green sturgeon have been confirmed to occur throughout the coast from Monterey Bay, California, to as far north as Graves Harbor, Alaska (NMFS 2009a). Green sturgeon observed northwest of Graves Harbor, Alaska, and south of Monterey Bay, California, have not been identified as belonging to the Northern DPS or Southern DPS. Genetic analyses indicate that green sturgeon aggregations in the Columbia River estuary and Willapa Bay have a larger proportion of Southern DPS green sturgeon (0.69 to 0.88) than Northern DPS green sturgeon, whereas Grays Harbor has a slightly larger proportion of Northern DPS green sturgeon (0.54 to 0.59) (Israel et al. 2009). More recent analysis based on samples collected in 2010 to 2012 shows a similar pattern with the average proportion of Southern DPS being higher in the Columbia River (0.72) and Willapa Bay (0.63) as compared to Grays Harbor (0.40) (Schreier et al. 2016).

Spatial Structure and Diversity

Although the geographic distribution of Southern DPS green sturgeon is broad, the available spawning habitat is limited. In the final rule to list Southern DPS green sturgeon as threatened under the ESA (71 FR 17757, April 7, 2006), NMFS identified the reduction of spawning habitat to a limited area of the Sacramento River as the principal factor for the species' decline. The final rule described a substantial loss of what was likely historical spawning habitat in the upper Sacramento and upper Feather Rivers, because of the construction of impassable barriers (i.e., Keswick Dam and Oroville Dam) that block access to green sturgeon (USFWS 1995, supported by Mora et al. 2009). The final rule also described how the remaining spawning habitat was impaired by habitat alterations (e.g., increased water temperatures and altered flow regimes) and loss of access to habitat associated with impassable barriers (e.g., Red Bluff Diversion Dam (RBDD)), and other threats such as impaired water quality because of agricultural runoff.

Since publication of the final ESA-listing rule, changes have occurred that have likely improved the status of the Southern DPS green sturgeon through improvements to the quality of the habitat in the Sacramento River. These include keeping the RBDD gates open all year (beginning in 2012), allowing fish access to upstream spawning habitat (NMFS 2015a), and measures to improve fish passage at the Fremont Weir in the Yolo Bypass (where green sturgeon have been stranded in the past) (NMFS 2011a). In addition, studies have confirmed that green sturgeon spawn in the lower Feather River (Seesholtz et al. 2015). Spawning habitat for the Southern DPS remains restricted, however, to a limited portion of the species' likely historical spawning habitat, exposing the Southern DPS green sturgeon to catastrophic events. Because of spawning periodicity, only a portion of the adult spawning population would be in the river in any one year. However, a single event could affect a large portion or all of the spawning habitat and thus affect a large proportion of the adult spawning population and a whole year class.

Studies have examined the genetic traits of Southern DPS green sturgeon to allow genetic differentiation from Northern DPS green sturgeon (Israel et al. 2004; Schreier et al. 2016; Anderson et al. 2017). However, little is known regarding how current levels of diversity (e.g., genetic, life history) compare with historical levels. The loss and alteration of available spawning habitat has potentially resulted in a reduction in the species' diversity. This reduction may increase the risk of extinction to the species by limiting the population's ability to withstand short-term environmental changes and to adapt to long-term environmental changes.

Abundance and Productivity

Population-level data for green sturgeon has only recently been collected for some river systems. Several challenges exist in understanding population trends in green sturgeon. Efforts to estimate green sturgeon population size have had to rely on sub-optimal data with known potential biases, including monitoring designed for white sturgeon (*Acipenser transmontanus*) populations, harvest time series, or entrainment from water diversion and export facilities (Adams et al. 2007). Sturgeon catch in many areas was not historically reported by species or DPS. Current efforts to track population trends are reviewed in Heublein et al. (2017).

The most useful dataset for examining population trends and inferring abundance comes from Dual Frequency Identification Sonar (DIDSON) surveys, which began in 2010. These surveys have been used to estimate the abundance of Southern DPS adults in the upper Sacramento River (current estimate 2,106 (95 percent confidence interval [CI] = 1,246-2,966) (Mora 2016). There are some caveats regarding these estimates. Movement of individual fish in and out of the area throughout the season could affect the estimate. The estimate also potentially does not reflect the total Southern DPS population as it does not include fish spawning in the lower Feather River. Most spawning occurs in the mainstem Sacramento River, but an unknown portion of the population spawns in the lower Feather River and potentially in the lower Yuba River. Data are not available at this time to estimate the number of spawning adults in those rivers. The DIDSON surveys and associated modeling will eventually provide population abundance trends over time.

The proportion of juveniles, subadults, and adults in the Southern DPS population at equilibrium (25 percent juveniles, 63 percent subadults, and 12 percent adults) (Beamesderfer et al. 2007) can be used to generate estimates of subadult abundance and the overall population abundance. Based on this equilibrium and the above assumptions, Mora (2016) estimated that the population consists of 11,055 subadults (95 percent CI = 6,540–15,571) and a total of 17,548 adults, subadults, and juveniles combined (95 percent confidence interval = 12,614–22,482).

Because we lack estimates of the historical abundance of green sturgeon for comparison to current estimates, we look to general principles in conservation biology relating population viability to population abundance. In general, an effective population size of 500 or more adults is needed for a population to be naturally self-sustaining, based on the principle that genetic drift is significant when effective population sizes are less than 500 (Franklin 1980; Soulé 1980).

Assuming that the ratio of the census to effective population size is about 0.2 for green sturgeon (based on the ratio for salmonids; green sturgeon-specific information is not available) (Waples et al. 2004), the census population size needed for a naturally self-sustaining population would be 2,500 adults. The estimated current abundance of the adult population (2,106; 95 percent confidence interval = 1,246-2,966) is less than the estimated census population size of 2,500 adults needed for a self-sustaining population.

Little is known about green sturgeon productivity. Green sturgeon do not mature until they are at least 15 to 17 years of age at a size of about 4.5 to 7 feet (1.4 to 2.2 m) in length (Beamesderfer et al. 2007). The length at first maturity is estimated to be 60 inches (152 cm) total length (TL) (14 to 16 years) for males and 64 inches (162 cm) TL (16 to 20 years) for females in the Klamath River (Van Eenennaam et al. 2006), and 57 inches (145 cm) TL for males and 65 inches (166 cm) TL for females in the Rogue River (Erickson and Webb 2007).

Productivity and recruitment information for Southern DPS green sturgeon is an area that requires additional research; existing data are too limited to be presented as robust estimates. Incidental catches of larval green sturgeon in the mainstem Sacramento River and of juvenile green sturgeon at the south Sacramento-San Joaquin Delta (Delta) pumping facilities suggest that green sturgeon are successful at spawning, but that annual year class strength may be highly variable (Beamesderfer et al. 2007; Adams et al. 2007). In general, sturgeon year class strength appears to be episodic with overall abundance dependent upon a few successful spawning events (NMFS 2010a). It is unclear if the population is able to consistently replace itself. This is important because the VSP concept requires that a population meeting or exceeding the abundance criteria for viability should, on average, be able to replace itself (McElhany et al. 2000). More research is needed to establish Southern DPS green sturgeon productivity. Productivity is likely reduced because of restriction of spawning to one area in the mainstem Sacramento River and continuing impacts on the remaining spawning habitat.

Limiting Factors

Commercial and Recreational Harvest and Bycatch

This section focuses on harvest and bycatch impacts in fisheries outside of the action area. Historically, large numbers of green sturgeon were harvested incidentally in white sturgeon commercial and recreational fisheries (Emmett et al. 1991; Adams et al. 2007). Relatively smaller numbers of green sturgeon were harvested as bycatch in the tribal gillnet salmon fisheries in the Columbia and Klamath Rivers. Fishery impacts on green sturgeon have been greatly reduced from historical levels because of increasingly restrictive fishing regulations, including bans on the retention of green sturgeon throughout California, Oregon, Washington, and Canada and revised white sturgeon fishing regulations that were enacted following the ESA listing of the Southern DPS (75 FR 30714, June 2, 2010). However, fisheries throughout the coast continue to incidentally catch green sturgeon.

Table 2-1 summarizes the estimated annual catch of Southern DPS green sturgeon in several fisheries occurring outside of the action area (i.e., commercial and recreational fisheries in freshwater rivers, coastal estuaries, and coastal marine waters outside of the EEZ off California, Oregon, and Washington), for which data were available. The total estimated annual catch (787 to 933 subadults and/or adults) represents 6 to 7 percent of the estimated adult and subadult population (2,106 adults and 11,055 subadults). We note that our incidental catch and mortality estimates and population estimates include a high degree of uncertainty and should be considered with caution. For example, our population estimates may be underestimates because they do not consider the number of spawning adults in the lower Feather River. The incidental catch and mortality estimates may be overestimates, because some are based on historical harvest levels and they do not account for potential recapture of the same fish in multiple fisheries.

Below, we provide a brief description of how the estimates in Table 2-1 were generated. We do not discuss the Klamath tribal fisheries because the green sturgeon harvested in that fishery belong to the Northern DPS. Catch in fisheries occurring within the action area is discussed in Section 2.4, Environmental Baseline, of this opinion.

Table 2-1. Summary of estimated incidental catch and mortality of Southern DPS (sDPS) green sturgeon (number of fish) in commercial and recreational fisheries occurring outside of the action area.

Fishery	Estimated sDPS Incidental Catch		Estimated sDPS Mortalities	
	Low estimate	High estimate	Low estimate	High estimate
Central Valley, CA, recreational fisheries	89	202	3	5
Oregon recreational fisheries	0	33	0	2
Lower Columbia River recreational fisheries	52	52	7	11
Lower Columbia River commercial fisheries	271	271	14	14
Washington State fisheries	375	375	18	18
TOTAL	787	933	42	50

In California, the commercial sturgeon fishery has been closed since 1917 (Pycha 1956), but recreational white sturgeon fisheries exist in the Central Valley (i.e., the Sacramento and lower Feather Rivers, the Delta, and the San Francisco, San Pablo, and Suisun Bays) (Adams et al. 2007). CDFW sturgeon report card data from 2007 through 2016 provide information on incidental catch of green sturgeon, indicating 215 to 311 fish caught per year from 2007 to 2009 and 89 to 202 fish per year in 2010 through 2016, after enactment of sturgeon fishing area closures in 2010 (Gleason et al. 2008; Dubois et al. 2009, 2010, 2011, 2012; Dubois 2013;

Dubois and Harris 2015, 2016; Dubois and Danos 2017). We assume that all of the green sturgeon caught and released were Southern DPS green sturgeon, based on genetic and tagging data that indicate only Southern DPS green sturgeon use the Central Valley rivers, bays, and delta (Lindley et al. 2008; Israel et al. 2009). Given continued implementation of the sturgeon fishing area closures, we estimate the fisheries incidentally catch 89 to 202 Southern DPS green sturgeon per year (including subadults and adults) and kill about 3 to 5 fish per year (using an estimated bycatch mortality rate of 2.6 percent for hook-and-line fisheries) (Robichaud et al. 2006).

In Oregon, green sturgeon were historically harvested in the state-regulated commercial trawl fisheries (part of the federal groundfish fishery, discussed in the Environmental Baseline section of this opinion) and in recreational sturgeon fisheries conducted in coastal estuaries. Harvest of green sturgeon in the recreational fisheries has been reduced compared to historical levels to 6 to 59 fish per year from 2008 through 2015, with no reported green sturgeon catches in 2011 through 2013 (excluding fisheries in the Columbia River) (ODFW 1995–2015). Assuming that 16 to 55 percent of the green sturgeon caught in Oregon belong to the Southern DPS (based on genetic stock composition analysis) (Israel et al. 2009), we estimate that the recreational fisheries incidentally catch 0 to 33 and kill 0 to 2 Southern DPS green sturgeon per year (using an estimated bycatch mortality rate of 2.6 percent for hook-and-line fisheries) (Robichaud et al. 2006).

In the lower Columbia River estuary, green sturgeon incidental catch has been much reduced because of management actions implemented to control white sturgeon harvest and prohibitions on the retention of green sturgeon. A recent analysis estimated that recreational fisheries may incidentally catch up to 52 and kill 7 to 11 Southern DPS green sturgeon per year and commercial fisheries may incidentally catch up to 271 and kill up to 14 Southern DPS green sturgeon per year (NMFS 2008a). Reinitiation of this consultation is ongoing.

In Washington, harvest of green sturgeon primarily occurred in state-regulated commercial and recreational fisheries targeting white sturgeon or salmon in the large coastal estuaries. Estimated incidental catch of green sturgeon was as high as 1,000 to 2,000 fish per year in Grays Harbor and Willapa Bay, but has since been reduced because of management measures (WDFW 2011b). WDFW estimates that state commercial and recreational fisheries (excluding the Columbia River fisheries, which are addressed separately above) may incidentally catch up to 375 and kill up to 18 Southern DPS green sturgeon per year (Kirt Hughes, WDFW, email to Phaedra Doukakis, NMFS, January 30, 2015, regarding revised estimates of Southern DPS green sturgeon). These are conservative estimates (potentially overestimates), based on the maximum historical harvest levels (expanded to include green sturgeon smaller or larger than the legal fishing slot limit) recorded during a time when the salmon and white sturgeon fishing seasons were structured similarly to what is expected in the future (WDFW 2011b).

Bycatch of green sturgeon also occurs in commercial fisheries off British Columbia and Alaska. Canada prohibits retention of green sturgeon in all fisheries. Green sturgeon are encountered in the commercial groundfish trawl fishery in British Columbia. Between 1996 and 2013, 36,156 pounds of green sturgeon were reported as bycatch, with the number of individual sturgeon unknown because bycatch is recorded only by weight (Fisheries and Oceans Canada 2016).

Approximately 87 percent of this bycatch occurred off the northwest coast of Vancouver Island, with the remainder off the west coast of Vancouver Island (9 percent), and in Hecate Strait and Queen Charlotte Sound (4 percent). From 2014 to 2016, 1,092 pounds of green sturgeon were discarded from the bottom trawl fishery (A. Keizer, DFO, email to Phaedra Doukakis, NMFS, and Robert Tadey, DFO, January 5, 2017, regarding Pacific halibut and groundfish bottom trawl fisheries). The North Pacific Groundfish Observer Program, which observes federal groundfish fisheries off Alaska, has recorded rare encounters with green sturgeon in trawl fisheries in the Bering Sea, including one fish in 1982; two fish in 1984; one fish in 2005; three fish in 2006; and one fish per year in 2009, 2012, 2013, and 2015 (NPGOP data received April 2015). It is unknown whether the green sturgeon encountered belonged to the Northern or Southern DPS. Green sturgeon are rarely encountered in coastal waters off Baja California, Mexico, and fishery impacts in Mexican waters are likely negligible.

Other Factors

Green sturgeon face several additional threats in the freshwater, estuarine, and marine environments within which they move throughout their life, including reduction/loss of spawning and rearing habitat, insufficient freshwater flow rates in spawning and rearing habitats, contaminants (e.g., pesticides), potential poaching, entrainment by water projects, vessel strikes, influence of exotic species, small population size, impassable barriers, and elevated water temperatures (Adams et al. 2007; NMFS 2010a). As discussed above, the principal factor in the ESA-listing of Southern DPS green sturgeon was the reduction of its spawning habitat to a single area in the Sacramento River because of migration barriers (e.g., dams) and habitat alterations, increasing the vulnerability of the spawning population to catastrophic events and of early life stages to variable environmental conditions within the system. Threats to the single remaining spawning population, coupled with the inability to alleviate those threats using current conservation measures, led to the decision to list the species as threatened.

2.2.1.3. Status of Puget Sound Chinook Salmon

This ESU was listed as a threatened species in 1999; its threatened status was reaffirmed June 28, 2005 (70 FR 37160). NMFS issued results of a 5-year review on August 15, 2011 (76 FR 50448), and concluded that this species should remain listed as threatened. On February 2, 2015, NMFS announced the initiation of 5-year status reviews for 32 listed species of salmon, steelhead, rockfish, and eulachon (80 FR 6695). In December 2015, NOAA's Northwest Fisheries Science Center evaluated the viability of the listed species undergoing 5-year reviews and issued a status review update providing updated information and analysis of the biological status of the listed species (NWFSC 2015). Where possible, particularly as new material becomes available, the status review information is supplemented with more recent information and other population-specific data that may not have been considered during the status review so that NMFS is assured of using the best available information.

NMFS adopted the recovery plan for Puget Sound Chinook salmon on January 19, 2007 (72 FR 2493). The recovery plan consists of two documents: the Puget Sound Salmon Recovery Plan prepared by the Shared Strategy for Puget Sound and NMFS's Final Supplement to the Shared Strategy Plan. The recovery plan adopts ESU and population level viability criteria recommended by the Puget Sound Technical Recovery Team (PSTRT) (Ruckelshaus et al.

2002). The PSTRT's Biological Recovery Criteria will be met when the following conditions are achieved:

1. All watersheds improve from current conditions, resulting in improved status for the species.
2. At least two to four Chinook salmon populations in each of the five biogeographical regions of Puget Sound attain a low risk status over the long-term.[4]
3. At least one or more populations from major diversity groups historically present in each of the five Puget Sound regions attain a low risk status.
4. Tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations are functioning in a manner that is sufficient to support an ESU-wide recovery scenario.
5. Production of Chinook salmon from tributaries to Puget Sound not identified as primary freshwater habitat for any of the 22 identified populations occurs in a manner consistent with ESU recovery.

Spatial Structure and Diversity

The PSTRT determined that 22 historical populations currently contain Chinook salmon and grouped them into five major geographic regions, based on consideration of historical distribution, geographic isolation, dispersal rates, genetic data, life history information, population dynamics, and environmental and ecological diversity (Table 2-2). Based on genetic and historical evidence reported in the literature, the PSTRT also determined that there were 16 additional spawning aggregations or populations in the Puget Sound Chinook Salmon ESU that are now putatively extinct[5] (Ruckelhaus et al. 2006). This ESU includes all naturally spawned Chinook salmon originating from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Also, Chinook salmon from 26 artificial propagation programs are included: the Kendall Creek Hatchery Program; Marblemount Hatchery Program (spring subyearlings and summer-run); Harvey Creek Hatchery Program (summer-run and fall-run); Whitehorse Springs Pond Program; Wallace River Hatchery Program (yearlings and subyearlings); Tulalip Bay Program; Issaquah Hatchery Program; Soos Creek Hatchery Program; Icy Creek Hatchery Program; Keta Creek Hatchery Program; White River Hatchery Program; White Acclimation Pond Program; Hupp Springs Hatchery Program; Voights Creek Hatchery Program; Diru Creek Program; Clear Creek Program; Kalama Creek Program; George Adams Hatchery Program; Rick's Pond Hatchery Program; Hamma Hamma Hatchery Program; Dungeness/Hurd Creek Hatchery Program; Elwha Channel Hatchery Program; and the Skookum Creek Hatchery Spring-run Program (79 FR 20802, April 14, 2014).

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[4] The number of populations required depends on the number of diversity groups in the region. For example, three of the regions only have two populations generally of one diversity type; the Central Sound Region has two major diversity groups; the Whidbey/Main Region has four major diversity groups.

[5] It was not possible in most cases to determine whether these Chinook salmon spawning groups historically represented independent populations or were distinct spawning aggregations within larger populations.

Table 2-2: Extant PS Chinook salmon populations in each geographic region (Ruckelshaus 2006).

Geographic Region	Population (Watershed)
Strait of Georgia	**North Fork Nooksack River**
	South Fork Nooksack River
Strait of Juan de Fuca	**Elwha River**
	Dungeness River
Hood Canal	**Skokomish River**
	Mid Hood Canal River
Whidbey Basin	Skykomish River (late)
	Snoqualmie River (late)
	North Fork Stillaguamish River (early)
	South Fork Stillaguamish River (moderately early)
	Upper Skagit River (moderately early)
	Lower Skagit River (late)
	Upper Sauk River (early)
	Lower Sauk River (moderately early)
	Suiattle River (very early)
	Cascade River (moderately early)
Central/South Puget Sound Basin	Cedar River
	North Lake Washington/ Sammamish River
	Green/Duwamish River
	Puyallup River
	White River
	Nisqually River

NOTE: NMFS has determined that the bolded populations in particular are essential to the recovery of the Puget Sound ESU. In addition, at least one other population within the Whidbey Basin and Central/South Puget Sound Basin regions would need to be viable for recovery of the ESU. The PSTRT noted that the Nisqually watershed is in comparatively good condition, and thus the certainty that the population could be recovered is among the highest in the Central/South Region. NMFS concluded in its supplement to the Puget Sound Salmon Recovery Plan that protecting the existing habitat and working toward a viable population in the Nisqually watershed would help to buffer the entire region against further risk (NMFS 2006b).

Three of the five regions (Strait of Juan de Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006a). Under the Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the White and Nisqually (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006a) The TRT did not define the relative roles of the remaining populations in the Whidbey and Central/South Sound Basins to ESU viability.

Therefore, NMFS developed additional guidance that considers distinctions in genetic legacy and watershed condition among other factors in assessing the risks to survival and recovery of the listed species by the Proposed Action across all populations within the Puget Sound Chinook salmon ESU. In doing so it is important to take into account whether the genetic legacy of the population is intact or if it is no longer distinct. Populations are defined by their relative isolation from each other, and by the unique genetic characteristics that evolve as a result of that isolation to adapt to their specific habitats. If these are populations that still retain their historical genetic legacy, then the appropriate course to ensure their survival and recovery is to preserve that genetic legacy and rebuild those populations. Preserving that legacy requires both a sense of urgency and the actions necessary and appropriate to preserve the legacy that remains. However, if the genetic legacy is gone, then the appropriate course is to recover the populations using the individuals that best approximate the genetic legacy of the original population, reduce the effects of the factors that have limited their production, and provide the opportunity for them to re-adapt to the existing conditions.

In keeping with this approach, NMFS further classified Puget Sound Chinook salmon populations into three tiers based on a systematic framework that considers the population's life history and production and watershed characteristics (Puget Sound Domain Team 2010) (Figure 2-5). This framework, termed the *Population Recovery Approach*, carries forward the biological viability and delisting criteria described in the Supplement to the Puget Sound Salmon Recovery Plan (Ruckelshaus et al. 2002; NMFS 2006a). The assigned tier indicates the relative role of each of the 22 populations comprising the ESU to the viability of the ESU and its recovery. Tier 1 populations are most important for preservation, restoration, and ESU recovery. Tier 2 populations play a less important role in recovery of the ESU. Tier 3 populations play the least important role. When we analyze proposed actions, we evaluate impacts at the individual population scale for their effects on the viability of the ESU. We expect that impacts on Tier 1 populations would be more likely to affect the viability of the ESU as a whole than similar impacts on Tier 2 or 3 populations, because of the relatively greater importance of Tier 1 populations to overall ESU viability. NMFS has incorporated this and similar approaches in previous ESA section 4(d) determinations and opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005a, 2008a, 2008b, 2010b, 2012b; 2015b).

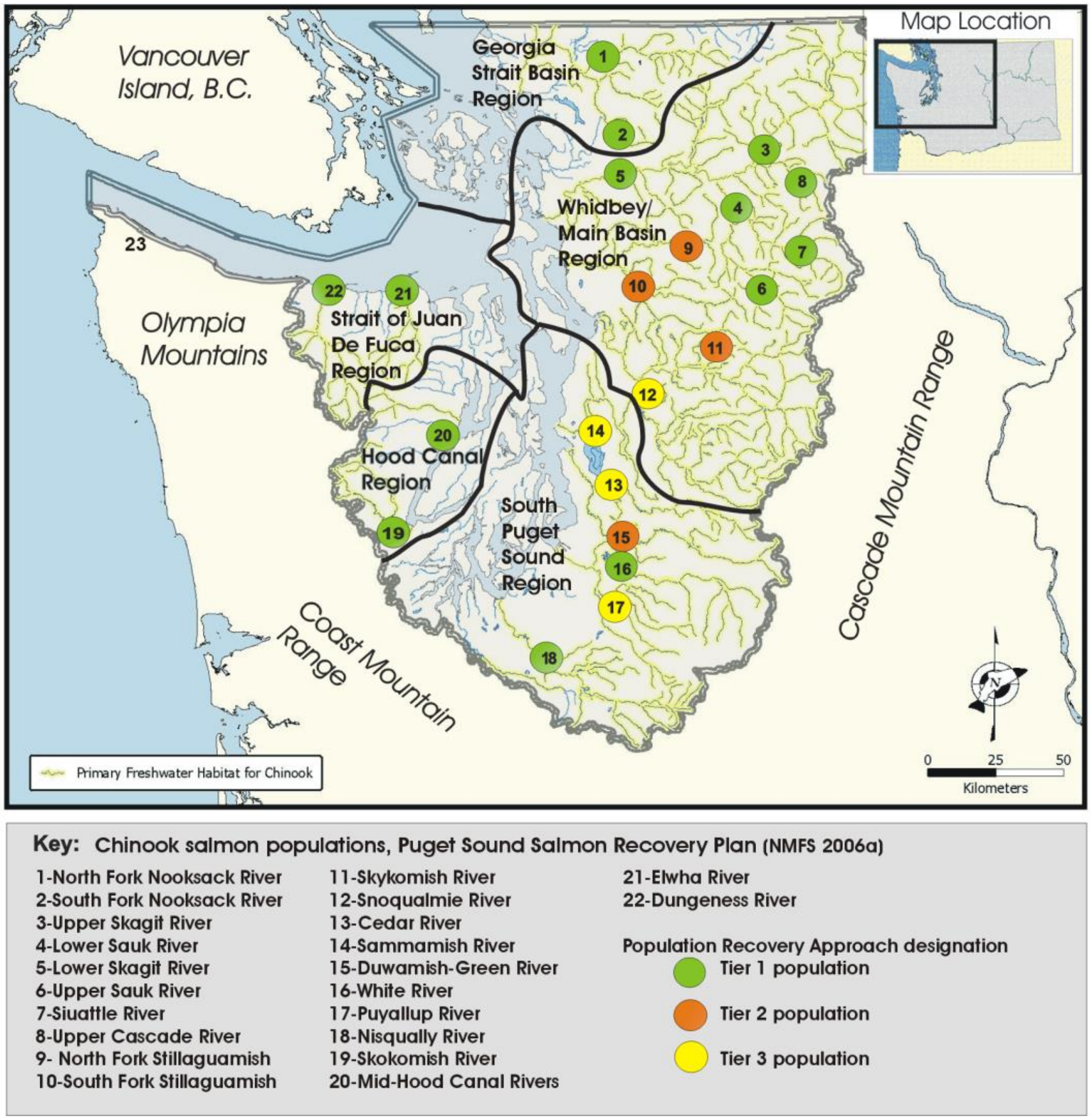

Figure 2-5. Populations of the Puget Sound Chinook salmon ESU.

In general, the Strait of Juan de Fuca, Georgia Basin, and Hood Canal regions are at greater risk than the other regions because of critically low natural abundance and/or declining growth rates of the populations in these regions. In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha, and Skokomish River populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins as a result of flood control activities and hydropower development. Habitat conditions conducive to salmon survival in most other watersheds have been degraded by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005b; 2006a; NMFS 2008c; SSPS 2007; 73 FR 7816, February 11, 2008). It is likely that genetic diversity has also been reduced by this habitat loss.

Abundance and Productivity

Most Puget Sound Chinook salmon populations are well below escapement levels identified as required for recovery to low extinction risk (Table 2-3). All populations are consistently below productivity goals identified in the recovery plan (Table 2-4). Although trends vary for individual populations across the ESU, most populations exhibit a stable or increasing trend in natural escapement (Table 2-3). However, natural-origin abundance across the Puget Sound ESU has generally decreased since the last status review, with only 6 of 22 populations (Cascade, Suiattle and Upper Sauk, Cedar, Mid-Hood Canal, Nisqually) showing a positive change in the 5-year geometric mean natural-origin spawner abundances since the prior status review (NWFSC 2015). While the previous status review in 2010 (Ford 2011) concluded there was no obvious trend for the total ESU, addition of the data to 2014 now shows widespread negative trends in natural-origin Chinook salmon spawner population abundances. (NWFSC 2015).[6]

Natural-origin escapements for eight populations are below their critical thresholds,[7] including both populations in three of the five biogeographical regions: Georgia Strait, Hood Canal, and Strait of Juan de Fuca (Table 2-3). When hatchery spawners are included, aggregate average escapement is over 1,000 for one of the two populations in each of these three regions. Four populations are above their rebuilding thresholds, three of which are in the Whidbey/Main Basin Region.

Trends in growth rate of natural-origin escapement are generally higher than growth rate of natural-origin recruitment (i.e., abundance prior to fishing) indicating some stabilizing influence on escapement possibly from past reductions in fishing-related mortality (Table 2-3). Since 1990, nine populations show productivity above replacement for natural-origin escapement including populations in all regions. Only six populations in three of the five regions demonstrate positive growth rates in natural-origin recruitment (Table 2-4). Survival and recovery of the Puget Sound Chinook Salmon ESU will depend, over the long term, on remedial actions related to all harvest, hatchery, and habitat related activities. Many of the habitat and hatchery actions identified in the Puget Sound Salmon Recovery Plan are likely to take years or decades to be implemented and to produce meaningful improvements in natural population attributes, and current trends are consistent with these expectations (NWFSC 2015).

[6] This is a synopsis of information provided in the recent 5-year status review and supplemental data and complementary analysis from other sources. Differences in results reported in Tables 2-3 and 2-4 from those in the status review are related to the data source, method, and time period analyzed (e.g., 15 vs. 25 years).

[7] After taking into account uncertainty, the critical threshold is defined as a point below which: (1) dispensatory processes are likely to reduce the population below replacement, (2) the population is at risk from inbreeding depression or fixation of deleterious mutations, or (3) productivity variation because of demographic stochasticity becomes a substantial source of risk (NMFS 2000). The rebuilding threshold is defined as the escapement that will achieve Maximum Sustained Yield (MSY) under current environmental and habitat conditions (NMFS 2000). Thresholds were based on population-specific data where available.

Table 2-3. Estimates of escapement and productivity (recruits/spawner) for Puget Sound Chinook salmon populations. Natural origin escapement information is provided where available. Populations below their critical escapement threshold are bolded. For several populations, hatchery contribution to natural spawning data are limited or unavailable.

Region	Population	1999 to 2014 Geometric Mean Escapement (Spawners)		NMFS Escapement Thresholds		Recovery Planning Abundance Target in Spawners (productivity)[2]	Average % Hatchery Fish in Escapement 1999 to2014 (min-max)[5]
		Natural[1]	Natural-Origin (Productivity[2])	Critical[3]	Rebuilding[4]		
Georgia Basin	Nooksack MU	2,272	268	400	500		
	NF Nooksack	1,810	**195**[8] (0.6)	*200*[6]	-	3,800 (3.4)	85 (63-94)
	SF Nooksack	383	**51**[8] (1.6)	*200*[6]	-	2,000 (3.6)	84 (62-96)
Whidbey/Main Basin	Skagit Summer/Fall MU						
	Upper Skagit River	9,173	8,869[8] (2.0)	967	7,454	5,380 (3.8)	3 (1-8)
	Lower Sauk River	543	538[8] (1.8)	*200*[6]	681	1,400 (3.0)	1 (0-10)
	Lower Skagit River	1,993	1,917[8] (1.8)	251	2,182	3,900 (3.0)	4 (2-8)
	Skagit Spring MU						
	Upper Sauk River	543	520[8] (1.5)	130	330	750 (3.0)	2 (0-5)
	Suiattle River	331	325[8] (1.2)	170	400	160 (3.2)	2 (0-5)
	Upper Cascade River	309	286[8] (1.1)	170	*1,250*[6]	290 (3.0)	7 (0-25)
	Stillaguamish MU						
	NF Stillaguamish R.	952	554 (0.8)	300	552	4,000 (3.4)	37 (8-62)
	SF Stillaguamish R.	110	**101** (0.7)	*200*[6]	300	3,600 (3.3)	NA
	Snohomish MU						
	Skykomish River	3,358	1,944[8] (1.3)	1,650	3,500	8,700 (3.4)	34 (15-62)
	Snoqualmie River	1,583	1,088[8] (1.3)	400	*1,250*[6]	5,500 (3.6)	19 (8-35)
Central/South Sound	Cedar River	844	816[8] (1.9)	*200*[6]	*1,250*[6]	2,000 (3.1)	23 (10-36)
	Sammamish River	1,172	**184**[8] (0.7)	*200*[6]	*1,250*[6]	1,000 (3.0)	83 (66-95)
	Duwamish-Green River	3,562	1,235[8] (1.0)	835	5,523	-	53 (20-79)
	White River[9]	1,540	724[8] (0.8)	*200*[6]	1,100[7]	-	44 (27-70)
	Puyallup River[10]	1,570	747[8] (1.1)	*200*[6]	522[7]	5,300 (2.3)	47 (18-76)
	Nisqually River	1,696	591[8] (1.6)	*200*[6]	1,200[7]	3,400 (3.0)	70 (53-85)
Hood Canal	Skokomish River	1,305	**334** (0.9)	452	1,160	-	67 (7-95)
	Mid-Hood Canal Rivers[11]	**175**		*200*[6]	*1,250*[6]	1,300 (3.0)	38 (5-63)

Strait of Juan de Fuca	Dungeness River	354	**106**[8] (0.6)	*200*[6]	925[7]	1,200 (3.0)	68 (39-96)
	Elwha River[12]	1,467	**108**[8]	*200*[6]	*1,250*[6]	6,900 (4.6)	89 (82-87)

[1] Includes naturally spawning hatchery fish. Nooksack spring Chinook salmon 2014–15 escapements not available.

[2] Source productivity is Abundance and Productivity Tables from NWFSC database; measured as the mean of observed recruits/observed spawners. Sammamish productivity estimate has not been revised to include Issaquah Creek. Source for Recovery Planning productivity target is the final supplement to the Puget Sound Salmon Recovery Plan (NMFS 2006a); measured as recruits/spawner associated with the number of spawners at Maximum Sustained Yield under recovered conditions.

[3] Critical natural-origin escapement thresholds under current habitat and environmental conditions (McElhaney et al. 2000; NMFS 2000).

[4] Rebuilding natural-origin escapement thresholds under current habitat and environmental conditions (McElhaney et al. 2000; NMFS 2000).

[5] Estimates of the fraction of hatchery fish in natural spawning escapements are from the Abundance and Productivity Tables and co-manager postseason reports on the Puget Sound Chinook Harvest Management Plan (PSTIT and WDFW 2013; WDFW and PSTIT 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2014) and the 2010–14 Puget Sound Chinook Harvest Management Plan (PSTIT and WDFW 2010). North Fork and South Fork Nooksack estimates include years through 2013.

[6] Based on generic VSP guidance (McElhaney et al. 2000; NMFS 2000).

[7] Based on alternative habitat assessment.

[8] Estimates of natural-origin escapement for Nooksack available only for 1999–2013, Skagit springs, Skagit falls and Skokomish available only for 1999–2014; Snohomish for 1999–2001 and 2005–14; Lake Washington for 2003–14; White River 2005-14; Puyallup for 2002-14; Nisqually for 2005–14; Dungeness for 2001–14; Elwha for 2010–14.

[9] Captive broodstock program for early run Chinook salmon ended in 2000; estimates of natural spawning escapement include an unknown fraction of naturally spawning hatchery-origin fish from late- and early-run hatchery programs in the White and Puyallup River basins.

[10] South Prairie index area provides a more accurate trend in the escapement for the Puyallup River because it is the only area in the Puyallup River for which spawners or redds can be consistently counted (PSIT and WDFW 2010).

[11] The Puget Sound TRT considers Chinook salmon spawning in the Dosewallips, Duckabush, and Hamma Hamma Rivers to be subpopulations of the same historically independent population; annual counts in those three streams are variable because of inconsistent visibility during spawning ground surveys. Data on the contribution of hatchery fish is very limited and primarily based on returns to the Hamma Hamma River.

[12] Estimates of natural escapement do not include volitional returns to the hatchery or those fish gaffed or seined from spawning grounds for broodstock collection.

Table 2-4. Long-term trends in abundance and productivity for Puget Sound Chinook salmon populations. Long-term, reliable data series for natural-origin contribution to escapement are limited in many areas.

Region	Population	Natural Escapement Trend[1] (1990–14)		Growth Rate[2] (1990–13)	
		NMFS		Recruitment (Recruits)	Escapement (Spawners)
Georgia Basin	NF Nooksack (early)	1.13	increasing	1.04	1.00
	SF Nooksack (early)	1.04	increasing	1.04	1.01
Whidbey/Main Basin	Upper Skagit River (moderately early)	1.02	stable	0.98	1.01
	Lower Sauk River (moderately early)	1.00	stable	0.97	0.98
	Lower Skagit River (late)	1.01	stable	0.97	0.99
	Upper Sauk River (early)	1.04	increasing	0.99	1.03
	Suiattle River (very early)	0.99	stable	0.97	1.00
	Upper Cascade River (moderately early)	1.03	increasing	0.99	1.03
	NF Stillaguamish River (early)	1.00	stable	0.97	1.00
	SF Stillaguamish River[3] (moderately early)	0.95	**declining**	0.94	0.97
	Skykomish River (late)	1.00	stable	0.93	1.00
	Snoqualmie River (late)	1.01	stable	0.97	0.99
Central/South Sound	Cedar River (late)	1.04	increasing	1.02	1.04
	Sammamish River[4] (late)	1.01	stable	1.04	1.07
	Duwamish-Green River (late)	0.95	**declining**	0.95	0.98
	White River[5] (early)	1.10	increasing	1.02	1.05
	Puyallup River (late)	0.97	**declining**	0.93	0.95
	Nisqually River (late)	1.06	increasing	0.93	1.00
Hood Canal	Skokomish River (late)	1.01	stable	0.90	0.96
	Mid-Hood Canal Rivers[3] (late)	1.03	stable	0.95	1.03
Strait of Juan de Fuca	Dungeness River (early)	1.05	stable	1.04	1.08
	Elwha River[3] (late)	1.01	stable	0.91	0.94

[1] Escapement Trend is calculated based on all spawners (i.e., including both natural origin spawners and hatchery-origin fish spawning naturally) to assess the total number of spawners passed through the fishery to the spawning ground. Directions of trends defined by statistical tests.
[2] Median growth rate (λ) is calculated based on natural-origin production. It is calculated assuming the reproductive success of naturally spawning hatchery fish is equivalent to that of natural-origin fish (for those populations where information on the fraction of hatchery fish in natural spawning abundance is available). Source: Abundance and Productivity Tables from NWFSC database.
[3] Estimate of the fraction of hatchery fish in time series is not available for use in λ calculation, so trend represents that in hatchery-origin + natural-origin spawners.
[4] Median growth rate estimates for Sammamish has not been revised to include escapement in Issaquah Creek.
[5] Natural spawning escapement includes an unknown fraction of naturally spawning hatchery-origin fish from late- and early run hatchery programs in the White and Puyallup River basin.

Limiting factors

Limiting factors described in SSPS (2007) and reiterated in Ford (2011) and NWFSC (2015) include:

- Degraded nearshore and estuarine habitat: Residential and commercial development has reduced the amount of functioning nearshore and estuarine habitat available for salmon rearing and migration. The loss of mudflats, eelgrass meadows, and macroalgae further limits salmon foraging and rearing opportunities in nearshore and estuarine areas.
- Degraded freshwater habitat: Floodplain connectivity and function, channel structure and complexity, riparian areas and large wood supply, stream substrate, and water quality have been degraded for adult spawning, embryo incubation, and rearing as a result of cumulative impacts of agriculture, forestry, and development.
- Anadromous salmonid hatchery programs: Salmon and steelhead released from Puget Sound hatcheries operated for harvest augmentation purposes pose ecological, genetic, and demographic risks to natural-origin Chinook salmon populations.
- Salmon harvest management: Total fishery exploitation rates have decreased substantially since the late 1990s when compared to years prior to listing (average reduction = -35 percent, range = -18 to -58 percent), but weak natural-origin Chinook salmon populations in Puget Sound still require enhanced protective measures to reduce the risk of overharvest.

2.2.1.4. Status of Lower Columbia River Chinook Salmon

Lower Columbia River Chinook salmon were first listed as threatened under the ESA in 1999 (64 FR 14308, March 24, 1999). The threatened status was reaffirmed on April 14, 2014. Critical Habitat for LCR Chinook salmon was designated on September 2, 2005 (70 FR 52706). NMFS issued results of a 5-year review on May 26, 2016 (81 FR 33468), and concluded that this species should remain listed as threatened.

NMFS has completed a roll-up recovery plan (NMFS 2013a) that addresses the entire Lower Columbia River Chinook ESU (as well as Lower Columbia River coho salmon, Lower Columbia River steelhead, and Columbia River chum salmon) through incorporation of management unit recovery plans and an Estuary Module. The following discussion summarizes information described in more detail in that plan as well as recent biological opinions (NMFS 2012b).

Within the geographic range of this ESU, 27 hatchery Chinook salmon programs are currently operational. Fourteen of these hatchery programs are included in the ESU (Table 2-5), while the remaining 13 programs are excluded (Jones Jr. 2015). Willamette River Chinook salmon are listed within the Willamette River Chinook Salmon ESU, but they are not listed within the LCR Chinook Salmon ESU. Genetic resources that represent the ecological and genetic diversity of a species can reside in a hatchery program. “Hatchery programs with a level of genetic divergence relative to the local natural population(s) that is no more than what occurs within the ESU are considered part of the ESU and will be included in any listing of the ESU” (70 FR 37160, June 28, 2005). For a detailed description of how NMFS evaluates and determines whether to include hatchery fish in an ESU or DPS, see 70 FR 37160 (June 28, 2005).

Table 2-5. Chinook salmon ESU description and major population groups (MPGs) (Sources: NMFS 2013a; Jones Jr. 2015; NWFSC 2015). The designations (C) and (G) identify Core and Genetic Legacy populations, respectively (Appendix B in WLC-TRT 2003).[1]

ESU Description[1]	
Threatened	Listed under ESA in 1999; updated in 2014.
6 major population groups	32 historical populations
Major Population Group	***Populations***
Cascade Spring	Upper Cowlitz (C,G), Cispus (C), Tilton, Toutle, Kalama, NF Lewis (C), Sandy (C,G)
Gorge Spring	(Big) White Salmon (C), Hood
Coast Fall	Grays/Chinook, Elochoman (C), Mill Creek, Youngs Bay, Big Creek (C), Clatskanie, Scappoose
Cascade Fall	Lower Cowlitz (C), Upper Cowlitz, Toutle (C), Coweeman (G), Kalama, EF Lewis (G), Salmon Creek, Washougal, Clackamas (C), Sandy River early
Gorge Fall	Lower Gorge, Upper Gorge (C), (Big) White Salmon (C), Hood
Cascade Late Fall	North Fork Lewis (C,G), Sandy (C,G)
Artificial production	
Hatchery programs included in ESU (14)	Big Creek Tule Fall Chinook, Astoria High School (STEP), Tule Fall Chinook, Warrenton High School (STEP), Tule Fall Chinook, Cowlitz Tule Fall Chinook Salmon Program, North Fork Toutle Tule Fall Chinook, Kalama Tule Fall Chinook, Washougal River Tule Fall Chinook, Spring Creek National Fish Hatchery (NFH) Tule Chinook, Cowlitz spring Chinook salmon (2 programs), Friends of Cowlitz spring Chinook, Kalama River Spring Chinook, Lewis River Spring Chinook, Fish First Spring Chinook, Sandy River Hatchery Spring Chinook salmon (ODFW stock #11)
Hatchery programs not included in ESU (13)	Deep River Net-Pens Spring Chinook, Clatsop County Fisheries (CCF) Select Area Brights Program Fall Chinook, CCF Spring Chinook salmon Program, Carson NFH Spring Chinook salmon Program, Little White Salmon NFH Tule Fall Chinook salmon Program, Bonneville Hatchery Tule Fall Chinook salmon Program, Hood River Spring Chinook salmon Program, Deep River Net Pens Tule Fall Chinook, Klaskanine Hatchery Tule Fall Chinook, Bonneville Hatchery Fall Chinook, Little White Salmon NFH Tule Fall Chinook, Cathlamet Channel Net Pens Spring Chinook, Little White Salmon NFH Spring Chinook

[1]Core populations are defined as those that historically represented a substantial portion of the species abundance. Genetic legacy populations are defined as those that have had minimal influence from non-endemic fish because of artificial propagation activities, or may exhibit important life history characteristics that are no longer found throughout the ESU (WLC-TRT 2003).

The LCR Chinook Salmon ESU comprises 32 historical populations within six MPGs. These are distributed through three ecological zones, whereby through a combination of life-history types based on run timing and ecological zones result in the six MPGs, some of which are considered extirpated or nearly so (Table 2-6). The run timing distributions across the 32 historical populations are: nine spring populations, 21 early-fall populations, and two late-fall populations (Figure 2-6).

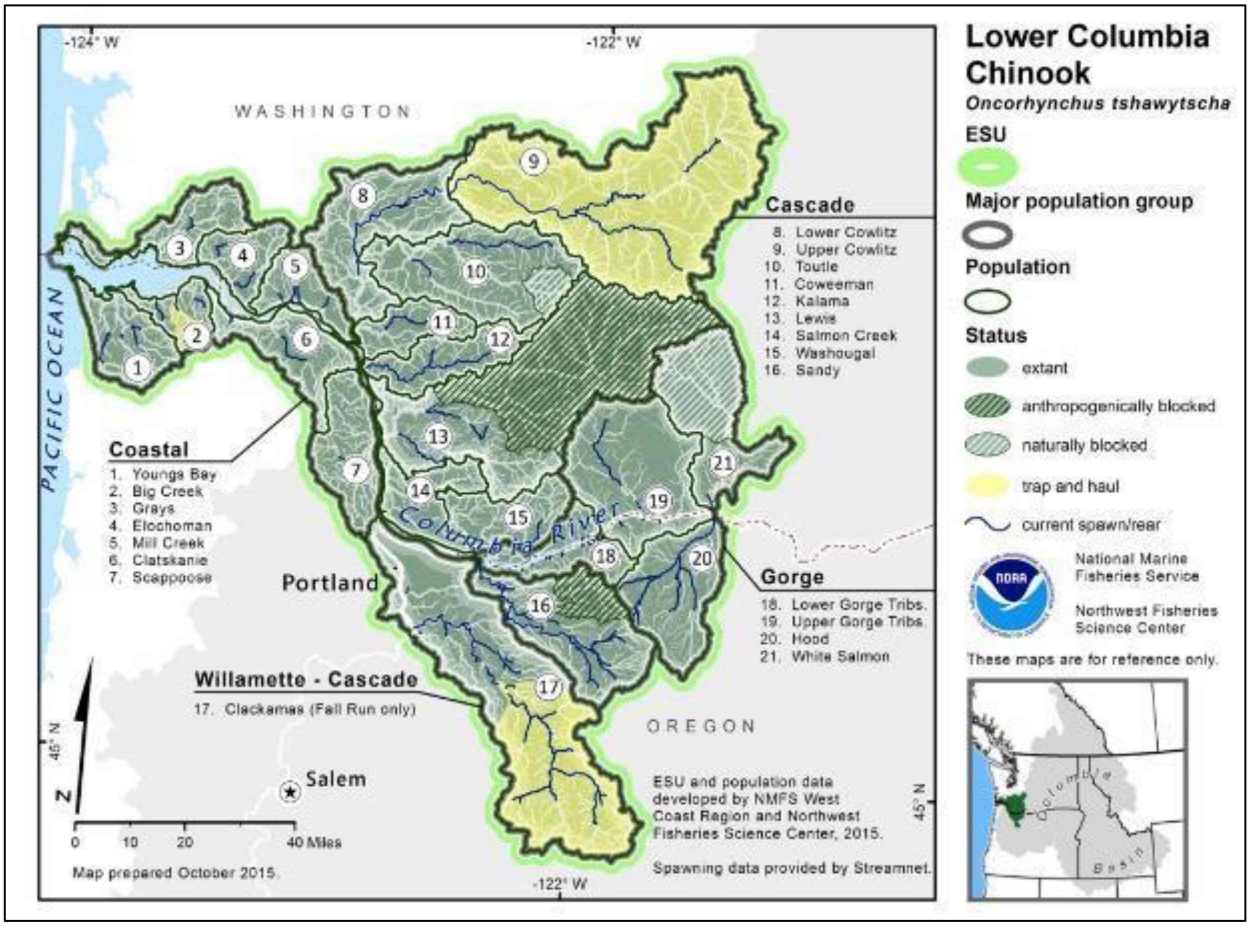

Figure 2-6. Map of the LCR Chinook Salmon ESU's spawning and rearing areas, illustrating populations and MPGs. Several watersheds contain or historically contained both fall and spring runs; only the fall-run populations are illustrated here (NWFSC 2015)

NMFS endorsed the recovery scenario and population level goals in the recovery plan as consistent with delisting. Based on the information provided by the WLC TRT and the management unit recovery planners, NMFS concluded in the recovery plan that the recovery scenario in Table 2-6 represents one of multiple possible scenarios that will meet biological criteria for delisting. The similarities between the Gorge and Cascade strata, coupled with compensation in the Cascade stratum for not meeting TRT criteria in the Gorge stratum, will provide an ESU no longer likely to become endangered.

Table 2-6. Current status for Lower Columbia River Chinook salmon populations and recommended status under the recovery scenario (NMFS 2012c).

	Status Assessment		Recovery Scenario	
Population	**Baseline Persistence Probability[1]**	**Contribution[2]**	**Target Persistence Probability**	**Abundance Target[3]**
Cascade Spring				
Upper Cowlitz	VL	Primary	H+	1,800
Cispus	VL	Primary	H+	1,800
Tilton	VL	Stabilizing	VL	100
Toutle	VL	Contributing	M	1,100
Kalama	VL	Contributing	L	300
Lewis NF	VL	Primary	H	1,500
Sandy (OR)	M	Primary	H	1,230
Gorge Spring				
White Salmon	VL	Contributing	L+	500
Hood (OR)	VL	Primary4	VH4	1,493
Coastal Fall				
Youngs Bay (OR)	L	Stabilizing	L	505
Grays/Chinook	VL	Contributing	M+	1,000
Big Creek (OR)	VL	Contributing	L	577
Eloch/Skam	VL	Primary	H	1,500
Clatskanie (OR)	VL	Primary	H	1,277
Mill/Aber/Germ	VL	Primary	H	900
Scappoose (OR)	L	Primary	H	1,222
Cascade Fall				
Lower Cowlitz	VL	Contributing	M+	3,100
Upper Cowlitz	VL	Stabilizing	VL	--
Toutle	VL	Primary	H+	4,000
Coweeman	VL	Primary	H+	900
Kalama	VL	Contributing	M	500
Lewis	VL	Primary	H+	1,500
Salmon	VL	Stabilizing	VL	--
Clackamas (OR)	VL	Contributing	M	1,551
Sandy (OR)	VL	Contributing	M	1,031
Washougal	VL	Primary	H+	1,200
Gorge Fall				
L. Gorge (WA/OR)	VL	Contributing	M	1,200
U. Gorge (WA/OR)	VL	Contributing	M	1,200
White Salmon	VL	Contributing	M	500
Hood (OR)	VL	Primary4	H4	1,245
Cascade Late Fall				
Lewis NF	VH	Primary	VH	7,300
Sandy (OR)	H	Primary	VH	3,747

[1]The Washington evaluations (LCFRB 2010) used the late 1990s as a baseline period for evaluating status; the Oregon evaluations (ODFW 2010) assume average environmental conditions of the period 1974–2004 and use a reference period of roughly 1994–2004 for harvest exploitation rates. These are adopted in the roll-up recovery plan (NMFS 2013a).
[2]Primary, contributing, and stabilizing designations reflect the relative contribution of a population to recovery goals and delisting criteria. Primary populations are targeted for restoration to a high or very high persistence probability. Contributing populations are targeted for medium or medium-plus viability. Stabilizing populations are those that will be maintained at current levels (generally low to very low viability), which is likely to require substantive recovery actions to avoid further degradation. The terminology of "primary," "contributing," and "stabilizing" is used in the Washington and White Salmon plans, and not Oregon. Because the terminology is useful in communicating a population's role within the recovery scenario, Oregon populations have been assigned a designation here consistent with their role.
[3]Abundance objectives account for related goals for productivity (from Table 7-4 in NMFS 2013a). Spatial structure and diversity will be evaluated separately based on criteria established by the TRT (McElhany et al. 2006).
[4]Oregon analysis indicates a low probability of meeting the delisting objectives for these populations.

Abundance, Productivity, and Trends

Gorge Spring MPG

Spring Chinook salmon populations occur in both the Gorge and Cascade MPGs (Table 2-5). The Hood River and White Salmon populations are the only populations in the Gorge MPG. The 2005 Biological Review Team (BRT) described the Hood River spring run as "extirpated or nearly so" (Good et al. 2005) and the 2005 ODFW Native Fish Status report describes the population as extinct (ODFW 2005). NMFS reaffirmed its conclusion that Hood River spring Chinook salmon are in the Gorge Spring MPG in the most recent status review (NWFSC 2015). Additionally, the White Salmon River population is considered extirpated (NMFS 2013a, Appendix C).

Most of the habitat that was historically available to spring Chinook salmon in the Hood River is still accessible. Because of the apparent extirpation of the population, Oregon initiated a reintroduction program using spring Chinook salmon from the Deschutes River. The nearest natural population of spring Chinook salmon is the Deschutes River population, but the population is part of a different ESU, the MCR Chinook Salmon ESU. Although the reintroduction program has been underway since the mid-90s, it has not met its original goals for smolt-to-adult survival rates. Deficiencies are attributed to production practices (ISRP 2008; CTWSR 2009; NMFS 2013a). The delisting persistence probability target is listed as very high, but NMFS (2013) believes that the prospects for meeting that target are uncertain.

The White Salmon River population is also considered extinct (Appendix C *in* NMFS 2013a). Condit Dam was completed in 1913 with no juvenile or adult passage, thus precluding access to all essential habitat. The breaching of Condit Dam in 2011 provides an option for recovery planning. The White River Recovery Plan calls for monitoring escapement into the basin for 4 to 5 years to see if natural recolonization occurs. Habitat conditions downstream of the dam site and in the area previously occupied by Northwestern Lake will need to be assessed and priority restoration actions identified. Sometime during or at the end of the interim monitoring program a decision will be made about whether to proceed with a reintroduction program using hatchery fish. The recovery scenario described in the roll-up recovery plan identifies the White Salmon River spring population as a contributing population with a low plus persistence probability target (Table 2-6).

Cascade Spring MPG

There are seven spring Chinook salmon populations in the Cascade MPG. The most recent total abundance information for spring Chinook salmon is provided in Table 2-7. The return of combined hatchery-origin and natural-origin spring Chinook salmon to the Cowlitz River, Kalama River, and Lewis River populations in Washington have all numbered in the thousands in recent years (Table 2-7). The Cowlitz and Lewis populations on the Washington side are managed for hatchery production because most of the historical spawning habitat has been inaccessible as a result of hydroelectric development in the upper basin (NMFS 2013a). The hatcheries' escapement objectives have been met in recent years with few exceptions (NMFS 2012d). Supplementation programs are now being implemented on the Cowlitz River and Lewis River. Harvest is managed to ensure that hatchery broodstock needs are met in order to support the needs of the supplementation program.

Table 2-7. Total annual run size of Lower Columbia River spring Chinook salmon populations (PFMC 2016a, Table B-12).

Year or Average	Cowlitz River	Kalama River	Lewis River	Sandy River (Total)	Sandy River (natural-origin fish at Marmot Dam)[1]
1971-1975	11,900	1,100	200	-	
1976-1980	19,680	2,020	2,980	975	
1981-1985	19,960	3,740	4,220	1,940	
1986-1990	10,691	1,877	11,340	2,425	
1991-1995	6,801	1,976	5,870	4,920	
1996	1,787	627	1,730	3,801	
1997	1,877	505	2,196	4,410	
1998	1,055	407	1,611	3,577	
1999	2,069	977	1,753	3,585	
2000	2,199	1,418	2,515	3,641	1,984
2001	1,609	1,796	3,777	5,329	2,445
2002	5,208	2,912	3,514	5,905	1,277
2003	15,972	4,556	5,040	5,615	1,151
2004	16,514	4,286	7,475	12,680	2,699
2005	9,353	3,367	3,512	7,668	1,808
2006	6,967	5,458	7,301	4,382	1,383
2007	3,974	8,030	7,596	2,813	1,410
2008	2,986	1,623	2,215	5,994	2,721
2009	5,977	404	1,493	2,429	856
2010	8,849	918	2,337	7652	1,391
2011	8,830	778	1,311	5721	
2012	5,834	862	1,895	5038	
2013	12,617	1,014	1,597	5700	
2014	9,536	1,013	1,482	5971	
2015	23,931	3,149	1,006	4000	
2016	22,407	3,980	468	4,151	

[1]Marmot Dam was removed in 2007 and is thus no longer available as a counting station. Returns from 2008 on are estimates ODFW calculated using the relationship between redds and natural-origin fish seen at Marmot Dam from 1996 to 1998 and 2002 to 2006.

Legacy effects of the 1980 Mount St. Helens eruption are still a fundamental limiting factor for the Toutle River spring Chinook salmon population (NMFS 2013a). The North Fork Toutle River was dramatically affected by sedimentation from the eruption. Because of the eruption, a sediment retention structure (SRS) was constructed to manage the ongoing input of fine sediments into the lower river. Nonetheless, the SRS is a continuing source of fine sediments and blocks passage to the upper river. A trap and haul system was implemented and operates annually from September to May to transport adult fish above the SRS. The transport program provides access to 50 miles of anadromous fish habitat located above the structure (NMFS 2013a). There is relatively little known about current spring Chinook salmon production in this basin. The Toutle population has been designated a contributing population targeted for medium persistence probability under the recovery scenario (Table 2-6).

<u>Cascade Late Fall MPG</u>

There are two late fall (bright) Chinook salmon populations in the Lower Columbia River Chinook ESU in the Sandy and North Fork Lewis Rivers. Both populations are in the Cascade MPG (Table 2-5). The baseline persistence probability of the Lewis and Sandy populations are listed as very high and high; both populations are targeted for very high persistence probability under the recovery scenario (Table 2-6).

The TAC designated for the 2018 Agreement provided estimates of the escapement of bright Chinook salmon to the Sandy River (Table 2-9); these are estimates of spawning escapement are estimates of peak redd counts obtained from direct surveys in a 16 km index area that is expanded to estimates of spawning escapement by multiplying by a factor of 2.5 (TAC 2017). The recovery plan includes an appendix that describes how index counts are expanded to estimates of total abundance (ODFW 2010, Appendix C). There are some minor differences between the values reported in Appendix C and those shown in Table 2-8 that reflect updates or revisions in prior index area estimates. The abundance target for delisting is 3,747 natural-origin fish (Table 2-6) and escapements have averaged about 728 natural-origin fish since 1995 (Table 2-8).

The Lewis River population is the principal indicator stock for management within the Cascade Late Fall MPG. It is a natural-origin population with little or no hatchery influence. The escapement goal, based on estimates of maximum sustained yield (MSY), is 5,700. The escapement has averaged 9,000 over the last ten years and has generally exceeded the goal by a wide margin since at least 1980. Escapement was below goal from 2006 through 2008 (Table 2-8). The shortfall is consistent with a pattern of low escapements for other far-north migrating stocks in the region and can likely be attributed to poor ocean conditions. Escapement improved in 2009 and has been well above goal since (Table 2-8). NMFS (2013) identifies an abundance target under the recovery scenario of 7,300 natural-origin fish (Table 2-6), which is 1,600 more fish than the currently managed for escapement goal. The recovery target abundance is estimated from population viability simulations and is assessed as a median abundance over any successive 12 year period. The median escapement over the last 12 years is 8,580, therefore exceeding the abundance objective (Table 2-8). Escapement of spring Chinook salmon to the Lewis River is expected to vary from year to year as it has in the past, but generally remain high relative to the population's escapement objectives, which suggests that the population is near capacity (NWFSC 2015).

Table 2-8. Annual escapement of natural origin Lower Columbia River bright fall Chinook salmon populations from 1995-2016[1].

Year	Lewis River[2,3]	Sandy River
1995	9,715	1,036
1996	13,077	505
1997	8,168	2,001
1998	5,173	773
1999	2,417	447
2000	8,741	84
2001	11,274	824
2002	13,293	1,275
2003	12,912	619
2004	12,928	601
2005	9,775	770
2006	5,066	1,130
2007	3,708	171

2008	5,485	602
2009	6,283	318
2010	9,294	373
2011	8,205	1,019
2012	8,143	62
2013	15,197	1,253
2014	20,809	436
2015	23,614	1,274
2016	8,957	451

[1] Date Accessed: October 4, 2017
[2] Online at: https://fortress.wa.gov/dfw/score/score/species/chinook.jsp?species=Chinook. These have been updated and adjusted with the BA (TAC 2017).
[3] Data are total spawner estimates of wild late fall (bright) Chinook salmon.

Gorge Fall MPG

The four populations in the Gorge MPG include the Lower Gorge, Upper Gorge, White Salmon, and Hood. The baseline persistence probability for all of these populations is very low. Populations in the Gorge Fall MPG have been subject to the effects of a high incidence of naturally spawning hatchery fish for years. The recovery plan targets the White Salmon and Lower and Upper Gorge populations for medium persistence probability, and the Hood River population for high persistence although, as discussed earlier in this subsection, it is unlikely that the high viability objective can be met (Table 2-6). There is some uncertainty regarding the historical role of the Gorge populations in the ESU and whether they truly functioned historically as demographically independent populations (NMFS 2013a). This is accounted for in the recovery scenario presented in the recovery plan.

Natural populations in the Gorge Fall MPG have been subject to the effects of a high incidence of hatchery fish straying and spawning naturally. The White Salmon population, for example, was limited by Condit Dam, as discussed above regarding Gorge Spring MPG, and natural spawning occurred in the river below the dam (NMFS 2013a, Appendix C). The number of fall Chinook salmon spawners in the White Salmon increased from low levels in the early 2000s to an average of 1,086 for the period from 2010 to 2015, but spawning is dominated by tule Chinook salmon strays from the neighboring Spring Creek Hatchery and upriver bright Chinook salmon from the production program in the adjoining Little White Salmon River[8]. The Spring Creek Hatchery, which is located immediately downstream from the Little White Salmon River mouth, is the largest tule Chinook salmon production program in the Columbia basin, releasing approximately 10 million smolts annually. The White Salmon River was the original source for the hatchery broodstock, so whatever remains of the genetic heritage of the population is contained in the mix of hatchery and natural spawners. There is relatively little known about current natural-origin fall Chinook salmon production in this basin, but it is presumed to be low.

There is relatively little specific or recent information on the abundance of tule Chinook salmon for the other natural populations in the Gorge Fall MPG. Stray hatchery fish are presumed to be decreasing contributors towards the spawning populations in these tributaries due to recent reductions in overall Gorge MPG hatchery releases, including the recent discontinuation of tule Chinook salmon releases from the Little White Salmon Hatchery. Hatchery strays still contribute

[8] These fish are not part of the LCR Chinook ESU.

to the escapement to the Lower Gorge, Upper Gorge, and Hood River populations on the Oregon side of the river (NMFS 2013a, Appendix A). These populations are mostly influenced by hatchery strays from the Bonneville Hatchery located immediately below Bonneville Dam, and the Spring Creek Hatchery located just above Bonneville Dam. The natural-origin abundance of returning Chinook salmon on the Washington side of the Lower and Upper Gorge populations has been steadily increasing in recent years. The tributaries in the Gorge on the Washington side of the river are similarly affected by hatchery strays. As a consequence, hatchery-origin fish contribute at varying degrees to spawning levels in all of the Gorge area tributaries, but actual estimates are unknown for areas like Eagle Creek, Tanner Creek and Herman Creek.

Cascade Fall MPG

There are ten populations in the Cascade MPG. Of these, only the Coweeman and East Fork Lewis populations are considered genetic legacy populations. The baseline persistence probability of all of these populations is listed as very low (Table 2-6). These determinations were generally based on assessments of status at the time of listing. The Lower Cowlitz, Kalama, Clackamas, and Sandy populations are targeted for medium persistence probability and Toutle, Coweeman, Lewis, and Washougal populations are targeted for high-plus persistence probability in the ESA recovery plan. The target persistence probability for the other two populations is very low: Salmon Creek, a population within a highly urbanized subbasin with limited habitat recovery potential, and Upper Cowlitz, a population with reintroduction of spring Chinook salmon as the main recovery effort (NMFS 2013a) (Table 2-6).

Total escapements (natural-origin and hatchery fish combined) to the Coweeman and East Fork Lewis have averaged 735 and 612, respectively, over the last eighteen years (Table 2-9), compared to recovery abundance targets of 900 and 1,500 (Table 2-6). The historical contribution of hatchery spawners to the Coweeman and East Fork Lewis populations is relatively low compared to that of other populations (Beamesderfer et al. 2011). The Kalama, Washougal, Toutle, and Lower Cowlitz natural populations are all associated with in-basin hatchery production and are subject to large numbers of hatchery strays (Beamesderfer et al. 2011). We have less information on returns to the Clackamas and Sandy Rivers, but ODFW indicated for both that 90% of the spawners are likely hatchery strays from as many as three adjacent hatchery programs (NMFS 2013a, Appendix A).

The Coweeman and Lewis populations do not have in-basin hatchery programs and are generally subject to less straying. Broodstock management practices for hatcheries are being revised to reduce the level of straying and the resulting effects when straying occurs. Weirs are being operated on the Kalama River to assist with broodstock management, and on the Coweeman and Washougal Rivers to further assess and control hatchery straying in each system. These are examples of actions the states have taken as part of a comprehensive program of hatchery reform to address the effects of hatcheries. The nature and scale of the reform actions were described in more detail in Frazier (2011) and Stahl (2011).

Table 2-9. LCR tule Chinook salmon total natural spawner escapement (natural-origin) and the proportion of hatchery-origin fish (pHOS[1]) on the spawning grounds for Cascade Fall MPG populations, 1997-2015 (from WDFW SCoRE[2])[3].

Year	Coweeman	pHOS	Washougal	pHOS	Kalama	pHOS	EF Lewis	pHOS	Upper Cowlitz[4]	pHOS	Lower Cowlitz	pHOS	Toutle[5]	pHOS
1997	689	na	4,529	na	3,539	na	307	na	27	na	2,710	na	na	na
1998	491	na	2,971	na	4,318	na	104	na	257	na	2,108	na	1,353	na
1999	299	na	3,105	na	2,617	na	217	na	1	na	997	na	720	na
2000	290	na	2,078	na	1,420	na	304	na	1	na	2,363	na	879	na
2001	802	na	3,836	na	3,613	na	526	na	3,646	na	4,652	na	4,971	na
2002	877	na	5,725	na	18,809	na	1,296	na	6,113	na	13,514	na	7,896	na
2003	1,106	na	3,440	na	24,710	na	714	na	4,165	na	10,048	na	13,943	na
2004	1,503	na	10,404	na	6,612	na	886	na	2,145	na	4,466	na	4,711	na
2005	853	na	2,671	na	9,168	na	598	na	2,901	na	2,870	na	3,303	na
2006	566	na	2,600	na	10,386	na	427	na	1,782	na	2,944	na	5,752	na
2007	251	na	1,528	na	3,296	na	237	na	1,325	na	1,847	na	1,149	na
2008	424	na	2,491	na	3,734	na	379	na	1,845	na	1,828	na	1,725	na
2009	783	na	2,741	na	7,546	na	596	na	7,491	na	2,602	na	539	na
2010	446	30%	833	86%	832	88%	378	64%	3,700	62%	3,169	29%	275	87%
2011	500	12%	842	82%	599	93%	827	71%	5,029	62%	2,782	25%	338	79%
2012	412	11%	305	72%	517	93%	601	52%	1,951	68%	1,946	29%	259	73%
2013	1,398	31%	3,018	58%	1,037	91%	1,441	85%	3,287	55%	3,593	19%	950	58%
2014	857	4%	1,362	33%	1,029	91%	856	57%	na	na	na	na	371	50%
2015	1,430	1%	1,703	57%	3,598	50%	947	50%	na	na	4,241	na	440	39%

[1] proportion of hatchery-origin spawners (pHOS): hatchery fish escaping to the spawning grounds. For example, Coweeman in 2013 had 1,398 natural-origin spawners and 31% hatchery spawners. To calculate hatchery-origin numbers, multiply (1,398/ (1-.31))-1,398 = 628 hatchery-origin spawners.

[2] Online at: https://fortress.wa.gov/dfw/score/score/species/chinook.jsp?species=Chinook

[3] Date Accessed: October 4, 2017

[4] Upper Cowlitz includes the Cispus portions of the Cowlitz River. Only natural spawner abundance estimates are shown. No data exists for 2014-2015 as of date of website access.

[5] Toutle River numbers include both the North Fork Toutle (Green River) and South Fork Toutle River fall (tule) Chinook salmon.

Coastal Fall MPG

There are seven natural populations in the Coast Fall Chinook salmon MPG. None are considered genetic legacy populations. The baseline persistence probability of five of the seven populations in this MPG is listed as very low, whereas the remaining two populations are listed as low (Youngs Bay and Scappoose) (Table 2-6). All of the populations are targeted for improved persistence probability in the recovery scenario. The Elochoman/Skamokawa, Clatskanie, Mill/Abernathy/Germany (M/A/G), and Scappoose populations are targeted for high persistence, while the Grays River is targeted for medium plus persistence probability. The Big Creek and Youngs Bay populations are targeted for low persistence probability (Table 2-6).

Populations in this MPG are subject to high levels of hatchery straying (Beamesderfer et al. 2011). There was a Chinook salmon hatchery on the Grays River, but that program was closed in 1997 with the last hatchery returns to the river in 2002. A temporary weir was installed for the first time on the Grays River in 2008 to quantify escapement and to help control the number of hatchery strays from hatchery programs outside the Grays River. As it turns out, a large number of out-of-ESU Rogue River "brights" from the Youngs Bay net pen programs were observed at the weir, and by 2010 the weir was functionally able to begin removing hatchery strays. It is worth noting that the escapement data, reported in Table 2-10, have been updated through 2015 relative to those reported in the 2010 status review (Ford 2011).

Table 2-10. Early-fall (tule) Chinook salmon (in Coast MPG) total natural spawner abundance estimates (natural- and hatchery-origin fish combined) and the proportion of hatchery-origin fish (pHOS1) on the spawning grounds for the Coast Fall MPG populations, 1997-2015 (from WDFW SCoRE[2]).

Year	Clatskanie[3]	pHOS	Grays	pHOS	Elochoman[5]	pHOS	M/A/G[5]	pHOS	Youngs Bay[4]	pHOS
1997	7	na	12	na	2,137	na	595	na	na	na
1998	9	na	93	na	358	na	353	na	na	na
1999	10	na	303	na	957	na	575	na	na	na
2000	26	90%	89	na	146	na	370	na	na	na
2001	26	90%	241	na	2,806	na	3,860	na	na	na
2002	39	90%	78	na	7,893	na	3,299	na	na	na
2003	48	90%	373	na	7,348	na	3,792	na	na	na
2004	11	90%	726	na	6,880	na	4,611	na	na	na
2005	10	90%	122	na	2,699	na	2,066	na	na	na
2006	4	90%	383	na	324	na	622	na	na	na
2007	9	90%	96	na	168	na	335	na	na	na
2008	9	90%	33	65%	1,320	na	780	na	na	na
2009	94	44%	210	62%	1,467	na	604	na	na	na
2010	12	88%	70	55%	154	88%	194	93%	1,152	0%
2011	12	100%	70	83%	59	95%	111	93%	1,584	61%
2012	6	92%	43	79%	64	73%	23	88%	170	97%
2013	3	92%	189	91%	187	71%	207	80%	409	95%
2014	7	91%	322	56%	192	78%	65	90%	119	95%
2015	6	91%	156	85%	313	68%	92	91%	382	81%

[1] Proportion of hatchery-origin spawners (pHOS): hatchery fish escaping to the spawning grounds. For example, Clatskanie in 2007 had 9 natural-origin spawners and 90% hatchery spawners. To calculate hatchery-origin numbers multiply (9/ (1-.90))-9 = 81 hatchery-origin spawners.
[2] Online at: https://fortress.wa.gov/dfw/score/score/species/chinook.jsp?species=Chinook
Date Accessed: October 4, 2017
[3] Clatskanie estimates are from:
http://odfwrecoverytracker.org/explorer/species/Chinook/run/fall/esu/241/244/ Date Accessed: October 4, 2017
[4] Youngs Bay estimate is from: http://odfw.forestry.oregonstate.edu/spawn/pdf%20files/reports/2012-13LCTuleSummary%20.pdf Date accessed: May 19, 2016
[5] Elochoman and Ge/Ab/Mi estimates from 1997-2009 are considered a proportion on the WDFW SCoRE website. Elochoman estimates include the Skamokawa Creek Fall Chinook Spawners (proportion).

Spatial Structure and Diversity

Spatial structure and diversity are VSP attributes that are evaluated for the LCR Chinook Salmon ESU using a mix of qualitative and quantitative metrics. Spatial structure has been substantially reduced in many populations within the ESU (NMFS 2013a). The 2015 VSP status for LCR Chinook salmon populations indicate that a total of 2 of 32 populations are at their recovery viability goals (Table 2-10), although under the recovery plan scenario only one of these populations are at a moderate level of viability (NWFSC 2015). The remaining populations generally require a higher level of viability, and most require substantial improvements to reach their viability goals (NWFSC 2015). The natural populations that did meet their recovery goals were able to do so because the goals were set at status quo levels.

Table 2-11 provides recently updated information about the abundance and productivity (A/P), spatial structure, diversity, and overall persistence probability for each population within the LCR Chinook Salmon ESU. Spatial structure has been substantially reduced in several populations. Low abundance, past broodstock transfers, other legacy hatchery effects, and ongoing hatchery straying may have reduced genetic diversity within and among LCR Chinook salmon populations. Hatchery-origin fish spawning naturally may also have reduced population productivity (LCFRB 2010; ODFW 2010).

Out of the 32 populations that make up this ESU, only the two late-fall “bright” runs – the North Fork Lewis and Sandy – are considered viable. Most populations (26 out of 32) have a very low probability of persistence over the next 100 years (and some are extirpated or nearly so) (NMFS 2016). Five of the six strata fall substantially short of the WLC-TRT criteria for viability; one stratum, Cascade late-fall, meets the WLC TRT criteria (NMFS 2013a; 2016).

Abundance and productivity (A/P) ratings for LCR Chinook salmon populations are currently low to very low for most populations, except for spring Chinook salmon in the Sandy River (moderate) and late-fall Chinook salmon in North Fork Lewis River and Sandy Rivers (very high for both) (Table 2-11) (NMFS 2013a). For some of these populations with low or very low A/P ratings, low abundance of natural-origin spawners (100 fish or fewer) has increased genetic and demographic risks. Other LCR Chinook salmon populations have higher total abundance, but several of these also have high proportions of hatchery-origin spawners. For tule fall Chinook salmon populations, poor data quality prevents precise quantification of population abundance and productivity; data quality has been poor because of inadequate spawning surveys and the presence of unmarked hatchery-origin spawners (NWFSC 2015).

Table 2-11. LCR Chinook Salmon ESU MPG, ecological sub-regions, run timing, populations, and scores for the key elements (A/P, spatial structure, and diversity) used to determine overall net persistence probability of the population (NWFSC 2015).[1]

MPG		Spawning Population (Watershed)	A/P	Spatial Structure	Diversity	Overall Persistence Probability
Ecological Subregion	**Run Timing**					
Cascade Range	Spring	Upper Cowlitz River (WA)	VL	L	M	VL
		Cispus River (WA)	VL	L	M	VL
		Tilton River (WA)	VL	VL	VL	VL
		Toutle River (WA)	VL	H	L	VL
		Kalama River (WA)	VL	H	L	VL
		North Fork Lewis (WA)	VL	L	M	VL
		Sandy River (OR)	M	M	M	M
	Fall	Lower Cowlitz River (WA)	VL	H	M	VL
		Upper Cowlitz River (WA)	VL	VL	M	VL
		Toutle River (WA)	VL	H	M	VL
		Coweeman River (WA)	L	H	H	L
		Kalama River (WA)	VL	H	M	VL
		Lewis River (WA)	VL	H	H	VL
		Salmon Creek (WA)	VL	H	M	VL
		Clackamas River (OR)	VL	VH	L	VL
		Sandy River (OR)	VL	M	L	VL
		Washougal River (WA)	VL	H	M	VL
	Late Fall	North Fork Lewis (WA)	VH	H	H	VH
		Sandy River (OR)	VH	M	M	VH
Columbia Gorge	Spring	White Salmon River (WA)	VL	VL	VL	VL
		Hood River (OR)	VL	VH	VL	VL
	Fall	Lower Gorge (WA & OR)	VL	M	L	VL
		Upper Gorge (WA & OR)	VL	M	L	VL
		White Salmon River (WA)	VL	L	L	VL
		Hood River (OR)	VL	VH	L	VL
Coast Range	Fall	Youngs Bay (OR)	L	VH	L	L
		Grays/Chinook rivers (WA)	VL	H	VL	VL
		Big Creek (OR)	VL	H	L	VL
		Elochoman/ Skamokawa creeks (WA)	VL	H	L	VL
		Clatskanie River (OR)	VL	VH	L	VL
		Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
		Scappoose River (OR)	L	H	L	L

[1] Persistence probability ratings and key element scores range from very low (VL), low (L), moderate (M), high (H), to very high (VH) (NWFSC 2015).

Limiting Factors and Threats

Understanding the limiting factors and threats that affect the Lower Columbia River Chinook ESU provides important information and perspective regarding the status of a species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. Lower Columbia River Chinook salmon populations began to decline by the early 1900s because of habitat alterations and harvest rates that were unsustainable given these changing habitat conditions. Human impacts and limiting factors come from multiple sources including hydropower development on the Columbia River and its tributaries, habitat degradation, hatchery effects, fishery management and harvest decisions, and ecological factors, including predation and environmental variability. Limiting factors and threats for the Lower Columbia River Chinook ESU were discussed in prior biological opinions (e.g., NMFS 2008a, 2008d, 2010b) and the management unit recovery plans. The ESU-level roll-up recovery plan consolidates the information available from various sources (NMFS 2013a).

The roll-up recovery plan provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them. Chapter 4 of the roll-up plan describes limiting factors on a regional scale and how they apply to the four listed species from the lower Columbia River considered in the plan. Chapter 7 of the roll-up recovery plan discusses the limiting factors that pertain to Lower Columbia River Chinook salmon in particular, with details that apply to the spring, fall, and late fall populations and major population groups in which they reside. The discussion of limiting factors in Chapter 7 is organized to address:

1. Tributary Habitat
2. Estuary Habitat
3. Hydropower
4. Hatcheries
5. Harvest
6. Predation

Chapter 4 includes additional details on large scale issues including:

7. Ecological Interactions
8. Climate Change
9. Human Population Growth

2.2.1.5. Status of Lower Columbia River Coho Salmon

LCR coho salmon were listed as threatened under the ESA, effective August 29, 2005 (70 FR 37160, June 28, 2005). The threatened status was reaffirmed on April 14, 2014. Critical Habitat was originally proposed January 14, 2013 and was finalized on January 24, 2016 (81 FR 9252). The ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries in Washington and Oregon from the mouth of the Columbia River up to and including the Big White Salmon and Hood rivers, and includes the Willamette River to Willamette Falls, Oregon, as well as 23 artificial propagation programs (Table 2-12, Figure 2-9). The Gorge MPG has three populations. The lower Gorge population includes several small tributaries located below Bonneville Dam. There are two populations in the upper Gorge. On the Washington side the Upper Gorge population includes fish returning to the Big White Salmon, Little White Salmon, and Wind Rivers and Spring Creek. On the Oregon side the Upper Gorge population includes Hood River and several small tributaries (Myers et al. 2006). The Upper Gorge early-returning adult coho salmon enter the Columbia River in mid-August and begin entering tributaries in early September, with peak spawning from mid-October to early November. Late-returning coho salmon pass through the lower Columbia from late September through December and enter tributaries from October through January.

Because of hatchery closures and program discontinuations over the past decade, NMFS recently updated its list of coho salmon hatchery programs that are included in the ESA listing (79 FR 20810, April 14, 2014) (Table 2-12). These hatchery stocks were included as part of the listed ESU in part based on a determination that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (70 FR 97160, June 28, 2006). Lack of data and poor data quality has made it difficult to assess rangewide status of the LCR coho salmon ESU. However, more recent spawner escapement information from 2002 in Oregon and from 2010 in Washington that was not available during previous status reviews suggests some populations may be doing better than previously thought. More on this new information is provided below.

Table 2-12. Current status for LCR coho salmon populations, recommended status under the recovery scenario (NMFS 2013a), and list of hatchery programs included in the ESU (Jones 2011).

Major Population Group	Population (State)	Status Assessment		Recovery Scenario	
		Baseline Persistence Probability[1]	Contribution[2]	Target Persistence Probability	Abundance Target[3]
Coast	Young's Bay (OR) - *Late*	VL	Stabilizing	VL	7
	Grays/Chinook (WA) - *Late*	VL	Primary	H	2,400
	Big Creek (OR) - *Late*	VL	Stabilizing	VL	12
	Elochoman/Skamokawa (WA) - *Late*	VL	Primary	H	2,400
	Clatskanie (OR) - *Late*	L	Primary	H	3,201
	Mill/Aber/Germ (WA) - *Late*	VL	Contributing	M	1,800
	Scappoose (OR) - *Late*	M	Primary	VH	3,208
Cascade	Lower Cowlitz (WA) - *Late*	VL	Primary	H	3,700
	Upper Cowlitz (WA) - *Early, late*	VL	Primary	H	2,000
	Cispus (WA) - *Early, late*	VL	Primary	H	2,000
	Tilton (WA) - *Early, late*	VL	Stabilizing	VL	--
	South Fork Toutle (WA) - *Early, late*	VL	Primary	H	1,900
	North Fork Toutle (WA) - *Early, late*	VL	Primary	H	1,900
	Coweeman (WA) - *Late*	VL	Primary	H	1,200
	Kalama (WA) - *Late*	VL	Contributing	L	500
	North Fork Lewis (WA) - *Early, late*	VL	Contributing	L	500
	East Fork Lewis (WA) - *Early, late*	VL	primary	H	2,000
	Salmon Creek (WA) - *Late*	VL	Stabilizing	VL	--
	Clackamas (OR) - *Early, late*	M	Primary	VH	11,232
	Sandy (OR) - *Early, late*	VL	Primary	H	5,685
	Washougal (WA) - *Late*	VL	Contributing	M+	1,500
Gorge	Lower Gorge (WA/OR) - *Late*	VL	Primary	H	1,900
	Upper Gorge/White Salmon (WA) - *Late*	VL	Primary	H	1,900
	Upper Gorge/Hood (OR) - *Early*	VL	Primary	H	5,162
Artificial production					

Hatchery programs included in ESU (23)	Grays River (Type-S), Sea Resources (Type-S), Peterson Coho Project (Type-S), Big Creek Hatchery (ODFW stock #13), Astoria High School (STEP) Coho Program, Warrenton High School (STEP) Coho Program, Cathlamet High School FFA Type-N Coho Program, Cowlitz Type-N Coho Program, Cowlitz Game and Anglers Coho Program, Friends of the Cowlitz Coho Program, North Fork Toutle River Hatchery (type-S), Kalama River Type -N Coho Program, Kalama River Type-S Coho Program, Lewis River Type-N Coho Program, Lewis River Type-S Coho Program, Fish First Wild Coho Program, Fish First Type-N Coho Program, Syverson Project Type-N Coho Program, Washougal River Type-N Coho Program, Eagle Creek NFH, Sandy Hatchery (ODFW stock #11), Bonneville/Cascade/Oxbow Complex (ODFW stock #14)
Hatchery programs not included in ESU (1)	Clatsop County Fisheries (CCF) Coho Salmon Program (Klaskanie River origin) *The Elochoman Type S and Type N coho salmon hatchery programs have been discontinued and NMFS has recommended removing them from the ESU (Jones 2011).

[1] VL = very low, L = low, M = moderate, H = high, VH = very high. These are adopted in the recovery plan.
[2]Primary, contributing, and stabilizing designations reflect the relative contribution of a population to recovery goals and delisting criteria. Primary populations are targeted for restoration to a high or very high persistence probability. Contributing populations are targeted for medium or medium-plus viability. Stabilizing populations are those that will be maintained at current levels (generally low to very low viability), which is likely to require substantive recovery actions to avoid further degradation.
[3]Abundance objectives account for related goals for productivity.

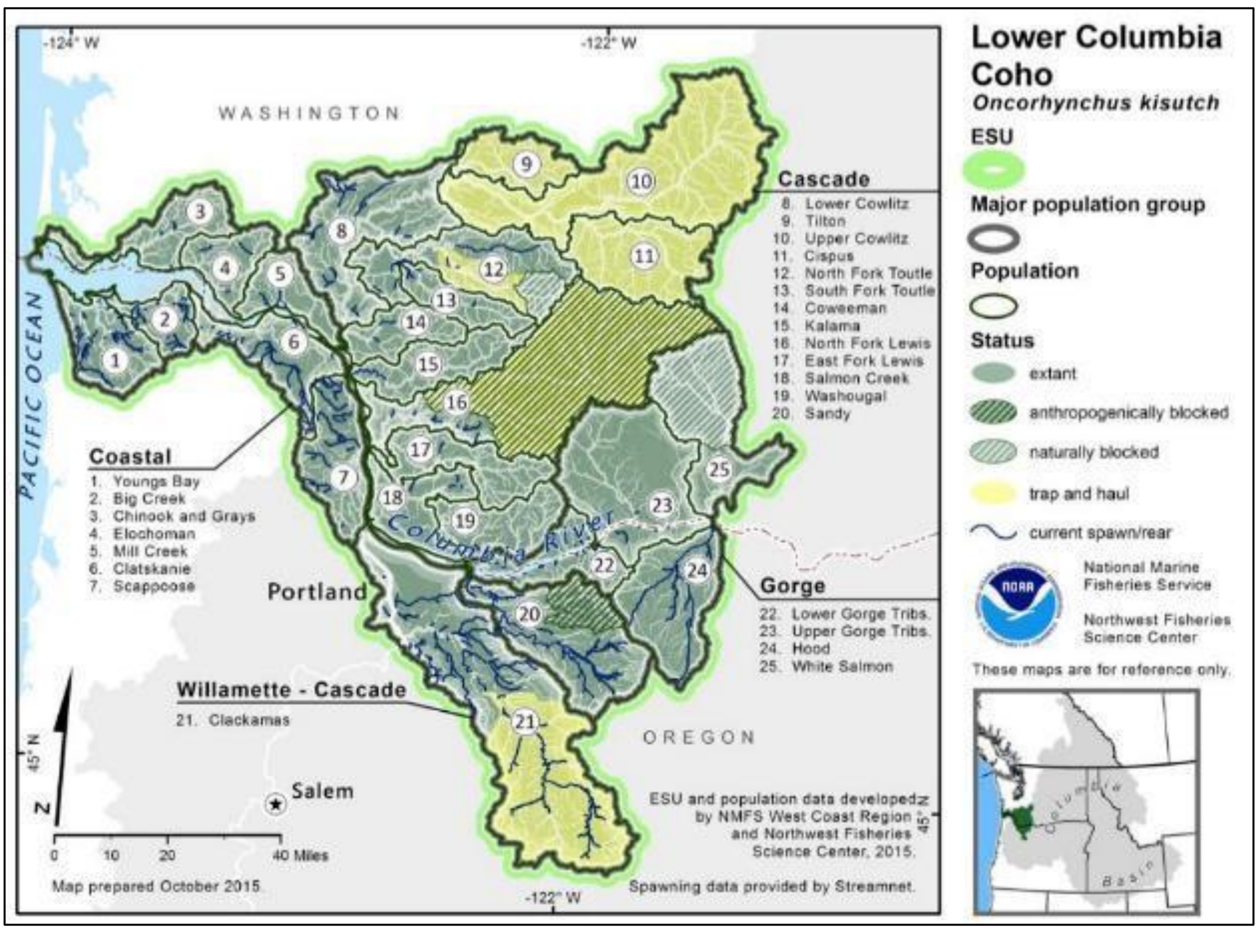

Figure 2-7. Map of the LCR Coho Salmon ESU's spawning and rearing areas, illustrating populations and MPGs (Source: NWFSC 2015)

NMFS conducted status reviews of the LCR coho salmon ESU in 1996 (NMFS 1996), in 2001 (Weitkamp 2001), in 2005 (Good et al. 2005), and again in 2011 (Ford 2011). In 1996, the

Biological Review Team (BRT) concluded that they could not identify any remaining natural populations of coho salmon in the lower Columbia River (excluding the Clackamas River) or along the Washington coast south of Point Grenville that warranted protection under the ESA, although this conclusion would warrant reconsideration if new information became available. At that time, LCR coho salmon were thought to be extirpated. In the 2001 review, the BRT was very concerned that the vast majority (more than 90 percent) of historical populations in the ESU appear to be either extirpated or nearly so. The two populations with relatively high production (Sandy and Clackamas Rivers) were at appreciable risk because of low abundance, declining trends, and failure to respond after a dramatic reduction in harvest. The large number of hatchery coho salmon in the ESU was also considered an important risk factor.

The 2005 status review concluded, based on information available through 2002, that only Clackamas and Sandy populations had appreciable levels of natural production. Very limited information on the remainder of the 21 populations was available at that time, and most were considered extirpated, or nearly so, during the low marine survival period of the 1990s. Available spawner and juvenile outmigrant trapping information did indicate that there was some natural coho salmon production in the lower Columbia River, but it was generally assumed that most of the smolt production was from hatchery strays that were spawning in the wild.

Four evaluations of LCR coho salmon status, all based on WLC-TRT criteria, were conducted after the 2005 status update (McElhany et al. 2007; LCFRB 2010; ODFW 2010; Ford 2011). McElhany et al. (2007) concluded that the ESU is currently at high risk of extinction. ODFW (2010) concluded that the Oregon portion of the ESU is currently at very high risk. The LCFRB (2010) does not provide a statement on ESU-level status, but describes the high fraction of populations in the ESU that are at high or very high risk. According to Ford (2011), of the 27 historical populations in the ESU, 24 are considered at very high risk. The latest status review (NWFSC 2015) relied on data available through 2014. According to the NWFSC, the status of a number of coho salmon populations have changed since previous reviews, mostly due to the improved level of monitoring (and subsequent understanding of status) in Washington tributaries, rather than a true change in status over time. Furthermore, the NWFSC (2015) determined that while recovery efforts have likely improved the status of a number of coho salmon populations, abundance is still at low levels and the majority of DIPs remain at moderate or high risk.

In 2017 NMFS adopted a Record of Decision ("Mitchell Act ROD") for a policy direction that would be used to guide NMFS's decision on the distribution of funds for hatchery production under the Mitchell Act (16 US C.F.R. § 755 757), which NMFS administers. NMFS's continued funding of Mitchell Act hatchery programs, under the Mitchell Act ROD was analyzed under the ESA and was found to not likely to jeopardize the continued existence of any species in the Columbia Basin (NMFS 2018). The Mitchell Act ROD directs NMFS to apply stronger performance goals to all Mitchell Act-funded, Columbia River Basin hatchery programs that affect ESA-listed primary and contributing salmon and steelhead populations. These stronger performance goals reduced the risks of hatchery programs on natural-origin salmon and steelhead populations, including the LCR Coho Salmon ESU. It required integrated hatchery programs to be better integrated and isolated hatchery programs to be better isolated. While the following information presented is a review of updated status information available, NMFS expects the prevalence of hatchery-origin coho salmon spawning contribution to decrease over the course of the 2018-2027 *United States v. Oregon* Management Agreement due to the ITS limits and terms and conditions required by the opinion (NMFS 2018).

Abundance and Productivity

Status of the species is determined based on the abundance, productivity, spatial structure, and diversity of its constituent natural populations. Best available information indicates that the species, in this case the LCR Coho Salmon ESU, is at high risk and remains at threatened status. Each population's baseline and target persistence probabilities are summarized in Table 2-12, along with target abundance for each population that would be consistent with delisting the species. Persistence probability is measured over a 100 year time period and ranges from very low (probability of less than 40%) to very high (probability of greater than 99%).

For LCR coho salmon, poor data quality prevented precise quantification of abundance and productivity. Data quality has been poor because of inadequate spawning surveys and, until recently, the presence of unmarked hatchery-origin spawners. Mass marking of hatchery-origin LCR coho salmon began in 1999 (LCFRB 2010) which generally allows assessment of what portion of escapement consists of hatchery-origin spawners and greatly improves the ability to assess the status of populations.

Hatchery production dominates the Washington side of this ESU and no populations are thought to be naturally self-sustaining because the majority of spawners are believed to be hatchery strays. Washington did not collect adult escapement estimates until recently. The state's monitoring strategy has instead relied primarily on a smolt monitoring program. Similar to the Washington populations, natural productivity on the Oregon side of the LCR Coho Salmon ESU is also believed to have decreased due to legacy effects of hatchery fish. While total hatchery production has been reduced from a peak in the 1980s most populations are still believed to have very low abundance of natural-origin spawners (NMFS 2013a; NWFSC 2015).[9]

In general, hatchery-origin fish comprise the large majority of LCR coho salmon annual adult returns (Table 2-13 and Table 2-14). Numbers can vary substantially from year-to-year because coho salmon encounter and are affected by the widely-varying conditions for marine survival related to environmental conditions particularly in the coastal upwelling zone. Until recently, no population was thought to be naturally self-sustaining, with the majority of spawners believed to be hatchery strays. Moreover, it is likely that hatchery effects have also decreased population productivity. New and added hatchery releases of coho salmon in areas upstream of the LCR may be impacting natural-origin LCR coho salmon through straying, competition, and predation in the lower mainstem and estuary.

Information that has recently become available indicates that the frequency of hatchery fish straying onto natural spawning grounds is actually quite low for several natural coho salmon populations, which are thought to be self-sustaining. Table 2-15 presents escapement of LCR coho salmon in selected Oregon tributaries (2002–15). Table 2-14 presents escapement of LCR coho salmon in selected Washington tributaries (2002–15). New information about escapement of LCR coho salmon in Oregon and Washington that was not available in prior status reviews (Table 2-13 and Table 2-14) suggest that there has been an increase in the wild fraction of natural-origin coho salmon in their relative abundances. Additionally, hatchery-fish straying into Oregon populations within the LCR Coho Salmon ESU has decreased while pockets of natural

[9] An average of approximately 10-17 million hatchery coho salmon since 2005 have continued to be released annually in the LCR.

production, such as with the Scappoose and Clackamas populations, are also now increasing in their contribution to the overall Oregon coho salmon abundance.

Table 2-13 and Table 2-14 provide estimates of escapement for tributaries on the Oregon and Washington sides of the lower Gorge population, respectively. It is unclear how comprehensive the surveys are or if the estimates are intended to be expanded estimates for the population as a whole. On the Washington side, the estimates are characterized as cumulative fish per mile index counts. This information, although limited, indicates there are several hundred spawners in these tributaries that collectively make up the population and that hatchery fractions are actually relatively low.

Table 2-13. Natural-origin spawning escapement numbers and proportion of hatchery-origin fish in the spawning grounds for LCR coho salmon populations in Oregon (http://www.odfwrecoverytracker.org/). For example, Clatskanie in 2007 had 583 natural-origin spawners and 48 percent hatchery spawners. To calculate hatchery-origin numbers multiply (583/(1-.48))-583 = 538 hatchery-origin spawners. Data through 2015, the last year available.

Major Population Group	Oregon Populations	Origin	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Coast	Youngs Bay	Natural	411	113	149	79	74	21	82	26	68	161	129	na	na	na
		pHOS	86%	86%	86%	75%	84%	40%	22%	92%	61%	66%	46%	na	na	na
	Big Creek	Natural	98	435	112	219	225	212	360	792	279	160	409	na	na	na
		pHOS	90%	40%	70%	36%	50%	15%	54%	30%	52%	21%	18%	na	na	na
	Clatskanie	Natural	167	563	398	494	421	927	995	1,195	1,686	1,546	619	611	3,246	240
		pHOS	22%	0%	0%	1%	10%	4%	0%	1%	3%	1%	11%	11%	4%	4%
	Scappoose	Natural	502	336	755	348	719	375	292	778	1,960	298	210	979	1,587	487
		pHOS	0%	10%	8%	0%	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Cascade	Clackamas	Natural	1,981	2,507	2,874	1,301	3,464	3,608	1,694	7,982	1,757	2,254	1,580	3,202	10,670	1,784
		pHOS	57%	10%	16%	28%	76%	14%	45%	27%	57%	10%	10%	2%	14%	11%
	Sandy	Natural	382	1,348	1,213	856	923	687	1,277	1,493	901	3,494	1,165	667	5,942	443
		pHOS	57%	0%	9%	0%	na	9%	0%	10%	12%	8%	3%	12%	3%	5%
Gorge	Lower Gorge	Natural	338	na	na	263	226	126	223	468	920	216	96	151	362	30
		pHOS	17%	na	na	85%	70%	67%	46%	29%	7%	54%	56%	6%	51%	38%
	Upper Gorge/ Hood	Natural	147	41	126	1,262	373	170	69	65	223	232	169	561	42	4
		pHOS	60%	na	na	45%	48%	45%	29%	0%	85%	69%	78%	65%	76%	64%

Table 2-14. Natural-origin and hatchery-origin spawning escapement for LCR coho populations in Washington (WDFW unpublished). For example, Mill Creek in 2010 had 859 natural-origin spawners and 12% hatchery spawners (pHOS). To calculate hatchery-origin numbers multiply (859/(1-.12))-859 = 117 hatchery-origin spawners.

Major Population Group	Washington Populations	Origin	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Coast	Gray's/Chinook	Natural	-	-	-	-	-	-	-	-	388	152	795	1,212	3,700	86
		pHOS	-	-	-	-	-	-	-	-	81%	97%	22%	65%	32%	80%
	Eloch/ Skam	Natural	-	-	-	-	-	-	-	-	834	851	505	721	4,158	168
		pHOS	-	-	-	-	-	-	-	-	73%	56%	29%	43%	34%	50%
	Mill Creek	Natural	-	-	-	-	-	-	-	-	859	576	207	101	932	-
		pHOS	-	-	-	-	-	-	-	-	12%	21%	2%	-	12%	-
	Abernathy	Natural	-	-	-	-	-	-	-	-	490	183	256	384	832	-
		pHOS	-	-	-	-	-	-	-	-	12%	21%	2%	-	12%	-
	Germany	Natural	-	-	-	-	-	-	-	-	322	48	122	149	475	-
		pHOS	-	-	-	-	-	-	-	-	12%	21%	2%	-	12%	-
Cascade	Lower Cowlitz	Natural	-	-	-	-	-	-	-	-	6,274	3,394	-	1,565	12,661	5,132
		pHOS	-	-	-	-	-	-	-	-	15%	8%	-	-	5%	8%
	Upper Cowlitz/Cispus	Natural	54,188	20,695	28,665	22,329	25,574	5,691	13,805	16,162	18,905	7,326	2,397	7,941	25,147	1,012
		pHOS	13%	28%	14%	21%	18%	40%	26%	26%	13%	51%	40%	0%	22%	-
	Tilton	Natural	1,732	601	722	1,332	738	827	1,006	1,305	929	2,025	1,301	2,744	9,074	-
		pHOS	91%	92%	95%	85%	69%	66%	64%	70%	80%	75%	79%	67%	39%	-
	SF Toutle	Natural	-	-	-	-	-	-	-	-	1,518	490	2,063	3,349	10,960	1,537
		pHOS	-	-	-	-	-	-	-	-	21%	22%	14%	-	19%	53%
	NF Toutle[2]	Natural	-	-	-	-	-	-	-	-	1,454	365	1,425	3,497	6,597	868
		pHOS	-	-	-	-	-	-	-	-	60%	30%	24%	-	32%	65%
	Coweeman	Natural	-	-	-	-	-	-	-	-	3,528	2,436	2,964	4,047	5,021	767

		pHOS	-	-	-	-	-	-	-	-	10%	6%	5%	-	17%	25%
	Kalama	Natural	-	-	-	-	-	-	-	-	5	-	69	64	99	18
		pHOS	-	-	-	-	-	-	-	-	99%	-	78%	-	91%	90%
	NF Lewis[3]	Natural	-	-	-	-	-	-	-	-	700	604	827	-	-	-
		pHOS	-	-	-	-	-	-	-	-	1%	3%	11%	-	100%	75%
	EF Lewis	Natural	-	-	-	-	-	-	-	-	1,363	1,025	3,681	3,251	2,531	389
		pHOS	-	-	-	-	-	-	-	-	32%	6%	9%	-	20%	17%
	Salmon Creek	Natural	-	-	-	-	-	-	-	-	-	1,248	1,897	2,693	4,257	1,348
		pHOS	-	-	-	-	-	-	-	-	-	20%	22%	-	0%	0%
	Washougal	Natural	-	-	-	-	-	-	-	-	795	562	531	604	737	101
		pHOS	-	-	-	-	-	-	-	-	44%	8%	13%	-	65%	67%
Gorge	Lower Gorge	Natural	-	-	-	-	28	-	-	-	385	504	524	1,125	704	650
		pHOS	-	-	-	-	0%	-	-	-	29%	13%	20%	-	35%	11%
	Upper Gorge/ Hood	Natural	147	41	126	1,262	373	170	69	65	223	232	169	561	42	4
		pHOS	-	-	-	-	-	-	-	-	-	-	-	-	23%	24%

[1] For example, Mill Creek in 2010 had 859 natural-origin spawners and 12 % hatchery spawners. To calculate hatchery-origin numbers multiply (859/(1-.12))-859 = 117 hatchery-origin spawners.

[2] Natural-origin escapement numbers and proportion of hatchery-origin fish combines the Green River (NF Toutle) coho salmon, the North Fork Toutle River coho salmon, and trap count data.

[3] Natural-origin escapement numbers and proportion of hatchery-origin fish combines the Cedar Creek (NF Lewis) coho salmon and the North Fork Lewis River Mainstem coho salmon.

[4] Date accessed: October 4, 2017.

Table 2-15 presents recent escapement information (2010–12) compared to recovery abundance targets. Many populations are still below goal, but several are close to or above goal, and all are generally improved from NMFS's earlier assessments that concluded that the LCR coho salmon populations were all extirpated or nearly so.

There is limited information available for the Gorge MPG populations. Table 2-13 provides estimates of escapement for tributaries on the Oregon side of the lower Gorge population and Table 2-14 provides similar estimates for the Washington side tributaries. It is not clear how comprehensive the surveys are or if the estimates are intended to be expanded estimates for the population as a whole. On the Washington side, the estimates are characterized as cumulative fish per mile index counts. The information, although limited, indicates there are several hundred spawners in these tributaries that collectively make up the population and that hatchery fractions are actually relatively low. The sum of natural-origin escapement to the Lower Gorge tributaries (Table 2-13 and Table 2-14) is 948, which is half of the recovery abundance target (Table 2-15) and well above the critical abundance threshold of 300 set for primary populations.

Table 2-13 provides estimates of escapement for the Upper Gorge Oregon-side population but is limited to Hood River and does not include returns to other Oregon-side tributaries. Table provides a limited set of information for the Upper Gorge Washington-side population, but these estimates are limited to the Wind River. The Big White Salmon is the largest tributary on the Washington side of the Upper Gorge MPG. Condit Dam, formerly located at river mile (RM) 3 on the Big White Salmon, was completed in 1913. Condit Dam was built without fish passage and there was little or no suitable habitat in the lower river. As a result, coho salmon in the Big White Salmon are considered extirpated. Condit Dam was taken out with removal completed in 2012, freeing up 21 miles of new habitat above the dam location. The recovery plan for the Big White Salmon calls for a period of passive reintroduction following dam removal, a process that is currently underway. Unfortunately, funding for spawning surveys has been limited and prioritized to look for Chinook salmon. As a consequence, there is no recent information on coho salmon abundance in the Big White Salmon.

Table 2-15. Recent (2010–12) escapement average compared to recovery abundance targets.

MPG	Population	Recovery Abundance Target	Ave. Annual Unmarked Spawners 2010–12	Recent Ave. as % of Escapement Goal
Coast	Grays/Chinook (WA)	2,400	438	18%
	Elochoman/Skamokawa (WA)	2,400	741	31%
	Clatskanie (OR)	3,201	1,246	39%
	Mill/Aber/Germ (WA)	1,800	1,022	57%
	Scappoose (OR)	3,208	806	25%
Cascade	Lower Cowlitz (WA)	3,700	4,725	128%
	Upper Cowlitz/Cispus (WA)	4,000	4,139	103%
	South Fork Toutle (WA)	1,900	1,446	76%
	North Fork Toutle (WA)	1,900	1,095	58%
	Coweeman (WA)	1,200	2,994	250%
	Kalama (WA)	500	37	7%

	North Fork Lewis (WA)	500	751	150%
	East Fork Lewis (WA)	2000	2,024	101%
	Clackamas (OR)	11,232	1,855	17%
	Sandy (OR)	5,685	1,859	33%
	Washougal (WA)	1,500	659	44%
Gorge	Lower Gorge (WA/OR)	1,900	948	50%

Existing recovery plans provide comprehensive all-H strategies for survival and recovery (LCFRB 2010; ODFW 2010; NMFS 2013a). Harvest and hatcheries were identified as key limiting factors for the LCR coho salmon ESU. Harvest has been reduced from exploitation rates of 90 percent and higher to what is now a proposed long-term average of 18 percent. Hatchery production for LCR coho salmon has been reduced from 30 to 40 million smolts to 10 million smolts currently. Hatchery reductions and other reforms specifically designed to reduce the effects of straying are also consistent with the hatchery provisions of the recovery plans in particular and overall recovery strategy in general (LCFRB 2010; ODFW 2010; NMFS 2013a).

Coast and Cascade MPGs

Ten out of the thirteen populations for these two MPGs that are identified as primary populations are specifically included in the Ad Hoc Lower Columbia River Natural Coho Workgroup's risk assessment. These ten primary populations are: Clatskanie, Scappoose, Elochoman/Skamakowa, Grays/Chinook (Coast MPG), and Clackamas, Sandy, Lower Cowlitz, Toutle, Coweeman, and East Fork Lewis (Cascade MPG).

Reductions in harvest rates, in combination with reductions in hatchery releases, habitat improvement, and other all-H benefits, have contributed to improved status and prospects for the survival and recovery of Coast MPG and Cascade MPG populations of the LCR coho salmon ESU as evidenced by the apparent improvement in status since the last status review. Increased numbers of natural-origin spawners and decreased fractions of hatchery spawners for most Coast MPG and Cascade MPG populations are consistent with the notion that fishery management actions implemented up to 2014 have contributed to and not impeded progress towards survival and recovery of most if not all the populations in these two MPGs. WDFW and ODFW will continue to collect status information for all LCR coho salmon populations. NMFS expects to review information related to status and other indicators after 3 years and periodically thereafter to confirm our assessment that the implementation of the new harvest matrix or other factors are not reversing the positive trends recently observed for these populations.

Gorge MPG

The Gorge MPG has three populations. The Lower Gorge population includes several small tributaries located on the Washington and Oregon side below Bonneville Dam. There are two populations in the Upper Gorge. On the Washington side, the Upper Gorge population includes fish returning to the Big White Salmon, Little White Salmon, and Wind Rivers, and Spring Creek. On the Oregon side, the Upper Gorge population includes Hood River and several small tributaries (McElhany et al. 2006).

There is less information available for the Gorge MPG populations. The information, although limited, indicates there are a several hundred spawners in these tributaries that collectively make up the population and that hatchery fractions are relatively low. The sum of natural-origin escapement to the Lower Gorge tributaries (Table 2-13 and Table 2-14) is 948, which is half of the recovery abundance target (Table 2-15) and well above the critical abundance threshold of 300 set for primary populations.

Reductions in overall harvest rates, in combination with reductions in basin-wide hatchery releases, habitat improvement, and other all-H benefits, has contributed to the survival and recovery of Gorge MPG populations as evidenced by the apparent improvement in status since the last status review (Ford 2011). The improvement is most evident for the Lower Gorge population. Escapement information for the Upper Gorge populations is limited and our sense that the status of the populations is improving must be inferred largely from the evidence available for other populations in the ESU.

Our perception of the status of LCR coho salmon has changed over time partly as a result of improving information but also because of real improvements in status. Assessments for the LCR Coho Salmon ESU since the 1990s indicate improved status with each successive report. LCR coho salmon were considered extirpated in 1996 and were not listed; however; the 2005 status review concluded that Clackamas and Sandy populations at least did have appreciable natural production and that the LCR coho salmon ESU had enough of its legacy to warrant protection under the ESA (Good et al. 2005). In the 2011 Status Review, Ford (2011) concluded that 21 of the 24 populations of the ESU were at very high risk. The remaining three (Sandy, Clackamas, and Scappoose) were considered at high to moderate risk. The most recent status review (Ford 2011) and recovery plan (NMFS 2013a) used status information available only through to 2008.

New information suggests an improvement in status for many of the LCR coho salmon populations relative to the latest status report (Ford 2011). The new information indicates that the proportion of hatchery-origin fish in the spawning grounds in the Coast and Cascade MPGs are quite low in the Sandy, Clatskanie, Scappoose, Mill Creek, Abernathy, Germany, Lower Cowlitz, Coweeman, and East Fork Lewis and that these in fact may be self-sustaining. Smolt production for several Washington populations coupled with the low hatchery fractions provides further evidence that these populations may be self-sustaining. According to Table 2-13 and Table 2-14, all three populations of the Gorge MPG have some level of natural production. Escapement estimates for the lower Gorge population in particular show low hatchery fractions and abundance that is about half of the recovery target. Average annual natural-origin spawners for 2010 to 2012 in Table 2-15 also offer a better assessment for all MPGs and the ESU as a whole compared to previous status reviews up to 2011 (Ford 2011). Several populations are near or above recovery abundance targets for natural-origin fish (Table 2-15).

Spatial Structure and Diversity

Any changes from the previous status review in VSP score for coho salmon populations reflect improvements in abundance, spatial structure, and diversity, as well as in monitoring (NWFSC 2015). Table 2-16 shows an overall summary of the abundance, productivity, spatial structure, and diversity ratings for each natural population within this ESU. Previous status reviews lacked adequate quantitative data on abundance and hatchery contribution for a number of populations whereas recent surveys provide a more accurate understanding of the status of these populations. However, with only two or three years of data, it is not possible to determine whether there has been a true improvement in status, though it is evident that the contribution of natural-origin fish is much higher than previously thought (NWFSC 2015).

Table 2-16. LCR Coho Salmon ESU populations and scores for the key elements (abundance/productivity (A/P), spatial structure, and diversity) used to determine current overall net persistence probability of the population (NMFS 2013a)[1].

Ecological Subregions	Population (Watershed)	A/P	Spatial Structure	Diversity	Overall Persistence Probability
Coast Range	Youngs Bay (OR)	VL	VH	VL	VL
	Grays/Chinook rivers (WA)	VL	H	VL	VL
	Big Creek (OR)	VL	H	L	VL
	Elochoman/Skamokawa creeks (WA)	VL	H	VL	VL
	Clatskanie River (OR)	L	VH	M	L
	Mill, Germany, and Abernathy creeks (WA)	VL	H	L	VL
	Scappoose River (OR)	M	H	M	M
Cascade Range	Lower Cowlitz River (WA)	VL	M	M	VL
	Upper Cowlitz River (WA)	VL	M	L	VL
	Cispus River (WA)	VL	M	L	VL
	Tilton River (WA)	VL	M	L	VL
	South Fork Toutle River (WA)	VL	H	M	VL
	North Fork Toutle River (WA)	VL	M	L	VL
	Coweeman River (WA)	VL	H	M	VL
	Kalama River (WA)	VL	H	L	VL
	North Fork Lewis River (WA)	VL	L	L	VL
	East Fork Lewis River (WA)	VL	H	M	VL
	Salmon Creek (WA)	VL	M	VL	VL
	Clackamas River (OR)	M	VH	H	M
	Sandy River (OR)	VL	H	M	VL
	Washougal River (WA)	VL	H	L	VL
Columbia Gorge	Lower Gorge Tributaries (WA & OR)	VL	M	VL	VL
	Upper Gorge/White Salmon (WA)	VL	M	VL	VL
	Upper Gorge Tributaries/Hood (OR)	VL	VH	L	VL

[1] Ratings range from very low (VL), low (L), moderate (M), high (H), to very high (VH) (NWFSC 2015).

Figure 2-8 shows the extinction risk ratings for all four VSP parameters, including spatial structure and diversity attributes, for Oregon populations (ODFW 2010). This figure was updated in 2010 using data available through 2008. The results indicate low to moderate extinction risk for spatial structure for most LCR coho salmon populations in Oregon but high diversity risk for all but two populations, the Sandy and Clackamas River populations. The assessments of spatial structure are combined with those of abundance and productivity to give an assessment of the overall status of LCR populations in Oregon. Extinction risk is rated as high or very high in overall status for all populations except the Scappoose and Clackamas river populations (Figure 2-8). Where updated ratings differ from those of McElhany et al. (2007) assessment the older rating is shown as an open diamond with a dashed outline.

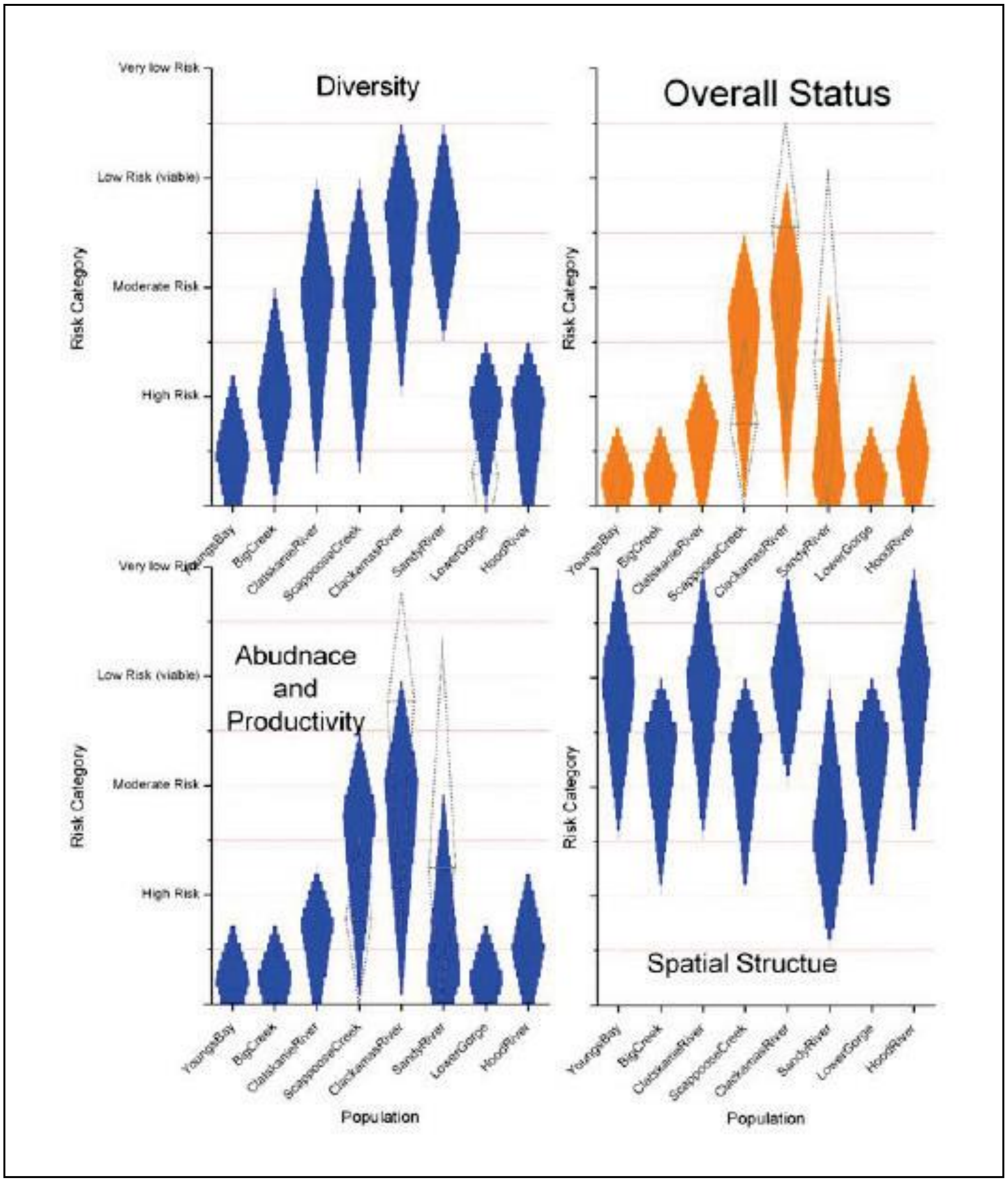

Figure 2-8. Extinction risk categories for LCR coho salmon populations in Oregon for the assessment attributes abundance/productivity, diversity, and spatial structure, as well as an overall rating for populations that combines the three attribute ratings (ODFW 2010).

The lack of data, as well as poor data quality, has made it difficult to assess spatial structure and diversity VSP attributes for LCR coho salmon. Low abundance, past hatchery stock transfers, other legacy hatchery effects, and hatchery straying may have reduced genetic diversity within and among coho salmon populations (LCFRB 2010; ODFW 2010). The low persistence probability and risk category for the majority of LCR coho salmon populations reported above is related to the loss of spatial structure and reduced diversity. Spatial structure of some coho salmon populations is constrained by migration barriers (i.e., tributary dams) and development of lowland areas (NMFS 2013a). Inadequate spawning survey coverage along with the presence until recently of unmarked hatchery-origin coho salmon mixing with natural-origin spawners also has made it difficult to assess the spatial structure of natural-origin populations. The mass marking of hatchery fish and more extensive spawning surveys have provided better information regarding species status in recent years.

In summary, the 2015 status review (NWFSC 2015) concluded that the LCR Coho Salmon ESU is still at very high risk. A total of 6 of the 23 populations in the ESU are at or near their recovery viability goals (Figure 69 in NWFSC 2015), although under the recovery plan scenario these populations had recovery goals only greater than 2.0 (moderate risk). The remaining populations require a higher level of viability (NWFSC 2015) and therefore still require substantial improvements. Best available information indicates that the LCR Coho Salmon ESU is at high risk and remains at threatened status.

Limiting Factors

LCR coho salmon populations began to decline by the early 1900s because of habitat alterations and harvest rates that were unsustainable given these changing habitat conditions. Human impacts and limiting factors come from multiple sources including hydropower development on the Columbia River and its tributaries, habitat degradation, hatchery effects, fishery management and harvest decisions, and ecological factors including predation and environmental variability. The ESU-level recovery plan consolidates the information regarding limiting factors and threats for the LCR coho salmon ESU available from various sources (NMFS 2013a).

The LCR recovery plan provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them. Chapter 4 of the recovery plan describes limiting factors on a regional scale and how they apply to the four listed species from the LCR considered in the plan (NMFS 2013a). Chapter 6 of the recovery plan discusses the limiting factors that pertain to LCR coho salmon in particular with details that apply to the major population groups in which they reside.

The discussion of limiting factors in Chapter 6 is organized to address:

- Tributary Habitat
- Estuary Habitat
- Hydropower
- Hatcheries
- Harvest
- Predation

Chapter 4 includes additional details on large scale issues including:

- Ecological Interactions
- Climate Change
- Human Population Growth

Rather than repeating this extensive discussion from the recovery plan, it is incorporated here by reference.

Harvest-related mortality is identified as a primary limiting factor for all populations within the ESU and occurs as a result of direct and incidental mortality of natural-origin fish in ocean fisheries, Columbia River recreational fisheries, and commercial gillnet fisheries. The LCR recovery plan envisions refinements in coho salmon harvest through (1) replacement or refinement of the existing harvest matrix to ensure that it adequately accounts for weaker components of the ESU, (2) continued use of mark-selective recreational fisheries, and (3) management of mainstem commercial fisheries to minimize impacts on natural-origin coho salmon (NMFS 2013a). The recent refinement of the harvest matrix ensured that harvest management is consistent with maintaining trajectories in populations where increasing natural production is beginning to be observed (e.g., the Clatskanie and Scappoose populations), with the assumption that additional refinements will be evaluated as natural production is documented in additional populations. Managing coho salmon harvest to minimize impacts on natural-origin fish has been complicated by uncertainties regarding annual natural-origin spawner abundance and actual harvest impacts on natural-origin fish (in both ocean and mainstem Columbia fisheries). The recovery plan notes these uncertainties and highlights the need for improved monitoring of harvest mortality and natural-origin spawner abundance.

High proportions of hatchery-origin fish in spawning populations has been purposeful in some areas—e.g., for reintroduction purposes in the Upper Cowlitz and Lewis subbasins—and will continue, but the recent opinion on the majority of hatchery production affecting this ESU (NMFS 2017h) expects federal funding guideline requirements to reduce limiting factors related to hatchery effects over the course of the next decade, thus likely benefiting the overall status of LCR coho.

2.2.1.6. Status of Snake River Fall Chinook Salmon

NMFS first listed the Snake River Fall-run Chinook Salmon ESU of Chinook salmon (*Oncorhynchus tshawytscha*) as a threatened species under the ESA on April 22, 1992 (57 FR 14653). NMFS revisited the listing June 28, 2005 (in light of its subsequent Hatchery Listing Policy) and determined that the species should remain listed as “threatened” (70 FR 37160). In 2010 and 2016, NMFS conducted 5-year reviews of the status of the species, and based on the best scientific information available at that time determined that the “threatened” classification remained appropriate (NMFS 2011b, 2016b).

The listed ESU includes all natural-origin fall-run Chinook salmon from the mainstem Snake River below Hells Canyon Dam at RM 247 (the lowest of three impassable dams that form the Hells Canyon Complex) and from the Tucannon River, Grande Ronde River, Imnaha River, Salmon River, and Clearwater River subbasins (Figure 2-9). Fall-run Chinook salmon from four artificial propagation programs are also considered part of the ESU: Lyons Ferry Hatchery Program, Fall Chinook Acclimation Ponds Program, Nez Perce Tribal Hatchery Program, and the Oxbow (Idaho Power Company) Hatchery Program (64 FR 50406, September 16, 1999).

Two historical populations (1 extirpated) within one MPG make up the Snake River Fall-run Chinook Salmon ESU. The extant natural population spawns and rears in the mainstem Snake River and its tributaries below Hells Canyon Dam. Figure 2-11 shows a map of the ESU area. The decline of this ESU was due to heavy fishing pressure beginning in the 1890s and loss of habitat with the construction of Swan Falls Dam in 1901 and the Hells Canyon Complex from

1958 to 1967, which extirpated one of the historical populations. Hatcheries mitigating for losses caused by the dams have played a major role in the production of Snake River fall-run Chinook salmon since the 1980s (NMFS 2012g). Since the species were originally listed in 1992, fishery impacts have been reduced in both ocean and river fisheries. Total exploitation rate has been relatively stable in the range of 40% to 50% since the mid-1990s (NWFSC 2015).

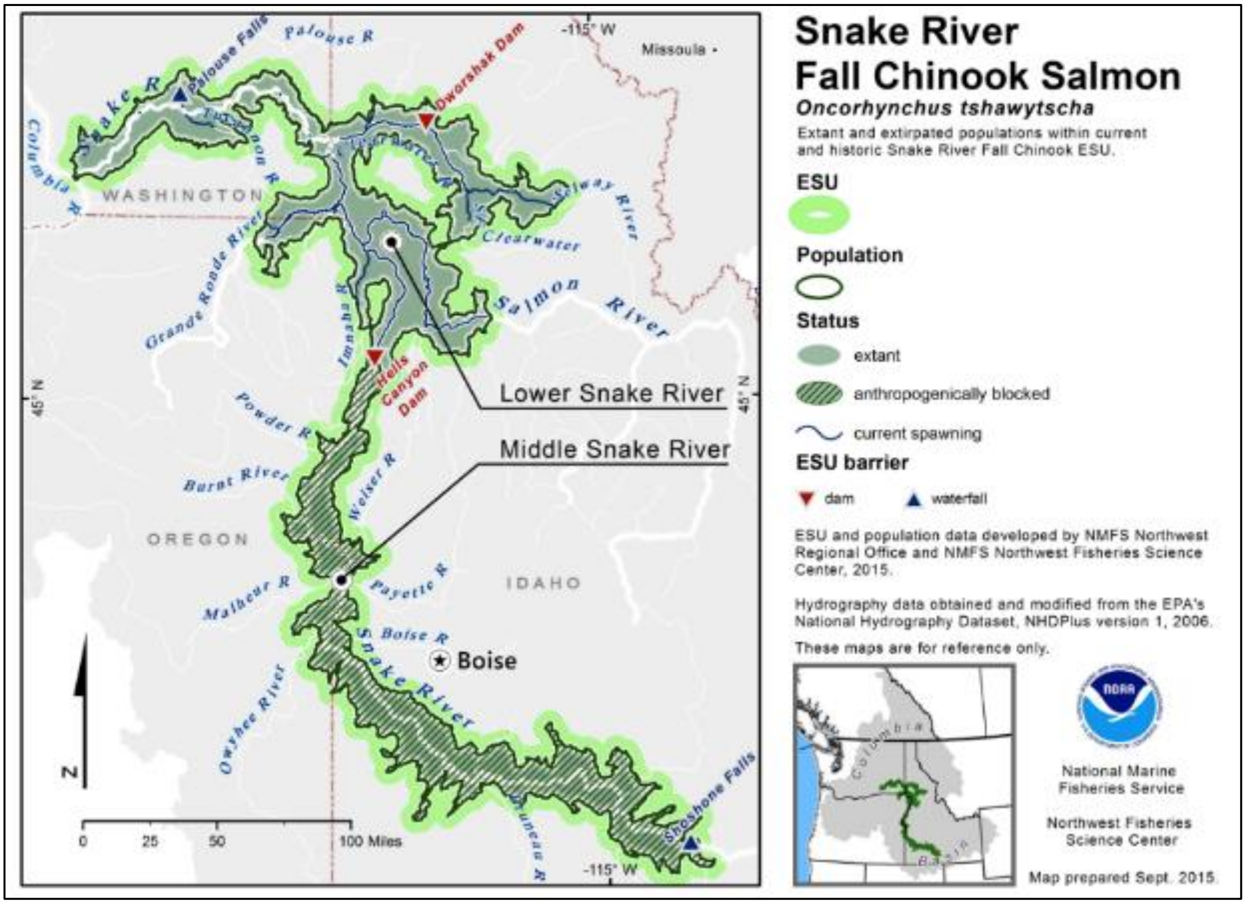

Figure 2-9. Map of the Snake River Fall-Run Chinook Salmon ESU’s spawning and rearing areas, illustrating populations and MPGs (NWFSC 2015).

Snake River fall-run Chinook salmon spawning and rearing occurs primarily in larger mainstem rivers, such as the Salmon, Snake, and Clearwater Rivers. Historically, the primary fall-run Chinook salmon spawning areas were located on the upper mainstem Snake River (Connor et al. 2005). Now, a series of Snake River mainstem dams block access to the Upper Snake River and about 85% of ESU’s spawning and rearing habitat. Swan Falls Dam, constructed in 1901, was the first barrier to upstream migration in the Snake River, followed by the Hells Canyon Complex beginning with Brownlee Dam in 1958, Oxbow Dam in 1961, and Hells Canyon Dam in 1967. Natural spawning is currently limited to: the Snake River from the upper end of LGR to Hells Canyon Dam; the lower reaches of the Imnaha, Grande Ronde, Clearwater, Salmon, and Tucannon rivers; and small areas in the tailraces of the Lower Snake River hydroelectric dams (Good et al. 2005).

Some fall-run Chinook salmon also spawn in smaller streams such as the Potlatch River, and Asotin and Alpowa Creeks, and they may be spawning elsewhere. The vast majority of spawning today occurs upstream of LGR, with the largest concentration of spawning sites in the mainstem Snake River (about 60%) and in the Clearwater River, downstream from Lolo Creek (about 30%) (NMFS 2012g).

As a consequence of losing access to historical spawning and rearing sites heavily influenced by the influx of ground water in the Upper Snake River and effects of dams on downstream water temperatures, Snake River fall-run Chinook salmon now reside in waters that may have thermal regimes that differ from those that historically existed. In addition, alteration of the Lower Snake River by hydroelectric dams has created a series of low-velocity pools that did not exist historically. Both of these habitat alterations have created obstacles to Snake River fall-run Chinook salmon survival. Before alteration of the Snake River Basin by dams, Snake River fall-run Chinook salmon exhibited a largely ocean-type life- history, where they migrated downstream during their first-year. Today, fall-run Chinook salmon in the Snake River Basin exhibit one of two life- histories that Connor et al. (2005) have called ocean-type and reservoir-type. Juveniles exhibiting the reservoir-type life-history overwinter in the pools created by the dams before migrating out of the Snake River. The reservoir-type life-history is likely a response to early development in cooler temperatures, which prevents juveniles from reaching a suitable size to migrate out of the Snake River and to the ocean.

Snake River fall Chinook salmon also spawned historically in the lower mainstems of the Clearwater, Grande Ronde, Salmon, Imnaha, and Tucannon River systems. At least some of these areas probably supported production, but at much lower levels than in the mainstem Snake River. Smaller portions of habitat in the Imnaha and Salmon Rivers have supported Snake River fall-run Chinook salmon. Some limited spawning occurs in all these areas, although returns to the Tucannon River are predominantly releases and strays from the Lyons Ferry Hatchery (LFH) program (NMFS 2012g).

Spatial Structure and Diversity

The extant Lower Snake River fall Chinook salmon population occupies the mainstem Snake River from the upper end of the Lower Granite Dam reservoir (near Lewiston, Idaho) to Hells Canyon Dam, and the lower reaches of several major tributaries. Existing maps of geomorphic spawning habitat potential and of redd distributions were used as input for evaluating spatial structure and diversity elements of viability (Appendix B *in* ICTRT 2007).

Two mainstem Snake River and three large tributary major spawning areas (MaSAs) are accessible to anadromous returns in the Lower Snake River fall Chinook salmon population. The ICTRT classified the population as trellis structured (ICTRT 2007). Applying the ICTRT guidelines for a complex (trellis-structured) population, the Lower Snake River fall Chinook salmon population is rated at very low risk for number and spatial arrangement of spawning areas.

The Lower Snake River fall Chinook salmon population was rated at low risk for allowing natural rates and levels of spatially mediated processes, and moderate risk for maintaining natural levels of variation, resulting in an overall spatial structure and diversity rating of moderate risk in the status review update (NWFSC 2015), resulting in an overall spatial structure and diversity rating of moderate risk.. The moderate risk rating was driven by changes in major life history strategies, shifts in phenotypic traits, and high levels of genetic homogeneity in samples from natural-origin returns. In addition, risk associated with indirect factors, specifically the high levels of hatchery spawners in natural spawning areas and the potential for selective pressure imposed by current hydropower operations and cumulative harvest impacts, contribute to the current rating level.

The overall current risk rating for the Lower Mainstem Snake River fall Chinook salmon population is viable. The single population delisting options provided in the Snake River Fall Chinook Salmon Recovery Plan would require the population to meet or exceed minimum requirements for a risk rating of Highly Viable with a high degree of certainty.

The current rating described above is based on evaluating current status against the criteria for the aggregate population. The overall risk rating is based on a low risk rating for abundance/productivity (A/P) and a moderate risk rating for spatial structure/diversity (SS/D). For abundance/productivity, the rating reflects remaining uncertainty that current increases in abundance can be sustained over the long run. The geometric mean natural-origin fish abundance obtained from the most recent 10 years of annual spawner escapement estimates is 6,418 fish. The most recent status review used the ICTRT simple 20-year recruits per spawner (R/S) method to estimate the current productivity for this population (1990-2009 brood years) and determined it was 1.5. Given remaining uncertainty and the current level of variability, the point estimate of current productivity would need to meet or exceed 1.70, which is the present potential metric for the population to be rated at very low risk. While natural-origin spawning levels are above the minimum abundance threshold of 4,200, and estimated productivity is also high, neither measure is high enough to achieve the very low risk rating necessary to buffer against significant remaining uncertainty (NWFSC 2015).

Abundance and Productivity

Best available information indicates that the Snake River fall-run Chinook Salmon ESU remains at threatened status, which is based on a low risk rating for abundance/productivity, and a moderate risk rating for spatial structure/diversity (NWFSC 2015). Prior to the early 1980s, returns of Snake River fall Chinook salmon were likely predominately of natural origin (Bugert et al. 1990). Natural-origin returns declined substantially following completion of the three-dam Hells Canyon Complex (1959-1967), which completely blocked access to major historical production areas in the Middle Snake River, and of the lower Snake River dams (1962-1975), which inundated additional habitat. Based on extrapolations from sampling at Ice Harbor Dam (1977 to 1990), the Lyons Ferry Hatchery (1987 to present), and Lower Granite Dam (1990 to present), hatchery strays made up an increasing proportion of returns at Lower Granite Dam through the 1980s (Bugert et al. 1990; Bugert and Hopley 1989). Strays from out-planting of Priest Rapids hatchery-origin fall Chinook salmon (an out-of-ESU stock from the mid-Columbia) and Snake River fall Chinook salmon from the Lyons Ferry Hatchery program (on-station releases initiated in the mid-1980s) were the dominant contributors. Estimated natural-origin returns reached a low of less than 100 fish in 1990.

Sampling methods and statistical procedures used in generating the estimated escapements have improved substantially over the past 10 to 15 years. Beginning with the 2005 return, estimates are available for the total run apportioned into natural and hatchery returns by age (and hatchery-origin) with standard errors and confidence limits (e.g., Young et al. 2012). In recent years, naturally spawning fall Chinook salmon in the lower Snake River have included returns originating from naturally spawning parents as well as returning hatchery releases. Hatchery-origin fall Chinook salmon escaping upstream above Lower Granite Dam to spawn naturally are now predominantly returns from hatchery program juvenile releases in reaches above Lower Granite Dam and from releases at Lyons Ferry Hatchery that have dispersed upstream.

The recently released NMFS Snake River fall-run Chinook Recovery Plan (NMFS 2017d) proposes that a single population viability scenario could be possible given the unique spatial complexity of the Lower Mainstem Snake River fall-run Chinook salmon population; the recovery plan notes that such a scenario could be possible if major spawning areas supporting the bulk of natural returns are operating consistent with long-term diversity objectives in the proposed plan.

Another aspect of spatial complexity is habitat use and distribution in the ocean. Snake River fall Chinook salmon have a very broad ocean distribution and are taken in ocean salmon fisheries from central California through southeast Alaska. They are also harvested in- river in tribal and non-tribal fisheries. Historically, they were subject to total exploitation rates on the order of 80 percent. Since they were listed in 1992, fishery impacts have been reduced in both ocean and river fisheries (Figure 2-13). Total exploitation rate has been relatively stable in the range of 40 to 50 percent since the mid-1990s.

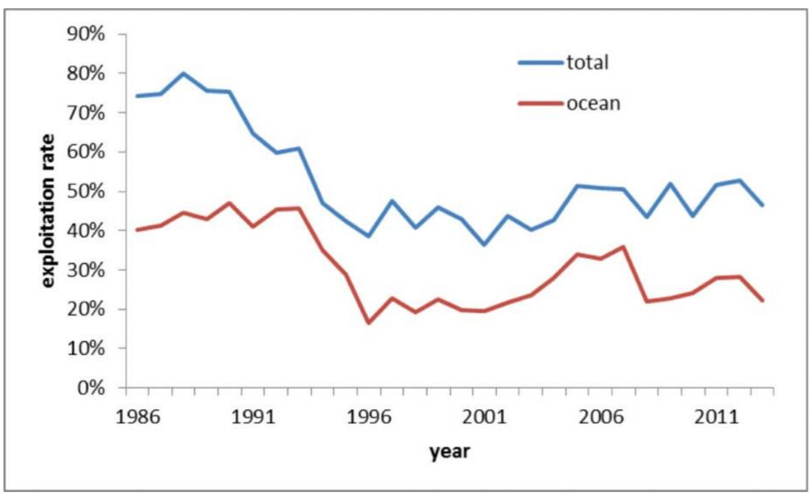

Figure 2-10. Total exploitation rate for Snake River fall Chinook salmon. Data for marine exploitation rates from the Chinook Technical Committee model (Calibration 1503) and for in-river harvest rates from the Columbia River Technical Advisory Committee.

Considering the most recent information available, an increase in estimated productivity (or a decrease in the year-to-year variability associated with the estimate) would be required to achieve delisting status, assuming that natural-origin abundance of the single extant Snake River fall-run Chinook salmon population remains relatively high. An increase in productivity could occur with a further reduction in mortalities across life stages. Such an increase could be generated by actions such as a reduction in harvest impacts (particularly when natural-origin spawner return levels are below the minimum abundance threshold) and/or further improvements in juvenile survivals during downstream migration. It is also possible that survival improvements resulting from various actions (e.g., improved flow-related conditions affecting spawning and rearing, expanded spill programs that increased passage survivals) in recent years have increased productivity, but that increase is effectively masked as a result of the relatively high spawning levels in recent years. A third possibility is that productivity levels may decrease over time as a result of negative impacts of chronically high hatchery proportions across natural spawning areas. Such a decrease would also be largely masked by the high annual spawning levels (NWFSC 2015).

Limiting Factors and Threats

Understanding the limiting factors and threats that affect the Snake River fall Chinook salmon ESU provides important information and perspective regarding the status of the species. One of the necessary steps in recovery and consideration for delisting is to ensure that the underlying limiting factors and threats have been addressed. Snake River fall Chinook salmon populations began to decline by the late 1800s because of habitat alterations and harvest rates that were unsustainable given these changing habitat conditions. Human impacts and limiting factors come from multiple sources, including hydropower development on the Columbia River and its tributaries, habitat degradation, hatchery effects, fishery management and harvest decisions, and ecological factors, including predation and environmental variability. Limiting factors and threats for the Snake River fall Chinook salmon ESU were discussed in the ESU-level recovery plan, which consolidates the information available from various sources (NMFS 2017d).

The recovery plan (NMFS 2017d) provides a detailed discussion of limiting factors and threats and describes strategies for addressing each of them. Section 3.3 of the plan provides criteria for addressing the underlying causes of decline. Furthermore, Section 4.1.2 B.4. of the plan (NMFS 2017d) describes the changes in current impacts on Snake River fall Chinook salmon. These changes include:

1. Hydropower systems
2. Juvenile migration timing
3. Adult migration timing
4. Harvest
5. Age-at-return
6. Selection caused by non-random removals of fish for hatchery broodstock
7. Habitat

Rather than repeating this extensive discussion from the recovery plan, it is incorporated here by reference.

Overall, the status of Snake River fall-run Chinook salmon has clearly improved compared to the time of listing and since the time of prior status reviews. The single extant population in the ESU is currently meeting the criteria for a rating of viable developed by the ICTRT, but the ESU as a whole is not meeting the recovery goals described in the recovery plan for the species, which require the single population to be "highly viable with high certainty" and/or will require reintroduction of a viable population above the Hells Canyon Dam complex (NWFSC 2015).

2.2.2. Status of Critical Habitat

We review the status of designated critical habitat affected by the Proposed Action by examining the condition and trends of essential physical and biological features throughout the designated area. These features are essential to the conservation of the listed species because they support one or more of the species' life stages (e.g., sites with conditions that support spawning, rearing, migration, and foraging.

2.2.2.1. Puget Sound/Georgia Basin Critical Habitat

Critical habitat was designated for all three species of rockfish in 2014 under section 4(a)(3)(A) of the ESA (79 FR 68041, November 13, 2014), and critical habitat for canary rockfish was removed when the species was delisted on January 23, 2017 (82 FR 7711). The specific areas designated for bocaccio include approximately 1,083.11 square miles (1,743.10 sq. km) of deep water (< 98.4 feet [30 m]) and nearshore (> 98.4 feet [30 m]) marine habitat in Puget Sound. The specific areas designated for yelloweye rockfish include 438.45 square miles (705.62 sq. km) of deepwater marine habitat in Puget Sound, all of which overlap with areas designated for bocaccio. Approximately 46 percent of designated critical habitat for adult yelloweye rockfish and bocaccio overlaps with areas where the halibut fishery in Puget Sound occurs. Section 3(5)(A) of the ESA defines critical habitat as "(i) the specific areas within the geographical area occupied by the species, at the time it is listed . . . on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed . . . upon a determination by the Secretary that such areas are essential for the conservation of the species."

Critical habitat is not designated in areas outside of U.S. jurisdiction; therefore, although waters in Canada are part of the DPSs' ranges for each species, critical habitat was not designated in that area. We also excluded 13 of the 14 Department of Defense Restricted Areas, Operating Areas, and Danger Zones, and waters adjacent to tribal lands from the critical habitat designation.

Based on the best available scientific information regarding natural history and habitat needs, we developed a list of physical and biological features essential to the conservation of adult and juvenile yelloweye rockfish and bocaccio, and relevant to determining whether proposed specific areas are consistent with the above regulations and the ESA section (3)(5)(A) definition of "critical habitat." The physical or biological features essential to the conservation of yelloweye rockfish and bocaccio fall into major categories reflecting key life history phases.

Adult bocaccio and adult and juvenile yelloweye rockfish: We designated sites deeper than 98 feet (30 m) that possess (or are adjacent to) areas of complex bathymetry. These features are essential to conservation because they support growth, survival, reproduction, and feeding opportunities by providing the structure to avoid predation, seek food, and persist for decades. Several attributes of these sites affect the quality of the area and are useful in considering the conservation value of the feature in determining whether the feature may require special management considerations or protection, and in evaluating the effects of a Proposed Action in a section 7 consultation if the specific area containing the site is designated as critical habitat. These attributes include: (1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; (2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities; and (3) structure and rugosity to support feeding opportunities and predator avoidance.

Juvenile bocaccio only: Juvenile settlement sites located in the nearshore with substrates such as sand, rock, and/or cobble compositions that also support kelp. These features are essential for conservation because they enable forage opportunities and refuge from predators, and enable behavioral and physiological changes needed for juveniles to occupy deeper adult habitats. Several attributes of these sites affect the quality of the area and are useful in considering the conservation value of the feature in determining whether the feature may require special management considerations or protection, and in evaluating the effects of a Proposed Action in a section 7 consultation if the specific area containing the site is designated as critical habitat. These attributes include: (1) quantity, quality, and availability of prey species to support individual growth, survival, reproduction, and feeding opportunities; and (2) water quality and sufficient levels of dissolved oxygen to support growth, survival, reproduction, and feeding opportunities.

Regulations for designating critical habitat at 50 C.F.R. § 424.12(b) state that the agencies shall consider physical and biological features essential to the conservation of a given species that "may require special management considerations or protection." Joint NMFS and USFWS regulations at 50 C.F.R. § 424.02(j) define "special management considerations or protection" to mean "any methods or procedures useful in protecting physical and biological features of the environment for the conservation of listed species." We identified a number of activities that may affect the physical and biological features essential to yelloweye rockfish and bocaccio such that special management considerations or protection may be required. Major categories of such activities include: (1) nearshore development and in-water construction (e.g., beach armoring, pier construction, jetty or harbor construction, pile driving construction, residential and commercial construction); (2) dredging and disposal of dredged material; (3) pollution and runoff; (4) underwater construction and operation of alternative energy hydrokinetic projects (tidal or wave energy projects) and cable laying; (5) kelp harvest; (6) fisheries; (7) non-indigenous species introduction and management; (8) artificial habitat creation; (9) research activities; (10) aquaculture, and (11) activities that lead to global climate change.

Overall, the status of critical habitat in the nearshore is impacted in many areas by the degradation from coastal development and pollution. The status of deep water critical habitat is impacted by remaining derelict fishing gear and degraded water quality among other factors. The input of pollutants affects water quality, sediment quality, and food resources in the nearshore and deep water areas of critical habitat.

2.2.2.2. Green Sturgeon Critical Habitat

Designated critical habitat for Southern DPS green sturgeon includes coastal marine waters shallower than 60 fathoms (approximately 360.89 feet or 110 m) from Monterey Bay, California to the Canadian border, including Monterey Bay and the Strait of Juan de Fuca (74 FR 52300, October 9, 2009). The physical and biological features, or PBFs, essential for species conservation are: (a) a migratory pathway necessary for the safe and timely passage of Southern DPS green sturgeon within marine and between estuarine and marine habitats; (b) suitable water quality (e.g., adequate dissolved oxygen levels and acceptably low levels of contaminants that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon); and (c) food resources, likely to include benthic invertebrates and fish species similar to those fed upon by green sturgeon in bays and estuaries, including crangonid and callianasid shrimp, Dungeness crab, mollusks, amphipods, and small fish such as sand lances (*Ammodytes* spp.) and anchovies (Engraulidae) (Moyle 2002; Dumbauld et al. 2008). Prey resources and impact from gear are unlikely to affect green sturgeon habitat and is discussed in more detail in Section 2.12, "Not Likely to Adversely Affect Determinations."

2.2.2.3. Salmon Critical Habitat

The designated critical habitat for the Puget Sound Chinook salmon, Lower Columbia River Chinook and coho salmon, and Snake River fall Chinook salmon ESUs do not include offshore marine areas of the Pacific Ocean and therefore do not overlap with the action area. The areas designated are all occupied and contain physical and biological features essential to the conservation of the species and that may require special management considerations or protection.

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 C.F.R. § 402.02). For the Pacific halibut fishery, the action area is the area in which the IPHC Area 2A halibut fishery takes place; the southern boundary of this area is Shelter Cove, California, which is located near the southern border of Humboldt County in northern California, and the northern border is the Canada/U.S. border. The action area includes all waters off the states of Washington, Oregon, and California north of Shelter Cove, each state's coastal and marine waters, and all waters of the Exclusive Economic Zone (EEZ) (3 to 200 nautical miles offshore). Halibut fishing in these waters is managed under the authority of the Halibut Act.

Many of the protected species covered by this consultation have a geographic range smaller than the spatial extent of fishing effort (distribution for each species is identified in the respective status sections). Others have geographic ranges that include areas that do not overlap with the fishery. To the extent that indirect effects may occur, these would be related to prey availability (e.g., Southern Resident killer whale critical habitat) and the action area encompasses the full geographic area that affects could occur from the Proposed Action.

2.4. Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions that are contemporaneous with the consultation in process (50 C.F.R. § 402.02).

2.4.1. Puget Sound/Georgia Basin Rockfish

The Puget Sound and Georgia Basin comprise the southern arm of an inland sea located on the Pacific Coast of North America that is directly connected to the Pacific Ocean. Most of the water exchange in Puget Sound proper is through Admiralty Inlet near Port Townsend, and the configuration of sills and deep basins results in the partial recirculation of water masses and the retention of contaminants, sediment, and biota (Rice 2007). Tidal action, freshwater inflow, and ocean currents interact to circulate and exchange salty marine water at depth from the Strait of Juan de Fuca, and less dense fresh water from the surrounding watersheds at the surface produce a net seaward flow of water at the surface (Rice 2007).

Most of the benthic deepwater (e.g., deeper than 90 feet (27.4 m)) habitats of Puget Sound proper consist of unconsolidated sediments such as sand, mud, and cobbles. The vast majority of the rocky-bottom areas of Puget Sound occur within the San Juan Basin, with the remaining portions spread among the rest of Puget Sound proper (Palsson et al. 2009). Depths in the Puget Sound extend to over 920 feet (280 meters).

Benthic habitats within Puget Sound have been influenced by a number of factors. The degradation of some rocky habitat, loss of eelgrass and kelp, introduction of non-natural-origin species that modify habitat, and degradation of water quality are threats to marine habitat in Puget Sound (Drake et al. 2010; Palsson et al. 2009). Some benthic habitats have been impacted by derelict fishing gear that include lost fishing nets, and shrimp and crab pots (Good et al. 2010). Derelict fishing gear can continue "ghost" fishing and is known to kill rockfish, salmon, and marine mammals as well as degrade rocky habitat by altering bottom composition and killing numerous species of marine fish and invertebrates that are eaten by rockfish (Good et al. 2010). Thousands of nets have been documented within Puget Sound and most have been found in the San Juan Basin and the Main Basin. The Northwest Straits Initiative has operated a program to remove derelict gear throughout the Puget Sound region. In addition, WDFW and the Lummi, Stillaguamish, Tulalip, Nisqually, and Nooksack Tribes and others have supported or conducted derelict gear prevention and removal efforts. Net removal has mostly concentrated in waters less than 100 feet (33 m) deep where most lost nets are found (Good et al. 2010). The removal of over 4,600 nets and over 3,000 derelict pots have restored over 650 acres of benthic habitat (Northwest Straights Initiative 2014), though many derelict nets and crab and shrimp pots remain in the marine environment. Several hundred derelict nets have been documented in waters deeper than 100 feet deep (NRC 2014). Over 200 rockfish have been documented within recovered derelict gear. Because habitats deeper than 100 feet (30.5 m) are most readily used by adult yelloweye rockfish and bocaccio, there is an unknown but potentially significant impact from deepwater derelict gear on rockfish habitats within Puget Sound.

Over the last century, human activities have introduced a variety of toxins into the Georgia Basin at levels that can affect adult and juvenile rockfish habitat and/or the prey that support them. Toxic pollutants in Puget Sound include oil and grease, polychlorinated biphenyls (PCBs), phthalates, PBDEs, and heavy metals that include zinc, copper, and lead. Several urban embayments in Puget Sound have high levels of heavy metals and organic compounds (Palsson et al. 2009).There are no studies to date that define specific adverse health effects thresholds for specific toxicants in any rockfish species; however, it is likely that PCBs pose a risk to rockfish health and fitness (Palsson et al. 2009). About 32 percent of the sediments in the Puget Sound region are considered to be moderately or highly contaminated (PSAT 2007), though some areas are undergoing clean-up operations that have improved benthic habitats (Sanga 2015).

Washington State has a variety of marine protected areas managed by 11 Federal, state, and local agencies (Van Cleve et al. 2009), though some of these areas are outside of the range of the rockfish DPSs. The WDFW has established 25 marine reserves within the DPSs' boundary, and 16 host rockfish (Palsson et al. 2009), though most of these reserves are within waters shallower than those typically used by adult yelloweye rockfish or bocaccio. The WDFW reserves total 2,120.7 acres of intertidal and subtidal habitat. The total percentage of the Puget Sound region within reserve status is unknown, though Van Cleve et al. (2009) estimate that one percent of the subtidal habitats of Puget Sound are designated as a reserve. Compared to fished areas, studies have found higher fish densities, sizes, or reproductive activity in the assessed WDFW marine reserves (Eisenhardt 2001; Palsson 1998; Palsson et al. 2004; Palsson and Pacunski 1995). These reserves were established over several decades with unique and somewhat unrelated ecological goals, and encompass relatively small areas (average of 23 acres).

We cannot quantify the effects of degraded habitat on the listed rockfish because these effects are poorly understood. However, there is sufficient evidence to indicate that ESA-listed rockfish productivity may be negatively impacted by the habitat structure and water quality stressors discussed above (Drake et al. 2010).

We discuss fisheries management pertinent to rockfish that is part of the environmental baseline in the Puget Sound area as a context for the fisheries take authorized within previous section 7 consultations (NMFS 2016c). In addition, we briefly summarize fisheries management in Canadian waters of the DPSs, as it is relevant to listed rockfish that use waters in Canada and the San Juan area. In 2010, the Washington State Fish and Wildlife Commission formally adopted regulations that ended the retention of rockfish by recreational anglers in Puget Sound and closed fishing for bottom fish in all waters deeper than 120 feet (36.6 m). On July 28, 2010, WDFW enacted the following package of regulations by emergency rule for the following non-tribal commercial fisheries in Puget Sound in order to protect dwindling rockfish populations:

1) Closure of the set net fishery
2) Closure of the set line fishery
3) Closure of the bottom trawl fishery
4) Closure of the inactive pelagic trawl fishery
5) Closure of the inactive bottom fish pot fishery

As a precautionary measure, WDFW closed the above commercial fisheries westward of the listed rockfish DPSs' boundary to Cape Flattery. The WDFW extended the closure west of the rockfish DPSs' boundary to prevent commercial fishermen from concentrating gear in that area. The commercial fisheries closures listed above were enacted on a temporary basis and WDFW permanently closed them in February 2011. The pelagic trawl fishery was closed by permanent rule on the same date.

Waters of Canada are not within the Action Area, but the DPS area for yelloweye rockfish and bocaccio includes areas of the Georgia Strait thus the status of the environmental baseline and rockfish management influences fish within Puget Sound. Fisheries management in British Columbia, Canada, has been altered to better conserve rockfish populations. In response to declining rockfish stocks, the government of Canada initiated comprehensive changes to fishery policies beginning in the 1990s (Yamanaka and Logan 2010). Conservation efforts were focused on four management steps: (1) accounting for all catch, (2) decreasing total fishing mortality, (3) establishing areas closed to fishing, and (4) improving stock assessment and monitoring (Yamanaka and Lacko 2001). The Department of Fisheries and Oceans (DFO) adopted a policy of ensuring that inshore rockfish are subjected to fisheries mortality equal to or less than half of natural mortality.

These efforts led to the 2007 designation of a network of Rockfish Conservation Areas (RCAs) that encompasses 30 percent of rockfish habitat of the inside waters of Vancouver Island (Yamanaka and Logan 2010). The DFO defined and mapped "rockfish habitat" from commercial fisheries log CPUE density data as well as change in slope bathymetry analysis (Yamanaka and Logan 2010). These reserves do not allow directed commercial or recreational harvest for any species of rockfish, or the harvest of other marine species if that harvest may incidentally catch rockfish. Because the RCAs are relatively new it is uncertain how effective they have been in protecting rockfish populations (Haggarty 2013), but one analysis found that sampled RCAs in Canada had 1.6 times the number of rockfish compared to unprotected areas (Cloutier 2011). There are anecdotal reports that compliance with the RCAs may be poor and that some may contain less than optimum areas of rockfish habitat (Haggarty 2013). Systematic monitoring of the RCAs may be lacking as well (Haggarty 2013). The DFO, WDFW, and NMFS will be conducting fish population surveys of some of the RCAs in 2018. Outside the RCAs, recreational fishermen generally may keep one rockfish per day from May 1 to September 30. Commercial rockfish catches in Area 4(b) are managed by a quota system (DFO 2011).

2.4.2. Green Sturgeon

Green sturgeon occur throughout the action area. Marine waters off Washington, Oregon, and California within the action area include designated critical habitat for green sturgeon (marine waters within the 60 fm contour from Monterey Bay to the Strait of Juan de Fuca) and represent a major portion of the marine migratory habitat of the Southern DPS. Impacts on this portion of the action area are described below and include disturbance of benthic habitats and communities, reductions in water quality (contaminants, increased sedimentation, and turbidity), and increased levels of underwater noise. Southern DPS green sturgeon also occur in Puget Sound; impacts affecting Puget Sound are described in Section 2.5.2, Effects of the Proposed Action/Green Sturgeon.

Several ocean-dredged material disposal sites have been designated along the coast. In recent years, NMFS has consulted with the EPA on the proposed designation of several sites off the Oregon coast, off the mouths of the Rogue River, Umpqua River, and Yaquina River (NMFS 2009b; NMFS 2009c, consultation #2008/05438; NMFS 2012e, consultation #2011/06017). In 2012, NMFS also consulted on the use of four ocean disposal sites off the Columbia River as part of the Columbia River Channel Operations and Maintenance Program (NMFS 2012f, consultation #/2011/02095). In 2016 to 2017, NMFS consulted on the U.S. Army Corps of Engineers' operations and maintenance dredging of the Oregon coastal navigation projects, a project that included both dredging and dredge disposal (NMFS 2017e, consultation #WCR-2016/5055). Disposal of dredged materials at these disposal sites has the potential to entrain and bury small (i.e., ≤ 2 feet in length) subadult green sturgeon that, unlike adults and larger subadults, may not be able to move quickly enough to avoid precipitating sediments. This may result in injury to small subadult green sturgeon, but the number affected is expected to be low given the location of the disposal sites and the migratory patterns of green sturgeon in marine waters (e.g., green sturgeon are likely to spend limited time in one area as they move from estuary to estuary). Increased suspended sediment and turbidity levels may also result from dredging and disposal activities, but the effects on water quality are expected to be short term and have minimal impacts on sturgeon migration along the coast. Other water quality effects could result from contaminants in the dredged material. However, existing statutes and regulations require dredged material to be tested and deemed "clean" prior to disposal, such that levels of compounds in the sediments are not expected to exceed concentrations harmful to green sturgeon and other organisms occurring at the disposal sites.

In-water construction activities occur throughout the coast, including pile driving and removal activities and installation of renewable energy installations. In 2011, NMFS consulted on the proposed Columbia River Jetty System Rehabilitation Project at the mouth of the Columbia River (NMFS 2011c, consultation #2010/06104). NMFS has also consulted on proposed renewable ocean energy projects off the Oregon coast (NMFS 2012c, consultation #2010/06138; NMFS 2012d, consultation #2012/02531). Potential impacts from these projects include underwater noise and electromagnetic fields that could attract or deter green sturgeon in the area, as well as the installation of structures that may pose physical barriers to migration. In general, the sound levels generated by these projects are expected to be below estimated threshold levels that would result in injury to fish. In addition, the projects typically cover a small area and would not create a continuous physical barrier to passage. Additional studies are needed, however, to better understand the impacts of underwater noise and electromagnetic fields on green sturgeon. In 2014, NMFS consulted on a project in Yaquina Bay (NMFS 2014b, consultation WCR-2013-9) that included dredging and riprap replacement that could impact green sturgeon through an increase in stormwater contaminants, reduction of forage in the dredging area, and physical injury from ocean disposal of dredged material. The number of green sturgeon injured or killed by reduced forage, increased stormwater contaminants, and ocean disposal each year was estimated to be small because of the areal extent of the effects, the migratory nature of green sturgeon, and the action occurring outside the species' spawning habitat.

Dredging activities, disposal of dredged material at ocean disposal sites, bottom trawling activities, and the management and operation of renewable ocean energy installations may affect benthic habitats and prey availability for green sturgeon in marine waters by disturbing benthic habitats and injuring or burying prey resources. In general, effects are expected to be localized and small relative to the abundance of prey available to green sturgeon. Some of these benthic communities are in high energy environments characterized by frequent disturbance and rapid recolonization. In addition, it is unclear whether disturbance of benthic habitats may reduce or enhance feeding opportunities for green sturgeon. Climate change may also alter conditions in coastal marine waters and result in shifts in the distribution of prey resources for green sturgeon in coastal marine areas. We are limited in our ability to assess the effects of climate change on green sturgeon critical habitat, however, because of the limited information available regarding green sturgeon habitat use in coastal marine waters. In addition, variation in the effects of climate change on the marine environment adds to the uncertainty. For example, the effects of climate change may cause some species to increase in abundance and expand in distribution, whereas other species may decline in abundance and become more restricted in distribution.

2.4.3. Puget Sound Chinook Salmon, Lower Columbia River Chinook and Coho Salmon, and Snake River Fall Chinook Salmon

Puget Sound Chinook Salmon

NMFS has convened recovery planning efforts across the Pacific Northwest to identify what actions are needed to recover listed salmon. A recovery plan for the Puget Sound Chinook salmon ESU was completed in 2007. This plan is made up of two documents: a locally developed recovery plan and a NMFS-developed supplement Puget Sound Salmon Recovery Plan (Shared Strategy for Puget Sound 2007) and Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan (NMFS 2006b)

Chinook salmon stocks are artificially propagated through 41 programs in Puget Sound. Currently, the majority of Chinook salmon hatchery programs produce fall-run (also called summer/fall) stocks for fisheries harvest augmentation purposes. Supplementation programs implemented as conservation measures to recover early returning Chinook salmon operate in the White (Appleby and Keown 1994), Dungeness (Smith and Sele 1995), and North Fork Nooksack Rivers, and for summer Chinook salmon on the North Fork Stillaguamish and Elwha Rivers (Fuss and Ashbrook 1995; Myers et al. 1998). Supplementation or re-introduction programs are in operation for early Chinook salmon in the South Fork Nooksack River, fall Chinook salmon in the South Fork Stillaguamish River (T. Tynan, pers. comm., NMFS, April 13, 2010), and spring and late-fall Chinook salmon in the Skokomish River. Human activities have degraded extensive areas of salmon spawning and rearing habitat in Puget Sound. Most devastating to the long-term viability of salmon has been the modification of the fundamental natural processes that allowed habitat to form and recover from disturbances such as floods, landslides, and droughts. Among the physical and chemical processes basic to habitat formation and salmon persistence are floods and droughts, sediment transport, heat and light, nutrient cycling, water chemistry, woody debris recruitment, and floodplain structure (SSPS 2007).

Development activities have limited access of salmon to historical spawning grounds and altered downstream flow and thermal conditions. Watershed development and associated urbanization throughout the Puget Sound, Hood Canal, and Strait of Juan de Fuca regions have resulted in direct loss of riparian vegetation and soils; significantly altered hydrologic and erosion rates and processes by creating impermeable surfaces (roads, buildings, parking lots, sidewalks, etc.); and polluted waterways, raised water temperatures, decreased large woody debris recruitment, decreased gravel recruitment, reduced river pools and spawning areas, and dredged and filled estuarine rearing areas (Bishop and Morgan 1996). Hardening of nearshore bank areas with riprap or other material has altered marine shorelines by changing sediment transport patterns and reducing important juvenile habitat. The development of land for agricultural purposes has resulted in reductions in river braiding, sinuosity, and side channels through the construction of dikes, hardening of banks with riprap, and channelization of the river mainstems (EDPU 2005; SSPS 2005). Poor forest practices in upper watersheds have resulted in bank destabilization, excessive sedimentation, and removal of riparian and other shade vegetation important for water quality, temperature regulation, and other aspects of salmon rearing and spawning habitat (SSPS 2005; SSPS 2007). There are substantial habitat blockages by dams in the Skagit and Elwha River basins, and minor blockages, including impassable culverts, throughout the region. In general, habitat has been degraded from its pristine condition, and this trend is likely to continue with further population growth and resultant urbanization in the Puget Sound region.

Over the last several years, NMFS has completed several section 7 consultations on large-scale habitat projects affecting listed species in Puget Sound. Among these are the Washington State Forest Practices Habitat Conservation Plan (NMFS 2006a) and consultations on Washington State Water Quality Standards (NMFS 2008c) and the National Flood Plain Insurance Program (NMFS 2008d). These documents considered the effects of the proposed actions that would occur up to the next 50 years on the ESA-listed salmon and steelhead species in the Puget Sound basin, listed Southern Resident killer whales, and the listed southern DPS of green sturgeon. Information on the status of these species, the environmental baseline, and the effects of the proposed actions are reviewed in detail. The environmental baselines in these documents consider the effects from timber, agriculture and irrigation practices, urbanization, hatcheries and tributary habitat, estuary, and large scale environmental variation. These biological opinions and habitat conservation plans, in addition to the watershed-specific information in the Puget Sound Salmon Recovery Plan mentioned above, provide a current and comprehensive overview of baseline habitat conditions in Puget Sound.

Lower Columbia River Chinook Salmon

As described in the previous status section, many of the Lower Columbia River Chinook salmon populations have been substantially affected by a combination of habitat degradation, high levels of hatchery production using non-local broodstock, and high harvest rates that have limited natural-origin spawners to very low levels (NMFS 2013a). Chinook salmon stocks are artificially propagated through 28 programs in the Columbia River; 16 of those are considered part of the ESU. Currently, the majority of Chinook salmon hatchery programs produce fall-run stocks for fisheries harvest augmentation purposes. Supplementation programs are in place for the Lewis River, Cowlitz River, and Sandy River populations. Reintroduction programs have been implemented for Hood River spring Chinook salmon, and upper Cowlitz and Cispus Rivers. A probable lack of locally adapted populations may be a contributing factor to the apparent low productivity of the tule populations, but there is no direct information on levels of tule Chinook salmon local adaptation (Walton 2010). Current stocking practices may also have an additive effect of contributing to low productivity through ecological competition from hatchery strays (NMFS 2013a). Other populations in the ESU may be less affected by these circumstances.

Lower Columbia River Coho Salmon

NMFS recently updated its list of coho salmon hatchery programs that are included in the ESA listing (79 FR 20810, April 1 4, 2014), which includes 23 programs. These hatchery stocks were included as part of the listed ESU in part based on a determination that these artificially propagated stocks are no more divergent relative to the local natural population(s) than what would be expected between closely related natural populations within the ESU (70 FR 97160, June 28, 2006). Lack of data and poor data quality has made it difficult to assess rangewide status of the LCR coho salmon ESU. However, more recent spawner escapement information from 2002 in Oregon and from 2010 in Washington that was not available during previous status reviews suggests some populations may be doing better than previously thought.

Snake River Fall Chinook Salmon

A recovery plan for the Snake River fall Chinook ESU was completed in 2017 (NMFS 2017d). The Snake River fall Chinook salmon ESU currently includes four interrelated hatchery programs: the Lyons Ferry Hatchery, the Fall Chinook Acclimation Project, the Nez Perce Tribal Hatchery, and the Idaho Power Company programs. Fish from these programs are all considered part of the Snake River fall Chinook salmon ESU (70 FR 37160, June 28, 2005). Considerable uncertainty remains about the effect of the Snake River fall Chinook salmon hatchery programs on the Lower Snake River population. Much of this uncertainty reflects the fact that the remaining population is very difficult to study because of geographic extent, habitat, and logistics. As previously mentioned, the uncertainties are more important for this ESU because there is only one extant population.

Since ESA listing, the hydropower and water storage project agencies have made important changes to improve salmon survival, such as structural improvements and additions to fish passage facilities, operational changes in flow and spill, improvements to the juvenile transportation program, and increased off-site mitigation through tributary and estuarine habitat improvement, predator control, and hatchery reform.

2.4.4. Research Effects in the Environmental Baseline

The listed salmon, green sturgeon, and rockfish species in this opinion are the subject of scientific research and monitoring activities. Most biological opinions issued by NMFS have conditions requiring specific monitoring, evaluation, and research projects to gather information to aid the preservation and recovery of listed species. The impacts of these research activities pose both benefits and risks. Research on the listed species in the action area is currently provided coverage under section 7 of the ESA or under the ESA 4(d) research programs, or included in the estimates of fishery mortality discussed in Section 2.5, Effects of the Proposed Action, in this opinion.

For the year 2018, NMFS has issued several ESA section 10(a)(1)(A) scientific research permits allowing lethal and non-lethal take of listed species. In a separate process, NMFS also has completed review of the state and tribal scientific salmon and sturgeon research programs under ESA section 4(d). Table 2-17 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A) within the action area for the listed Puget Sound Chinook salmon ESU, Puget Sound/Georgia Basin rockfish species DPS, Southern DPS eulachon, and Southern DPS green sturgeon.

Table 2-17. Total expected take of the ESA-listed species for scientific research and monitoring already approved for 2018 plus the permits covered in this Biological Opinion.

Species	Life Stage	Origin[a]	Total Take	Percent of Abundance	Lethal Take	Percent of ESU/DPS killed
PS Chinook salmon[b]	Adult	LHAC	1,623	19.05194%	124	1.02820%
		LHIA	897		12	
		Natural	1,011	5.49069%	38	0.20638%
	Juvenile	LHAC	140,472	0.38915%	11,479	0.03180%
		LHIA	157,264	2.19268%	3,814	0.05318%
		Natural	448,433	17.71648%	9,180	0.36268%
LCR Chinook salmon	Adult	LHAC	933	2.50%	21	0.06%
		LHIA	62	5.04%	2	0.16%
		Natural	1,032	3.50%	13	0.04%
	Juvenile	LHAC	88,654	0.26%	1,929	0.01%
		LHIA	483	0.04%	53	0.00%
		Natural	1,264,665	10.18%	15,631	0.13%
LCR coho salmon	Adult	LHAC	3,003	13.43%	56	0.25%
		LHIA	250	35.02%	4	0.56%
		Natural	3,345	10.14%	34	0.10%
	Juvenile	LHAC	70,218	0.93%	2,177	0.03%
		LHIA	2,377	0.99%	128	0.05%
		Natural	229,540	37.05%	3,053	0.49%
Snake River fall Chinook salmon	Adult	LHAC	1,061		37	
		LHIA	663		20	
		Natural	4,617		38	
	Juvenile	Hatchery	154		2	
		LHAC	69,843		1,012	
		LHIA	104,090		791	
		Natural	678,397		7,427	
	Smolt	LHAC	2,389		29	
		LHIA	8,058		85	
		Natural	4,959		72	
S eulachon[d]	Adult	Natural	5,885	0.02%	3,004	0.01%
	Juvenile	Natural	405		356	
PS/GB bocaccio[d]	Adult	Natural	23	1.82371%	13	0.58619%
	Juvenile	Natural	61		14	
PS/GB yelloweye rockfish[d]	Adult	Natural	75	0.29742%	34	0.00342%
	Juvenile	Natural	66		15	

[a] LHAC=Listed Hatchery Adipose Clipped, LHIA = Listed Hatchery Intact Adipose.
[b] Abundances for adult hatchery salmonids are LHAC and LHIA combined.
[c] Abundances for all adult PS steelhead are combined
[d] Abundances for juvenile listed rockfish and eulachon are unknown; all take and mortalities will be analyzed as adults

Species	Life Stage		Sum of Expected Take	Sum of Incidental Mortality
Green Sturgeon DPS	Adult	Capture/Handle/Release Fish	76	1
	Subadult	Observe/Harass	19	0

Actual take levels associated with these activities are almost certain to be substantially lower than the permitted levels. There are three reasons for this. First, most researchers do not handle the full number of individual fish they are allowed. Our research tracking system reveals that researchers, on average, end up taking about 37 percent of the number of fish they estimate needing. Second, the estimates of mortality for each proposed study are purposefully inflated (the amount depends upon the species) to account for potential accidental deaths, and it is therefore very likely that fewer fish (in some cases many fewer), especially juveniles, than the researchers are allotted would be killed during any given research project. Finally, researchers within the same watershed are encouraged to collaborate on studies (i.e., share fish samples and biological data among permit holders) so that overall impacts on listed species are reduced.

2.4.4.1. Harvest and Bycatch Effects in the Environmental Baseline

Puget Sound/Georgia Basin Rockfish

In this section, we summarize past and present impacts on rockfish from federal and state-managed fisheries within the portion of the action area in the Puget Sound/Georgia Basin. Recreational fishermen targeting bottom fish the shrimp trawl fishery in Puget Sound can incidentally catch listed rockfish. In 2012, we issued an incidental take permit (ITP) to the WDFW for listed rockfish in these fisheries (Table 2-18) and the WDFW is working on a new ITP application (WDFW 2017). If issued, the new permit would be in effect for up to 15 years.

Table 2-18. Anticipated Maximum Annual Takes for Bocaccio, Yelloweye Rockfish by the fisheries within the WDFW ITP (2012 – 2017) (WDFW 2012).

	Recreational bottom fish		Shrimp trawl		Total annual takes	
	Lethal	Non-lethal	Lethal	Non-lethal	Lethal	Non-lethal
Bocaccio	12	26	5	0	17	26
Yelloweye Rockfish	87	55	10	0	87	65

In 2017, we estimated that up to 68 yelloweye rockfish and 77 bocaccio were incidentally caught by recreational anglers targeting salmon (NMFS 2017f) and that all of these incidentally caught fish were mortalities. We anticipate similar numbers of mortalities in the salmon fishery and the fisheries in Table 2-18 in 2018 and beyond, but have not yet conducted an analysis under section 7 (a)(2). As shown in Table 2-17, for 2018 we permitted various researchers a total lethal take of 49 yelloweye rockfish and 27 bocaccio.

Green Sturgeon

In this section, we summarize past and present impacts on green sturgeon from Federal and state-managed fisheries within the action area. Other fisheries that affect Southern DPS green sturgeon, but occur outside of the action area, are discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat, of this opinion. Green sturgeon interactions in the fisheries may involve capture in fishing gear, removal from the water, and handling of the fish prior to release back into the water. Retention of green sturgeon is prohibited throughout the west coast, but some portion of the green sturgeon incidentally caught dies immediately or after being released back into the water. Because Southern DPS green sturgeon are not morphologically distinguishable from Northern DPS green sturgeon, the effects of these fisheries described below are not specific to Southern DPS green sturgeon. To estimate the effects of these fisheries on Southern DPS green sturgeon, we used stock composition information from genetic and tagging studies to estimate the proportion of the green sturgeon incidentally caught that may belong to the Southern DPS.

Pacific Halibut Fishery

We provide a brief summary of the past effects of the Pacific halibut fishery on Southern DPS green sturgeon. Section 2.5, Effects of the Proposed Action, provides an analysis of these effects and the expected effects of the fishery on green sturgeon under the Proposed Action.

There are no records of green sturgeon catch in the Washington treaty fisheries and the non-treaty directed commercial fishery, and occasional records of green sturgeon catch in the recreational fisheries. ORBS data for 2001 to 2012 show occasional catches of green sturgeon in the recreational fishery off Oregon, including one green sturgeon encountered in 2005 and one encountered in 2012 (expanded to two fish in 2005 and three fish in 2012, based on ORBS expansion methods) (Lynn Mattes, ODFW, email to Susan Wang and Sarah Williams, NMFS, and Daniel Erickson, ODFW, January 14, 2014, regarding Pacific halibut fisheries), with no records from 2013 to July 2017 (L. Mattes, ODFW, letter to Gretchen Hanshew, NMFS, August 16, 2017, regarding Pacific halibut fisheries). All green sturgeon were released alive. The ORBS data also show nine green sturgeon caught and released alive in the second week of May 2006, but further review of the raw interview data indicate that this record may be a data entry error (Lynn Mattes, ODFW, email to Gretchen Hanshew, NMFS, January 14, 2014, regarding halibut recreational fishing behavior and salmon). There are no records of green sturgeon landed or released dead.

Ocean Sampling Program (OSP) data from the late 1980s to present indicate no records of green sturgeon catch in the recreational Pacific halibut fisheries off the outer coast of Washington, although any green sturgeon catch would have been recorded (Heather Reed, WDFW, email to Susan Wang and Phaedra Doukakis, NMFS, January 21, 2014, regarding Pacific halibut fisheries and green sturgeon catch data). Occasional catches of green sturgeon have occurred in the Puget Sound recreational fishery. One green sturgeon was caught and released in the Puget Sound creel survey in 2008, and one catch record card reported two green sturgeon harvested in 2003, though this record is suspected to be a misidentification (Heather Reed, WDFW, email to Susan Wang and Phaedra Doukakis, NMFS, January 21, 2014, regarding Pacific halibut fisheries and green sturgeon catch data). WDFW RecFin data for 2003 to 2013 also show one green sturgeon caught and released in the Puget Sound bottom fish fishery in 2008 (unpublished WDFW RecFin data, from Eric Kraig, WDFW, January 7, 2014). No green sturgeon were reported in the Washington recreational halibut fisheries from 2014 to July 2017 (Heather Reed, WDFW, email to Susan Wang and Phaedra Doukakis, NMFS, January 5, 2017, regarding Pacific halibut fisheries and green sturgeon catch data; M. Culver, WDFW, email to Susan Bishop, NMFS WCR, August 24, 2017, regarding halibut fisheries in Washington waters). For the recreational fisheries off the coast of California, there are no records of green sturgeon catch in the CRFS database (data collection began in 2004) (C. McKnight, pers. comm., CDFW, January 28, 2014; D. Wilson-Vandenberg, CDFW, email to Susan Wang, Phaedra Doukakis, and other NMFS and CDFW personnel, January 5, 2017, regarding Pacific halibut fisheries off California and CDFW green sturgeon catch data).

Overall, the estimated number of green sturgeon encountered in the Pacific halibut fisheries has ranged from zero to three per year, with no encounters in most years. All of the records indicate the fish were released alive. The fish may belong to either the Southern DPS or Northern DPS. Genetic analyses have not yet been conducted to determine the DPS composition of green sturgeon caught in the Pacific halibut fisheries.

Pacific Coast Groundfish Fishery

In 2017, NMFS evaluated the impacts of the Federal Pacific Coast groundfish fishery on Southern DPS green sturgeon (NMFS 2017b, consultation number 2017-7552). Green sturgeon have been encountered in the limited entry (LE) groundfish bottom trawl and the at-sea Pacific hake/whiting (at-sea hake) sectors occurring along the California, Oregon, and Washington coasts, with varying levels of bycatch over the years (Al-Humaidhi et al. 2012; Lee et al. 2017). The majority of the green sturgeon encounters occurred in the LE groundfish bottom trawl sector in marine waters off Oregon and Washington (Al-Humaidhi et al. 2012; Lee et al. 2017). From 2002 to 2015, the LE groundfish bottom trawl sector encountered up to an estimated 21 Southern DPS green sturgeon per year and the at-sea hake sector encountered up to one Southern DPS green sturgeon per year (Lee et al. 2017). In some years, there is the potential for the LE groundfish sector to encounter greater numbers of Southern DPS green sturgeon (up to 39 per year), resulting in up to 40 Southern DPS green sturgeon encountered by the Pacific Coast groundfish fishery in any one year. In the at-sea hake sector, the green sturgeon encountered are dead (up to one Southern DPS green sturgeon per year). In the LE groundfish sector, the majority of the green sturgeon are released alive, though some level of immediate and post-release mortality occurs, estimated at 8 percent (see NMFS 2017b, consultation number 2017-7552). Applying this bycatch mortality rate, we estimate that up to three Southern DPS green sturgeon may be killed in the LE groundfish sector per year, resulting in up to four Southern DPS green sturgeon killed per year in the Pacific Coast groundfish fishery overall. The opinion also allows for incidental take of Southern DPS green sturgeon by the NMFS Observer Program, when observing and handling fish encountered in this fishery and the California halibut bottom trawl fishery (described below). No lethal take would be expected from this handling by the NMFS observers.

In 2017, NMFS evaluated the impacts of the Federal Pacific Coast groundfish fishery on listed salmon (NMFS 2017b, consultation number 2017-7552). The bycatch of salmon in these fisheries is limited primarily to Chinook salmon, with relatively few individuals from other species caught each year. The bycatch of all Chinook salmon in the whiting fishery averaged about 7,300 annually from 1991 to 2005. This compares to an incidental take limit of 11,000 Chinook salmon per year that is specified in the biological opinion. Since completing the consultation in 2006, the annual bycatch has declined and averaged about 4,100 annually from 2006 to 2010. Reinitiation of consultation concluded December 11, 2017 (NMFS 2017b).

The bycatch of Chinook salmon in the limited entry trawl fishery (both midwater and bottom trawl gears, combined) averaged 11,320 fish from 2002 to 2004. However, the bycatch of Chinook salmon has dropped steadily from a high of over 18,000 in 2002 to less than 2,000 in 2004. The bycatch of Chinook salmon has continued to drop in recent years and the average catch of Chinook salmon in the limited entry trawl fishery from 2005 to 2015 is 7,047 fish.

Bycatch of Chinook salmon has been below 9,000 fish from 2006 to 2015 with the exception of 2014 when 15,267 fish were caught (NWFSC 2017).

When the supplemental biological opinion on the groundfish fishery was completed in 2006, information related to the stock composition of the Chinook salmon caught in the groundfish fisheries was relatively limited. Based on the genetic composition of tagged Chinook salmon of the ESA-listed Chinook salmon ESUs, NMFS concluded that four (Snake River fall Chinook salmon, Lower Columbia River Chinook salmon, Upper Willamette Chinook salmon, and Puget Sound Chinook salmon) were the ones most likely to be subject to measurable impacts. Qualitative characterization of these ESU-specific impacts ranged from rare to exploitation rates that ranged from a “small fraction of 1 percent per year” to “less than 1 percent per year” depending on the ESU or populations being considered (NMFS 2006a). Since then, information regarding the stock composition of the Chinook salmon bycatch has become available from samples taken in 2008 from the shoreside whiting fishery and at-sea fishery. The samples were analyzed using genetic stock identification (GSI) techniques. These studies provide more specific information regarding the stock composition of the Chinook salmon bycatch in the whiting fishery, but the results were consistent with the more qualitative expectations in the 2006 supplemental opinion (i.e., much less than 1 percent mortality per year for Puget Sound and Lower Columbia River Chinook salmon) (NMFS 2006a).

California Halibut Bottom Trawl Fishery

Green sturgeon are encountered in the state-regulated California halibut bottom trawl fishery conducted in coastal marine waters. The annual fleet-wide bycatch estimates for green sturgeon range from 45 to 786 fish during years 2002 to 2010 and 30 to 637 fish from 2011 to 2015 (Lee et al. 2017). Changes in state fishing regulations were implemented in 2006 to reduce access to the California halibut fishery (California Fish and Game Code Section 8494) and appear to have decreased total California halibut landings and the number of encounters with green sturgeon per year. It is possible that individual green sturgeon are encountered by the fishery more than once per year, but recapture rates are not known. A genetic study on green sturgeon bycatch samples from 2007 to 2013 showed that 95 percent of green sturgeon encountered off California likely belong to the Southern DPS (Lee et al. 2017). Based on the 2011 through 2015 bycatch data, we estimate that the California halibut bottom trawl fishery encounters 28 to 631 Southern DPS green sturgeon per year. Applying a bycatch (immediate plus post-release) mortality rate of 10.3 percent (see NMFS 2017b, consultation number 2017-7552), we estimate that encounters in the California halibut bottom trawl fishery kills 3 to 65 Southern DPS green sturgeon per year.

Salmon Fisheries

The PFMC manages fisheries for Chinook and coho in federal waters under the Salmon Fishery Management Plan (PFMC 2016b). It covers wild and hatchery fish under conservation objectives and status determination criteria to manage the fishery for optimum yield, and allocates salmon among user groups. The PFMC management of coastal fisheries is an open process that begins in late February, after abundance estimates are released, and continues at March and April Council meetings and public hearings. Each year, season length, quota, and bag limits are set based on the amount of salmon available for harvest under conservation reference points (PFMC 2016b).

Puget Sound salmon fisheries are managed by the State of Washington and the treaty tribes. Currently there is no multi-year fishing plan for these fisheries – the state and tribes plan fisheries on an annual basis. Each year they develop conservation objectives to conserve and rebuild Puget Sound Chinook salmon, and allowable levels of mortality in order to permit harvest of surplus hatchery-raised salmon that co-occur with the Puget Sound Chinook ESU. The North of Falcon process is used to establish seasons for recreational and commercial fisheries in Washington's state waters, including Puget Sound. This is an open process involving federal, state, tribal, and industry representatives, as well as citizens.

In the past, fisheries exploitation rates were, in most cases, too high in light of the declining productivity of natural Chinook and coho salmon stocks. Over the last decade or more, the co-managers implemented several strategies to manage fisheries to reduce harvest impacts and to implement harvest objectives that are consistent with the underlying production of the natural population. Time and area closures are implemented to reduce catches of weak stocks and to reduce Chinook and coho salmon bycatch in other fisheries. Other regulations, such as size limits, bag limits, and requirements for the use of barbless hooks in all recreational fisheries, are also used. The state and tribal fishery co-managers manage Chinook and coho salmon mortality in PFMC, Puget Sound salmon, and tribal steelhead net fisheries to meet the conservation and allocation objectives described in a series of jointly developed Puget Sound Chinook salmon harvest plans. These plans have been adopted sequentially as the harvest component of the Puget Sound Salmon Recovery Plan, which includes the Puget Sound Chinook salmon ESU.

Forty percent or more of the harvest of most Puget Sound Chinook salmon stocks occurs in salmon fisheries outside the action area and primarily in Canadian waters. These fisheries are managed under the terms of the Pacific Salmon Treaty Agreement. The effects of these fisheries were assessed in previous biological opinions (NMFS 2004a; 73 FR 7816, February 11, 2008).

Exploitation rates on Puget Sound spring Chinook salmon and fall Chinook salmon stock aggregates have each been less than 20 percent on average in recent years. In 2004, NMFS issued a biological opinion on the anticipated effects of PFMC fisheries on the listed Puget Sound Chinook salmon ESU for 2004 and future fishing years. The 2004 opinion found that exploitation rates in PFMC Area fisheries (NMFS 2004a) on Puget Sound spring and fall Chinook salmon populations of 3 and 6 percent, respectively, would not jeopardize the species.

The exploitation rate on Lower Columbia River tule Chinook salmon in PFMC salmon fisheries averaged 13 percent from 2001 to 2010 (NMFS 2012a), accounting for 31 percent of the total exploitation that occurred in all fisheries over this time period. NMFS completed a biological opinion on PFMC fisheries for the Lower Columbia River Chinook salmon ESU in 2012. That biological opinion allowed for take based on an abundance-based framework for tules resulting in exploitation rates between 30 and 41 percent (including impacts in Columbia in-river fisheries) and ocean exploitation rates consistent with achieving escapement goal objectives for spring (0 to 28 percent) and bright stocks (1 to 11 percent).

The exploitation rate on Lower Columbia River coho salmon in PFMC salmon fisheries averaged 15 percent, with a range of seven and 24 percent between 2005 and 2016 (PFMC 2016a). Management objectives for Lower Columbia River natural coho must not exceed a coastwide marine and mainstem Columbia River exploitation rate of 18 percent. Management objectives for Snake River fall Chinook include a reduction of at least 30 percent in the total ocean age-3 and age-4 adult equivalent exploitation rate from the 1988-1993 average. The 2016 preseason Snake River Fall Index projection was 40.9 percent; the postseason estimate was not available (PFMC 2016a).

2.5. Effects of the Proposed Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 C.F.R. § 402.02). Indirect effects are those that are caused by the Proposed Action and are later in time, but still are reasonably certain to occur.

In addition to allocating TAC among the halibut fisheries, the CSP also allocates halibut quota to the salmon troll and sablefish primary fisheries (see Section 1.3.2.1) for retention of halibut caught incidental to those fisheries. However, take of ESA-listed species during the implementation of those fisheries is covered by existing biological opinions for the salmon and groundfish fisheries; therefore, those fisheries are not discussed further in this analysis (NMFS-2012a; NMFS 2016c; NMFS 2017b; USFWS 2017). As relevant, the estimated effects those fisheries have on ESA-listed species was considered as part of the environmental baseline for purposes of this analysis and will be included in the Integration and Synthesis discussion, below.

2.5.1. Puget Sound/Georgia Basin Rockfish

We first assess the general effects of proposed recreational and commercial halibut fisheries, and the IPHC stock assessment survey used to manage halibut populations, on individual yelloweye rockfish and bocaccio that are encountered and killed or injured. Next, we assess the population-level effects of each fishery. We then assess the potential habitat and prey effects of the recreational and commercial fisheries targeting halibut in the U.S. portion of the Puget Sound/Georgia Basin. We analyze direct effects on listed rockfish in two steps: First, we estimate the number of listed rockfish likely caught in the fisheries and assess both the sublethal and lethal effects on individuals. Second, we consider the consequences of those sublethal and lethal effects at the population level. We analyze indirect effects by considering the potential effects of fishing activities on benthic habitats and the availability of prey resources for listed rockfish. Throughout, we identify data gaps and uncertainties, and explain how we base assumptions in our analysis on the best available science.

The halibut fishery does not occur in the South Sound, in Hood Canal, and some of the Main Basin. As such, we assess the effects of the fishery in portions of the Main Basin, the eastern Strait of Juan de Fuca, and the San Juan Islands.

2.5.1.1. Effects from Recreational Halibut Fishing in Puget Sound

Anglers targeting halibut use lures and bait that catch yelloweye rockfish and bocaccio. Historically, many anglers would simultaneously target halibut and rockfish (Olander 1991). In recent years, a number of recreational anglers have begun to anchor their boats while halibut fishing. While anchored, they typically put down a chum-bag to attract halibut to their bait/jigs. Anglers typically anchor in areas with less bottom structure and rocky habitat to avoid losing the anchor. Because the retention of rockfish is no longer allowed per WDFW regulations, anglers cannot target rockfish but nonetheless can unintentionally hook them. Recreational fishermen targeting halibut and bottom fish are now required by state regulations to return all rockfish species to the water with a descending device. While WDFW regulations for anglers targeting bottom fish (such as lingcod) do not allow fishing in waters deeper than 120 feet (36.6 m) (where subadult and adult listed rockfish are most likely to reside), this regulation does not apply to anglers targeting halibut. The halibut regulations do include a prohibition on barbed hooks and limit fishing gear to two individual hooks (no treble hooks). Each measure would reduce injury to ESA-listed rockfish by reducing soft-tissue damage and the time needed to release fish from the hook. Capturing (and handling) fish on hook-and-line causes them injury, physiological stress, or can kill them. In some cases, individual fish can recover fairly rapidly and be released alive without the use of a descending device.

For rockfish caught in waters deeper than 60 feet (18.3 m), the primary cause of injury and death is barotrauma. Barotrauma occurs when rockfish are brought up from depth and the rapid decompression causes over-inflation and/or rupture of the swim bladder, which can result in multiple injuries, including organ torsion, stomach eversion, and exophthalmia (bulging eyes), among other damages (Parker et al. 2006; Jarvis and Lowe 2008; Pribyl et al. 2011). These injuries cause various levels of disorientation, which can result in fish remaining at the surface after they are released and making them subject to predation, damage from solar radiation, and gas embolisms (Hannah and Matteson 2007; Palsson et al. 2009). Injuries can include harm from differences in water pressure experienced by fish brought to the surface from depths (barotraumas), differences in water temperatures (between the sea and surface), and hypoxia upon exposure to air. The severity of these injuries is dictated by the amount of time fish are held out of the water and their general treatment while aboard. Physical trauma may lead to predation after fish are released (Palsson et al. 2009; Pribyl et al. 2011).

A number of devices have been invented and used to return rockfish to the depth of their capture as a means to mitigate barotrauma. When rockfish are released at depth, there are many variables that may influence long-term survival, such as angler experience and handling time in addition to thermal shock and depth of capture (Schroeder and Love 2002; Jarvis and Lowe 2008; Pribyl et al. 2009; Pribyl et al. 2011). A study of yelloweye rockfish found that when they are caught in the hook-and-line fishery and released at the surface, the mortality rate is high; however, when they are released with a decompression device, survival may be high (Hochalter and Reed 2011). Another study demonstrated that rosy rockfish (*Sebastes rosaceus*) with barotrauma-induced exophthalmia (bulging eyes) and recompressed in a controlled chamber showed improved visual function after 4 days and further improvement at 1 month (Rogers et al. 2011). A recent study found that short-term (48 hours) survival for recompressed yelloweye rockfish was 95.1 percent, while 77.8 percent of canary rockfish survived when caught in less than 100 m (Figure 1 *in* Hannah et al. 2014). The PFMC Groundfish Management Team also estimated mortality rates reflecting release with descending devices for cowcod, canary, and yelloweye rockfish management (PFMC 2014) that follows initial estimates of surface mortality created by developing a generalized linear model of the proportion of fish released dead by depth and by species based on information from observer program data (PFMC 2008). The 2014 rates accounted for reduced mortality as a result of being rapidly returned to depth, mitigating barotrauma, sun exposure, and surface predation-related mortality. The estimation method incorporated short-term mortality rates from cage studies and longer-term mortality rates from acoustic tagging studies. The mortality estimates and associated confidence intervals in each depth bin were estimated using a Bayesian Hierarchical Method, which accounted for variation between species and the sample size of each species using data from the latitude of the focal species (PFMC 2014). The report did not include discard mortality rates for bocaccio. Thus, only the discard mortality rates for yelloweye rockfish are reported below (Table 2-19).

Table 2-19. Bayesian Hierarchical Method: Total discard mortality (%) estimates by depth bin for yelloweye rockfish at the surface, and reflecting the use of descending devices incorporating short-term mortality, long-term mortality, unaccounted for mortality, and upper 60, 75, 90, and 95 percent confidence intervals as precautionary buffers for uncertainty (Source PFMC 2014).

Depth (fm)	Current Surface Mortality	Mortality w/ Descending Device	Estimate w/ 60% CI	Estimate w/ 75% CI	Estimate w/ 90% CI	Estimate w/ 95% CI
0-10	22%	22%[1]	22%[1]	22%[1]	22%[1]	22%[1]
10-20	39%	22%	23%	24%	26%	27%
20-30	56%	22%	23%	24%	24%	27%
30-50	100%	23%	24%	25%	27%	28%
50-100	100%	35%	39%	45%	57%	65%
>100	100%	100%	100%	100%	100%	100%

[1] The value reflects surface mortality because mortality estimates for descending devices are not expected to exceed surface release.

There is also some emerging evidence that female yelloweye rockfish can remain reproductively viable after recompression. A study conducted in Alaska found that fifteen recompressed female yelloweye rockfish remained reproductively viable 1 to 2 years after the event (Blain 2014). Blain (2014) also found no evidence that embryo quality was adversely affected 1 to 2 years after the recompression event in the study.

WDFW has estimated that anglers targeting halibut have caught some yelloweye rockfish (Table 2-20). There are a number of uncertainties regarding WDFW recreational fishing bycatch estimates because (1) they are based on dockside interviews of a subset of fishermen, (2) anglers whose trips originated from a marina are typically not surveyed at the dock, and (3) identification of rockfish to species is poor, only 5 percent of anglers could identify bocaccio and 31 percent yelloweye (Sawchuck 2012).

Table 2-20. WDFW estimates of yelloweye rockfish and bocaccio caught in the recreational halibut fishery in 2017.

Species	Projected Annual Take for Recreational Halibut Fishery	Percent of DPS/ESU
Yelloweye rockfish	82 (range 0 to 82)	<0.0001
Bocaccio	0	0

We do not know the average depth of listed rockfish caught in the halibut fishery, though it is likely that many anglers target halibut in waters from 100 to 400 feet (30.5 to 121.9 m) of water

(Olander 1991). For the purposes of estimating mortality rates, we assume that the average depth of caught and released listed rockfish is 300 feet (91.4 m). Estimated mortality based on 95 percent confidence interval of released yelloweye rockfish from this depth is 28 percent (PFMC 2014). WDFW estimates for listed rockfish bycatch from anglers targeting halibut are typically low relative to fishermen targeting salmon or bottom fish. This is likely because the halibut season is short compared to these other fisheries and because, as discussed below, many adult listed rockfish have already been removed from the population. The popularity of anchoring while targeting halibut may reduce rockfish encounters because anglers typically avoid rocky habitats when fishing on the anchor, thus they may also avoid prime habitats occupied by adult yelloweye rockfish and bocaccio. If the 2017 estimate of maximum fishery catch of 82 yelloweye rockfish occurred in the recreational halibut fishery, it would have a moderate impact on their abundance and a proportionally similar impact on yelloweye rockfish productivity, spatial structure, or diversity, particularly because not all of these fish would be mortalities.

2.5.1.2. Effects from Commercial Halibut Fishery in Puget Sound and Standardized Stock Assessment

The IPHC plans to include research fisheries in Puget Sound as part of the 2018 halibut standardized stock assessment (SSA), using the same gear and similar stations that were used in the 2011 and 2014 surveys, and could conduct additional surveys through the year 2022. The IPHC may add a few additional stations as necessary. The SSA would have similar bycatch risk and habitat effects as the commercial fishery discussed below, with the caveat that it is of much less intensity (around 13 sets with 6 skates) compared to the actual fishery. As such, we include the effects of the SSA survey in the following analysis of the commercial fishery in Puget Sound.

As described in the Proposed Action, gear used in the commercial fisheries includes:
- Hook-and-line (rod and reel, no more than two hooks)
- Hand line (no more than two hooks)
- Longline (snap gear only)
- Bottom troll (no more than six lines)

Effects on individual listed rockfish from being caught on commercial halibut gear would be virtually the same as described above in the recreational fishery. However, fish caught on longline gear would be hooked and suspended near the seafloor for minutes to hours; thus, effects would be more severe and some fish likely harmed or killed by predators such as dogfish, sixgill sharks, harbor seals, and sea lions (James 2016).

We do not know the gear and catch characteristics of the commercial halibut fishery in Puget Sound, including:
- The average number of hooks per skate
- The average number of skates used per set
- The number of sets per landing
- The proportion of gear types used (i.e., rod/reel, hand line, longline, bottom troll)

The NWIFC has provided reports of listed rockfish caught in the commercial halibut fishery for 2014, 2015, 2016, and 2017. The Lummi Nation also provided eight yelloweye rockfish and several biological samples from additional yelloweye rockfish to NMFS from the 2016 and 2017 fishery. There is some uncertainty regarding the record keeping of the non-halibut catch in the tribal halibut fishery in Puget Sound. The NWIFC reported a total of 31 yelloweye rockfish and no bocaccio caught in the commercial fishery over 3 years (James 2016), but have also noted tribal concern about the potential uses of rockfish catch information. The tribes have not provided the precise location or gear used in the fishery, and therefore it is challenging to estimate the total catch of listed rockfish in future seasons.

In order to conduct this analysis, we assumed that the dominant gear used are longlines because they are much more efficient and likely result in greater catch per effort compared to hand lines, and bottom troll gear. As described in the Proposed Action, we presumed that 100 hooks are used per skate (which is the typical industry standard); that 4, 6, or 8 skates are used per set; and that 2 to 3 sets are conducted per landing. These are the same assumptions used for the 2014 and 2017 fishery analysis (NMFS 2014a; NMFS 2017a) and represent a conservative and consistent assessment method.

In the absence of sufficient data on listed rockfish bycatch in the fishery at issue, we considered data from nearby commercial halibut fisheries and past state fisheries with similar fishery characteristics. In order to understand the potential bycatch of listed rockfish, we assess available data on the average catch per skate from longline research reports published by the Government of Canada's DFO, some of which are developed in coordination with the IPHC. These information sources come from research and fisheries using longlines from inside (mostly waters in Canada) and outside of the range of the DPSs. Table 2-21 summarizes available data on the average number of yelloweye rockfish and bocaccio per skate from research outside the DPSs' range.

Table 2-21. Data on yelloweye rockfish and bocaccio from outside the DPSs' area.

Type of Survey and Source	**Yelloweye** fish per skate (year)	**Bocaccio** fish per skate	**Location**
Halibut standardized stock assessment data. COSEWIC 2008.	2.25 (1995) 1.06 (2003) 1.32 (2004)	Not reported	B.C. waters (outside of the DPSs).
Halibut standardized stock assessment. Obradovich et al. 2008.	0.683	0.011	From PSMC area grouping 3C/D, 5A
Halibut standardized stock assessment. Yamanaka et al. 2008.	0.716	0.012	From PSMC area grouping 3C/D, 5A
Halibut standardized stock assessment. Yamanaka et al. 2007.	0.774	0.005	From West Coast Vancouver Island region.
Halibut standardized stock assessment. Lochead et al. 2006.	0.782	0.005	From West Coast Vancouver Island region.
Standardized stock assessment. Fleming et al. 2010.	1.715	0.245	From PSMC area grouping 3C/D, 5A
Halibut stock assessment survey. Yamanaka et al. 2004.	0.42	0.0	West Coast Vancouver Island

Available data from outside the DPSs' range show that yelloweye rockfish were caught from an average of 0.716 to 2.25 fish per skate and bocaccio from an average of 0.0 to 0.245 fish per skate. The data from the west coast of Vancouver Island may not be directly analogous to the risk of catch inside the Puget Sound/Georgia Basin DPSs because the abundance and population characteristics of each species differ (Drake et al. 2010). As such, we then assess available data from within the DPSs' range to understand the risk of bycatch from longline fisheries. Most of this recent information is from waters in the Canadian portion of the DPSs' range.

Non-tribal commercial longline (or set line) fisheries in the Puget Sound were closed by WDFW in 2010 to protect rockfish. Data from the past non-tribal set line fisheries within the DPSs' range show that yelloweye rockfish and bocaccio have been caught in the North Puget Sound area that overlaps with the area of the contemporary halibut fishery (waters of the San Juan Islands and Strait of Juan de Fuca area) (Table 2-22) (Palsson et al. 2009).

Table 2-22. Proportion of yelloweye rockfish and bocaccio in the total rockfish catch for past set line fisheries in the North Puget Sound. Table created from data in Palsson et al. 2009.

	1970-1987	1988	1989	1990	1991-1992	1993-2003
Yelloweye	28%	49.8%	72.5%	83.4%	91.9%	48.8%
Bocaccio	2.8%	0.0%	0.0%	0.0%	0.0%	0.0%

Data from set line fisheries in the North Sound show that bocaccio were undocumented as catch after 1988 and yelloweye rockfish were a large component of the rockfish catch in each time period. However, the data presented in Palsson et al. (2009) is not directly analogous to the contemporary commercial halibut fishery because the set line fisheries targeted other species, such as dogfish and rockfish, and may have used different baits and fished in different habitat types, all of which may have influenced the catch rate of yelloweye rockfish and bocaccio. In addition, the composition of rockfish catch from the set line fishery may not be directly analogous to the present-day commercial halibut fishery because listed rockfish have been depleted and size structure of listed rockfish truncated (Drake et al. 2010). We cannot calculate the catch rates of fish per skate from the data summarized in Palsson et al. (2009).

Most of the remaining data from within the DPSs' range comes from longline research and fisheries on the inside of Vancouver Island. Some of these surveys were inshore rockfish population assessments, while others were halibut stock assessment surveys. Most of these research reports provide catch-per-skate for yelloweye rockfish and bocaccio (summarized in Table 2-23).

Table 2-23. Longline research and fisheries data from the inside of Vancouver Island (Canada).

Type of Survey and Source	Yelloweye	Bocaccio	Location
DFO inshore rockfish longline surveys. Lochead and Yamanaka 2007	2.3792 (kg/skate) Converted to 1.191 fish per 100 hook skate.	0.0 (kg/skate)	Inside waters of Vancouver Island[a].
DFO inshore rockfish longline surveys. Lochead and Yamanaka 2006.	2.8411(kg/skate) Converted to 0.52 fish per 100 hook skate.	0.0 (kg/skate)	Central and North inside Vancouver Island [a] (DFO areas 12 and 13)
DFO inshore rockfish longline surveys. Lochead and Yamanaka 2004.	2.7761 (kg/skate) Converted to 1.08 fish per 100 hook skate.	0.0 (kg/skate)	Central and North inside Vancouver Island[a] (DFO areas 12 and 13)
Halibut standardized stock assessment. IPHC 2011.	0.0 fish per skate	0.0 fish per skate	Puget Sound
Halibut standardized stock assessment. IPHC 2014.	0.0 fish per skate	0.0 fish per skate	Puget Sound

Dogfish longline survey. King and McFarlane 2009.	Converted to 0.23 fish per 100 hook skate	0.0 fish per skate	Inside of Vancouver Island
Dogfish longline survey. King et al. 2012.	Converted to 0.12 fish per 100 hook skate	0.0 fish per skate	Inside of Vancouver Island

[a] Some data from outside the DPSs' geographic range

Available data from research in the Canadian portions of the DPSs' range show that yelloweye rockfish were caught from 0.23 to 1.191 fish per skate and bocaccio were not caught. In 2011, 2014, and 2017 the IPHC expanded their Stock Assessments Surveys into the Puget Sound/Georgia Basin DPSs. They fished 13 to 14 stations within the U.S. portion of the DPSs and 2 stations just to the west of the DPSs' border (near Port Angeles). Each station was fished with standardized gear (1,800 feet of groundline, 100 hooks) with a minimum 5-hour soak time. No rockfish of any species were caught within this survey in 2011 and 2014 (Dykstra 2011, 2014) and one yelloweye rockfish was caught at a station near San Juan Island in 2017 (Geernaert 2017).

Of the reports summarized in Table 2-23, the inshore rockfish surveys conducted by the DFO in 2005 (Lochead and Yamanaka 2007) and the 2011 IPHC survey provide the most spatial coverage for waters inside the DPSs' range and provide data closest to the waters fished by the tribal commercial longline fishery in U.S. waters. The goal of the 2005 survey conducted by DFO was to provide a relative index of abundance for inshore rockfish stocks. The study used a depth-stratified random design to determine sampling locations. To ensure that rockfish habitat was sampled, the DFO used benthic habitat charts to determine if sampling blocks were located on flat, muddy, or sandy bottoms (where rockfish are unlikely to occur) and eliminated these sites for sampling. As such, the study preferentially selected rockfish habitat in close proximity to U.S. waters and thus provides a geographically close and conservative comparison for catch rates from longlines targeting halibut. For these reasons, we assess this data to elucidate a range of potential bycatch rates for waters within the U.S. portion of the DPSs' range.

Lochead and Yamanaka (2007) found that yelloweye rockfish were caught at greater rates further away from the international border. Yelloweye rockfish were caught at one station in DFO management regions along the international border (Areas 19, 18, and 29) (Lochead and Yamanaka 2007) (Figure 2-11). No bocaccio were caught in this survey.

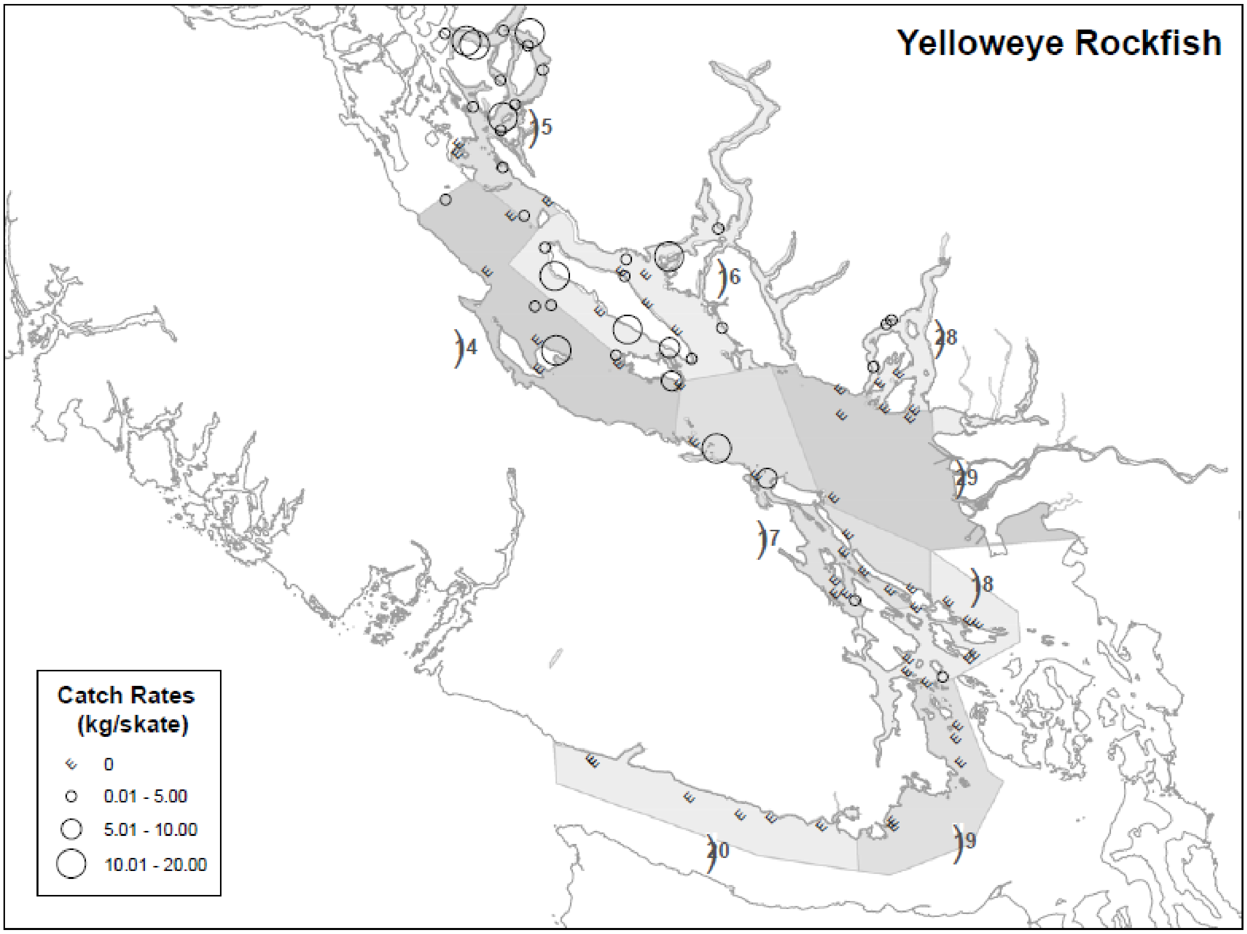

Figure 2-11. Catch of yelloweye rockfish in the DPS (from Lochead and Yamanaka 2007).

In order to determine a range of potential bycatch rates for proposed longline fisheries, we considered the data and catch rates as summarized in Table 2-22 and Table 2-23. We prioritized catch data that is closer in space and time to the U.S. halibut fishery in the rockfish DPSs' range because it serves as the best proxy to estimate bycatch rates in the proposed commercial longline fishery. As such, we further assessed the specific catch rates for Areas 18, 19, and 29 in the study by Lochead and Yamanaka (2007) because they are the closest to the halibut fisheries in the Proposed Action and consist of more sets (89) than used by the IPHC (11 to 12 where the halibut fishery occurs in Puget Sound area) in their 2011, 2014, and 2017 survey (Table 2-24).

Table 2-24. Catch rates for areas along the international boarder reported in Lochead and Yamanaka (2007).

Species/Area	Total for Areas 18, 19, and 29 (along international border)
Yelloweye	Converted to 0.0313 fish per skate
Bocaccio	0.0

Yelloweye Rockfish Bycatch Estimates

To estimate potential bycatch rates for yelloweye rockfish in the tribal/commercial longline fishery in Puget Sound, we used the following data and assumptions:

- We used catch-per-skate in Areas 18, 19, and 29 (all along the international border), data summarized in Table 2-25, to estimate potential bycatch for yelloweye rockfish.
- To determine this range of catch, we assessed the low (443), average (527), and high (569) annual landings that have occurred for each DPS over the past several years (see Section 1.3, Proposed Federal Action).
- Two to three sets were used per each landing (see Section 1.2, Consultation History).
- Four, six, or eight skates were used for each set (see Section 1.2, Consultation History).

Table 2-25. Yelloweye rockfish bycatch estimates from the commercial halibut fishery.

Species	Low Estimate[a]	Medium Estimate[b]	High Estimate[c]	Abundance Scenario[d]	Percent of DPS killed (low estimate)	Percent of DPS killed (medium estimate)	Percent of DPS killed (high estimate)
Yelloweye Rockfish	111	247	427	143,086	0.08	0.17	0.3

a The low range estimate uses catch data from areas along the international border reported in Lochead and Yamanaka (2007), the low number of landings (501), the low number of sets (2), and the low number of skates (4) used in Puget Sound.
b The medium range estimate uses the same catch data from areas along the international border reported in Lochead and Yamanaka (2007), the average number of landings (534), the average number of sets (2.5), and the average number of skates (6) used in Puget Sound.
c The high range estimate uses the same catch data from areas along the international border reported in Lochead and Yamanaka (2007), the high number of landings (550), the high number of sets (3), and the high number of skates (8) used in Puget Sound.
[d] This Abundance scenario is derived from the combined WDFW ROV survey in the San Juan Islands in 2010, and the 2015 ROV survey in Puget Sound proper (described in Section 2.2, Analytical Approach). We use the lower confidence intervals reported in WDFW (2017). We chose the 2010 survey in the San Juan Islands because it occurred over a wider range of habitat-types than the 2008 survey.

Available data show yelloweye rockfish are a consistently caught species on longline research surveys on the inside waters (Table 2-21), and available information indicates they are caught at greater rates toward the northern portions of the inside waters of Vancouver Island (Table 2-21, Figure 2-12).

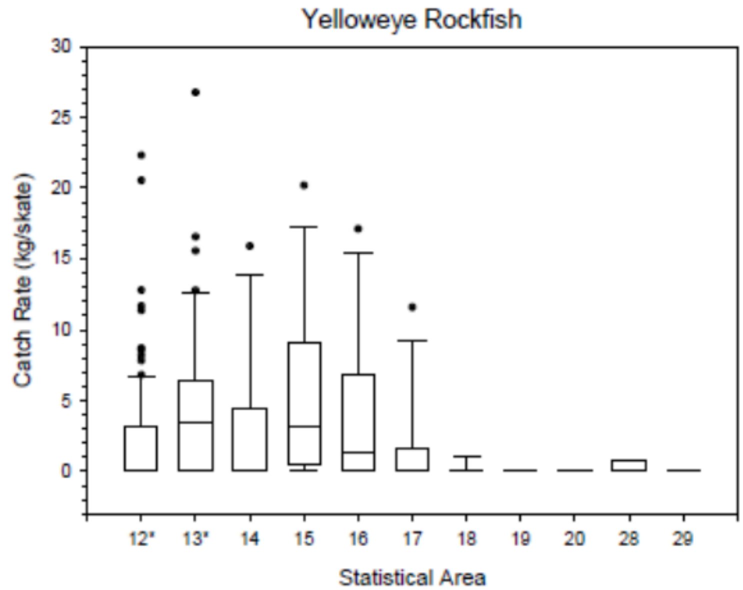

Figure 2-12. Yelloweye rockfish catch rate by statistical area on inside waters of Vancouver Island. Areas 18, 19, and 29 are along the international border (From Lochead and Yamanaka 2007).

Research surveys from near the international border (Lochead and Yamanaka 2007) and in Puget Sound (Claude Dykstra, IPHC, email to Dan Tonnes, NMFS, December 14, 2011 and June 2, 2014) show that yelloweye rockfish are rarely caught in recent times. Rare encounter rates may be the result of depressed population numbers in inside waters and because of the relative lack of older, bigger fish (Pacunski et al. 2013) that are typically more susceptible to hook-and-line catch. Yelloweye rockfish are primarily associated with the bottom, which makes them much more susceptible to longline baits compared to some other semi-pelagic rockfish species, such as bocaccio.

It is very likely that the actual catch of yelloweye rockfish in the commercial longline fishery in Puget Sound would be closer to or below the low estimate and medium estimate (111 to 247 fish) than the high estimate (427 fish). As a rough point of comparison, the IPHC stock assessment surveys in Puget Sound (that overlap with the commercial halibut fishery) caught one yelloweye rockfish over three survey years, for an aggregate of 0.0049 fish per skate. If we use this fish-per-skate applied to the commercial halibut fishery, with the same assumptions as Table 2-24, it would lead to a low of 40, a medium of 62, to a high of 67 yelloweye rockfish caught per year. As such, we anticipate that take of yelloweye rockfish under the proposed commercial fishing is not expected to exceed the medium estimate of 247 fish annually. We presume that any fish caught in the commercial halibut fishery would be killed.

Bocaccio Bycatch Estimates

Available data show that bocaccio have not been caught on longline gear in research surveys on the inside waters of the DPS's range in recent times (Table 2-22), and are caught at low levels in areas outside of the DPS's range compared to many other rockfish species. This may be because population numbers are naturally lower within the DPS range compared to coastal waters, population abundance is depressed in inside waters, and/or because of their life history. Bocaccio are semi-pelagic rockfish, meaning they can spend time suspended in the water column and also move long distances. These factors likely make them less susceptible to longline baits that are deployed at or very near the bottom.

Of the six longline research studies we found for waters within the range of the DPS, no bocaccio were reported as caught (Table 2-23), and available longline data for fisheries inside the DPS do not show bocaccio catch since the 1970s (Table 2-22). For a conservative analysis, we can compare a bycatch scenario where bocaccio would be caught at the lowest reported rate (0.005 fish per skate) in coastal waters outside of the DPS' range (Table 2-21). Even if bocaccio were caught at this rate in the commercial longline fishery in Puget Sound it would equate to a low of 18, a medium of 40, and a high of 68 fish caught annually (using the same assumptions used to generate estimates in Table 2-25).

However, given the lack of catches reported in Puget Sound by the IPHC (Claude Dykstra, IPHC, email to Dan Tonnes, NMFS, December 14, 2011 and June 2, 2014), recent set line data reported by Palsson et al. (2009), the lack of reported catches in the longline fishery over the past 3 years (James 2016), and lack of bocaccio catch in waters from the inside of Vancouver Island and Puget Sound (Table 2-23), it is likely that the actual catch of bocaccio in the commercial longline fishery in Puget Sound would be closer to (and below) the low estimate (18 fish) than the medium (40 fish) or high estimate (68 fish) annually. We presume that any fish caught in the commercial fishery would be killed.

2.5.1.3. Fishery Effects on Listed Rockfish Population Demographics and Productivity

Longline fisheries predominantly catch larger and sexually mature rockfish (Obradovich et al. 2008; Flemming et al. 2010), and this dynamic is likely for recreationally caught rockfish. Yelloweye rockfish do not typically enter the longline fishery until they approach and exceed 12 inches (300 mm) (Figure 2-13) (Obradovich et al. 2008). Most bocaccio appear to enter the fishery from 16 to 24 inches long (400 to 600 mm) (Obradovich et al. 2008; Yamanaka et al. 2008; Flemming et al. 2010).

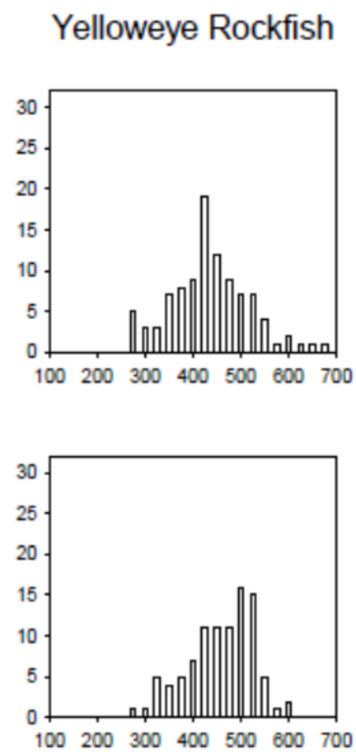

Figure 2-13. Yelloweye rockfish catch size distribution from longline catch in Lochead and Yamanaka (2007). The y axis is age of fish and the x axis is length in millimeters. Top chart is for male and bottom chart is for female yelloweye rockfish.

It is probable that baits and hooks of longlines are too big for ingestion for rockfish smaller than 12 inches (300 mm). As a consequence, these fisheries remove older rockfish from the population. Longline-caught yelloweye rockfish range from about 10 years old to over 100 years old (Yamanaka et al. 2007; Obradovitch et al 2008) (Figure 2-14).

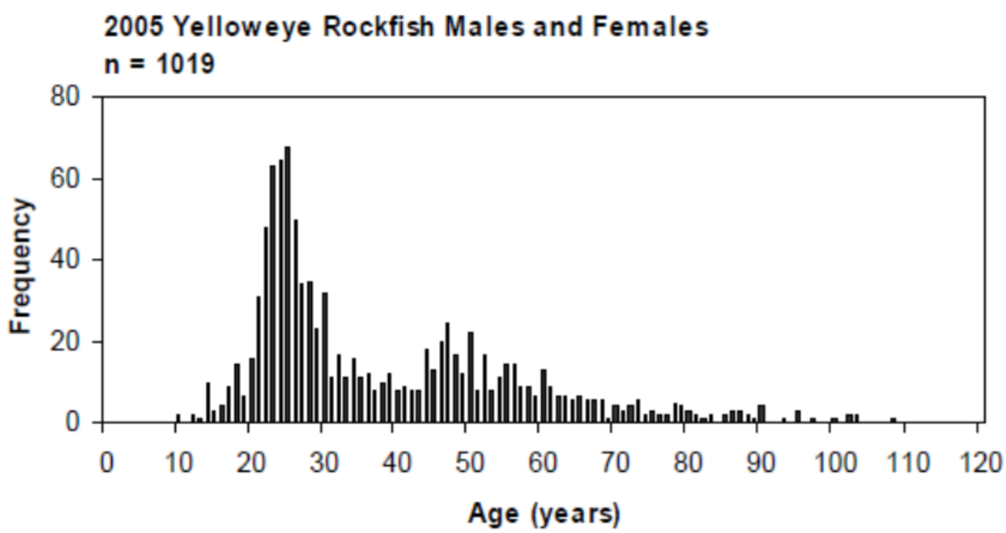

Figure 2-14. Age distribution of yelloweye rockfish longline catch (reported in Yamanaka et al. 2007).

Any bocaccio that would be caught in the longline fishery would also likely be adults, given the lack of smaller fish documented in research surveys (Obradovich et al. 2008; Yamanaka et al. 2008; Flemming et al. 2010). Research fisheries have found zero to few sexually immature yelloweye rockfish and bocaccio within the catch (Obradovich et al. 2008; Yamanaka et al. 2008; Fleming et al. 2010). For example, Obradovich et al. (2008) found no sexually immature bocaccio, and only 0.9 percent of the yelloweye rockfish catch consisted of immature fish. The rest of each species were sexually "maturing" to "resting." Yamanaka et al. (2008) reported 0.8 percent of the yelloweye catch as sexually immature, while Lochead and Yamanaka (2007) reported 4.6 percent of the yelloweye catch as sexually immature. As such, the vast majority of fisheries bycatch from halibut fisheries are likely to be older and more productive yelloweye rockfish and bocaccio.

The removal of larger and older fish from the population would have a disproportionate impact on population productivity by reducing the total number of larvae released and potentially affecting the timing of parturition and viability of individual larvae from smaller females. Yelloweye rockfish are a common proportion of longline catch (Table 2-21, Table 2-22, and Table 2-23), particularly in areas with maturing and mature fish (Obradovich et al. 2008; Yamanaka et al. 2008; Flemming et al. 2010) approaching sizes greater than 12 inches (300 mm). Thus, the impacts on yelloweye rockfish demographics and productivity would be more acute than on bocaccio.

Habitat Effects from Fisheries

The habitat effects of the Proposed Action are discussed generally here and additional analysis regarding habitat effects are located in Section 2.2, Rangewide Status of the Species and Critical Habitat, and Section 2.7, Integration and Synthesis.

<u>Habitat Effects: Puget Sound Area</u>

Hook-and-line gear used by the recreational halibut fishery would have the potential to alter benthic habitats by snagging structure and losing gear. Recreational bottom fish anglers use jigs, weights, hooks and anchors that could alter benthic habitats by snagging structure and some gear could be lost. However, there have been no observations of adverse effects in deepwater areas of the seafloor from lost recreational fishing gear in WDFW habitat surveys (Pacunski et al. 2013), and lost gear in the recreational halibut fishery would be on very small spatial scales.

Gear used in commercial halibut fisheries could result in small adverse effects on some deepwater (greater than 98 feet (30 m)) areas. Alteration to bottom habitats from longline fisheries is likely minimal because the gear is limited in weight and area fished (Morgan and Chuenpagdee 2003). When hauling longlines, there is potential for the hooks to snag structural organisms such as sponges and thus move rocks and/or cause small areas of turbidity (Morgan and Chuenpagdee 2003). Longline gear that is lost can result in longer-term habitat alterations, though these would be expected to decrease over time as sediments and biota cover the lines. Some longlines can be snagged and lost on the sea floor and thus have the potential to alter habitat in localized areas. However, only five longlines have been documented in the extensive derelict gear surveys or removal efforts in Puget Sound (Kyle Antonelis, email to Dan Tonnes, NMFS, January 29, 2014, regarding derelict gear surveys and removal efforts).

2.5.2. Green Sturgeon

The proposed fishing may affect Southern DPS green sturgeon directly by capture in the fishing gear and removal and handling of those fish prior to release back into the water. The proposed fishing may also affect Southern DPS green sturgeon indirectly by reducing prey availability in marine waters. We analyzed the effects in three steps. First, we examined the overlap between the fishery and Southern DPS green sturgeon distribution. Next, we evaluated direct effects by estimating the number of Southern DPS green sturgeon that may be encountered and the mortalities expected annually from the proposed fishing, considering the effects at both the individual and population levels. Finally, we evaluated indirect effects by considering the potential effects of fishing activities on the availability of prey resources for green sturgeon. We identify data gaps and uncertainties, and describe how we based assumptions in our analysis on the best available science.

2.5.2.1. Degree of Spatial Overlap

The spatial extent of the proposed fishery overlaps with the Southern DPS green sturgeon's main migratory corridor (from Monterey Bay to Vancouver Island), indicating the potential for incidental catch of the species in the fishery. Within this range, Southern DPS green sturgeon make multiple migrations throughout their lives to and from their natal spawning habitat in the California Central Valley to coastal bays and estuaries further up the coast, including Humboldt Bay in California, Coos Bay and Winchester Bay in Oregon, the Columbia River estuary, and Willapa Bay and Grays Harbor in Washington, as well as forays (less common) into Puget Sound (Moser and Lindley 2007; Lindley et al. 2008; Lindley et al. 2011). Thus, green sturgeon densities may be highest in marine waters adjacent to these coastal bays and estuaries. Green sturgeon typically occupy marine waters within the 110 meter (60 fm) depth contour, but can occur in deeper waters (Erickson and Hightower 2007).

The recreational fisheries have the highest degree of overlap with Southern DPS green sturgeon, because the fisheries occur throughout the coast from Puget Sound to northern California. The Washington treaty fisheries have the lowest degree of overlap, because they are restricted to Puget Sound and the area off the north coast of Washington to the waters off Grays Harbor. The non-treaty directed commercial fishery also has a low degree of overlap with Southern DPS green sturgeon. The non-treaty commercial fishery off Washington is not likely to encounter green sturgeon because the area within the 100-fm contour (where green sturgeon would most likely occur) is closed to commercial fishing because of the RCA. The RCA closure along the Oregon and northern California coasts also limits the non-treaty commercial fishery to waters shoreward of the 20-fm and 40-fm contours, thus limiting the overlap with Southern DPS green sturgeon. Although both commercial and recreational Pacific halibut fishing is allowed throughout the coast of California, fishing typically does not occur in waters south of Mendocino County, further limiting the spatial overlap with Southern DPS green sturgeon distribution.

2.5.2.2. Effects from Encounters in Fishing Gear

The proposed fishing may cause stress, injuries, and mortalities to Southern DPS green sturgeon from capture in fishing gear and associated handling. This analysis considers whether effects of capture and handling in the proposed fisheries may reduce the reproduction, numbers, or distribution of Southern DPS green sturgeon. We evaluated these effects based on the best scientific information available about past fishery interactions with green sturgeon.

Uncertainty exists regarding the number of green sturgeon captured in the Pacific halibut fisheries in the past because consistent methods of monitoring green sturgeon catch have not been implemented in most of the fisheries. Bycatch monitoring for green sturgeon has varied by fishery sector and area, but has been the most consistent in the recreational fisheries. As described in the Environmental Baseline section of this opinion, the available data show occasional encounters of one to three green sturgeon a year, with no green sturgeon encounters in most years. All of the documented encounters were in the recreational fishery. We do not know if the lack of recorded green sturgeon encounters in the tribal fisheries and non-treaty directed commercial fishery is because of a lack of encounters or a lack of consistent monitoring for green sturgeon encounters.

Based on the gear types used in the fisheries (e.g., longline, troll, hook-and-line), the limited spatial overlap with green sturgeon, and the limited fishing seasons, we would expect the number of green sturgeon encounters in these fisheries to be similar to or less than what has been recorded for the recreational fisheries. This is consistent with available data from other fisheries using similar gear. For example, bycatch of green sturgeon has not been observed in other longline fisheries within the action area (e.g., limited entry fixed gear primary and non- primary sablefish fisheries and open access fixed gear fisheries; observer coverage has ranged from 1 to 43 percent per year) (Al-Humaidhi et al. 2012; NMFS 2012a, consultation #2012/876; Lee et al. 2015, 2017). The commercial Pacific halibut fishery in Canada also uses hook-and-line (longline) gear and has 100 percent monitoring through at-sea observers or electronic monitoring systems. Monitoring data for this fishery from 2008 to 2017 included only one record of a green sturgeon encounter (Robert Tadey, DFO, email to Susan Wang, NMFS, and Chantelle Caron, DFO, October 3, 2013, regarding Pacific halibut fisheries off B.C. and DFO green sturgeon catch data; Adam Keizer, DFO, email to Phaedra Doukakis, NMFS, January 5 and 6, 2017 and November 23, 2017, regarding Pacific halibut fishery and green sturgeon catch data).

Given the present uncertainties in the available data, we made precautionary assumptions in our analysis to ensure the proposed fishing is not likely to jeopardize the continued existence of Southern DPS green sturgeon. We included in our analysis the maximum estimated number of green sturgeon encounters in the proposed fisheries between 2001 and 2017 (up to three green sturgeon per year) (Lynn Mattes, ODFW, email to Susan Wang and Sarah Williams, NMFS, and Daniel Erickson, ODFW, January 14, 2014, regarding Pacific halibut fisheries off Oregon and ODFW green sturgeon catch data). Because biological information and tissue samples were not collected from the green sturgeon encountered in the fishery, we are not able to determine whether the fish were subadults or adults and whether they belonged to the Southern or Northern DPS. To be conservative, we assumed that all of the green sturgeon encountered per year would be subadult or adult Southern DPS green sturgeon. Therefore, the proposed fishing is expected to incidentally catch up to three Southern DPS green sturgeon subadults or adults per year from 2018 to 2022.

The potential effects of this incidental catch include sublethal and/or lethal effects on individual fish. All of the green sturgeon bycatch records indicate that the fish were released alive. Based on this, we would expect most of the fish to be released alive and survive. These fish may experience sublethal effects, including stress and injury that may result in altered migratory behavior or altered growth and development. Capture and release in the fishery may disrupt the migration of adults on their spawning migration, resulting in a loss of spawning potential. We would also expect some portion of the fish to die because of delayed mortality after release. We do not have direct estimates of post-release mortality for these fisheries. The best available information is an estimated post-release mortality rate of 2.6 percent for hook-and-line gear, based on a white sturgeon study in the Fraser River (Robichaud et al. 2006). Although conditions may differ in marine waters and when using longline or troll gear, this is the best estimate available at this time. Based on this estimated post-release mortality rate, we estimate that incidental catch in the proposed fisheries kills up to one Southern DPS green sturgeon per year (2.6 percent of up to three fish per year = 0.078 fish killed per year, rounded up to one fish per year).

To analyze the effects at the population level, we use Mora's (2016) estimated population abundance of Southern DPS green sturgeon adults (2,106; 95 percent confidence interval [CI] = 1,246-2,966) and subadults (11,055; 95 percent CI = 6,540-15,571). Given these estimated abundances, the expected incidental take of Southern DPS green sturgeon in the proposed fishery would affect 0 to 0.24 percent of the adult population, with lethal take of 0 to 0.08 percent of the adult population, or affect 0 to 0.05 percent of the subadult population, with lethal take of 0 to 0.015 percent of the subadult population per year. Given past interactions with the fishery, we would expect no encounters with green sturgeon in most years. The high estimates represent conservative estimates given the highest estimated take per year (three fish encountered and one fish killed) and the lowest estimated adult and subadult abundances. As stated before, there is a level of uncertainty in the population abundance estimates, as well as in the estimated incidental catch per year. We do not expect the Proposed Action to further restrict the spatial structure or diversity of the species; however, the Proposed Action could reduce the abundance or productivity of individuals caught in the fishery. Given the low number of fish likely to be encountered per year, we would expect a minimal reduction in abundance and/or productivity for the Southern DPS green sturgeon population.

2.5.2.3. Effects on Prey Availability

We expect the proposed fishery to have low impacts on prey availability for Southern DPS green sturgeon. Green sturgeon are known to feed on small fish and benthic invertebrates in coastal estuaries and likely have similar prey species in marine waters. Although the proposed fishery overlaps with green sturgeon distribution and critical habitat, the fish species caught in the proposed fishery are not typical prey items for green sturgeon.

2.5.3. Chinook and Coho Salmon

The data used for this analysis encompasses the 2007 to 2016 time period for the ocean recreational, ocean commercial, and Puget Sound commercial halibut fisheries, and 2012 to 2015 for the Puget Sound recreational halibut fishery. These time periods were chosen because the structure of the all-depth and shoreside fisheries, fishery agreements, establishment of Rockfish Conservation Areas, reduction in fishing days, and number of vessels in both the commercial and recreational halibut fisheries (Section 1.3, Proposed Federal Action), as well as the pattern of salmon bycatch and regulation in these years is expected to be reflective of the period under consideration in the biological opinion, because these aspects of the fishery are likely to remain similar through 2022. Additionally, many of these developments and shorter seasons are beneficial to listed salmon.

As described above (Section 1.3, Proposed Federal Action), halibut are harvested in commercial, tribal, and recreational fisheries. As detailed below, only the recreational halibut fishery impacts ESA-listed salmon; those impacts are limited to four ESUs and the magnitude of the impact is thought to be minimal. Pacific halibut fisheries pose low risk to ESA-listed salmon stocks. Between 2012 and 2016, only two salmon were caught incidental to the recreational halibut fishery when salmon were not targeted (J. Simon, CDFW, email to Gretchen Hanshew, July 26, 2017, regarding salmon caught in the halibut fishery). This is in part due to differences in the gear that is used to target salmon and halibut. Barbless hooks must be used when fishermen are targeting salmon. Larger circle or “J” hooks are most commonly used when fishing for halibut, as mentioned in more detail in Section 1.3.5, Gear Fished in the Halibut Fishery.

Commercial halibut fisheries occur in Washington, Oregon, and California waters, generally as far south as Point Arena; most of the commercial fishery occurs in Oregon waters. Commercial halibut fishing rarely, if ever, affects salmon because of the depth of the halibut fishery, the size of the terminal tackle used, and the very short commercial halibut fishing season. The commercial halibut fishery occurs in open waters up to 150 fathoms in depth; commercial halibut fishing gear is deployed on or near the seafloor as described in Section 1.3, Proposed Federal Action, because halibut are a benthic species spending most of their time on or near the substrate. Salmon are generally fished at 80 fathoms or less (OSU 2003). Chinook salmon, for example, are generally found above 40 fathoms (Healey 1991) and are a pelagic species living in the water column; thus, they would be very unlikely to interact with commercial halibut fishing gear. The commercial halibut fishery uses size 16/0 hooks, much larger than what is used to fish for salmon, typically 4/0 or 3/0 size hooks. The IPHC and Canadian DFO conduct stock assessment surveys using commercial gear in the same general and adjacent areas and depths as the commercial halibut fishery, and they record all bycatch of non-halibut species. There are no survey records of salmon bycatch in the action area (B. Leaman, IPHC Executive Director, letter to Frank Lockhart, NMFS, June 1, 2012; B. Leaman, IPHC Executive Director, letter to Steven Freese, NMFS WCR, August 15, 2016), Canadian Strait of Juan de Fuca, or Georgia Strait (King and McFarlane 2009; King et al. 2012; Lochead et al. 2006; Lochead and Yamanaka 2004; Lochead and Yamanaka 2006; Lochead and Yamanaka 2007). Collectively, the available information indicates that salmon are rarely, if ever, caught incidentally by commercial halibut gear. Additionally, commercial halibut fisheries off Oregon have only been open 1 or 2 days each year since 2009, providing very little opportunity to interact with salmon. Therefore, we do not expect that any salmon will be caught incidentally in the proposed commercial halibut fisheries.

The tribal commercial halibut fishery occurs off the Washington coast and in the Salish Sea (including the Strait of Juan de Fuca and Puget Sound in the area of the San Juan Islands); the season has historically been short in duration (less than 2 weeks) (Table 1-3). The tribal ceremonial and subsistence (C&S) fishery occurs in the same area and using the same gear as the tribal commercial fishery. Although Table 1-3 indicates the fishery is open 365 days per year, C&S halibut fishing does not occur 365 days a year. Limited ceremonial fisheries are scheduled for specific occasions (e.g., funerals, community events) by tribal regulation, and subsistence fishing allows for the infrequent catch of halibut in fisheries targeted at other species during the year (Sandy Zeiner, NWIFC Fisheries Biologist, email to Sarah Williams, NMFS, March 4, 2014, regarding date of salmon bycatch). Commercial fishermen are not required to record catch or encounters of species other than halibut in logbooks although the states require that catch is recorded on fish tickets if landed. One unidentified salmon was recorded as bycatch in the 2012 tribal commercial fishery in Puget Sound (Sandy Zeiner, NWIFC Fisheries Biologist, email to Sarah Williams, NMFS, May 31, 2012, regarding season structure, effort, and salmon bycatch; Sandy Zeiner, NWIFC Fisheries Biologist, email to Susan Bishop, NMFS, March 5, 2014, regarding fishing depths of Puget Sound tribal halibut fisheries), but otherwise there is no reported incidental catch of salmon in the commercial or tribal C&S fisheries (M. Culver, WDFW Regional Director, letter to Frank Lockhart, NMFS, May 15, 2012; M. Culver, WDFW Regional Director,email to Susan Bishop, NMFS, February 13, 2014, regarding halibut fisheries in Washington waters; B. Leaman, IPHC Executive Director, letter to Frank Lockhart, NMFS, June 1, 2012; IPHC 2014; G. Kirchner, ODFW Section Manager, email to Susan Bishop, NMFS WCR, July 6, 2014, regarding salmon bycatch during halibut fisheries; S. Williams, ODFW Deputy Administrator, letter to Frank Lockhart, NMFS, June 21, 2012, regarding halibut fishery data request). Therefore, we do not expect that salmon will be caught incidentally in the proposed tribal halibut fisheries.

Recreational halibut fisheries occur in Washington, Oregon, and northern California waters. Since 2009, the recreational halibut fisheries in Oregon and California waters have generally occurred coincident with open seasons for salmon managed under the Pacific Fishery Management Council's Pacific Coast Salmon Fishery Management Plan (M. Culver, WDFW Regional Director, letter to Frank Lockhart, NMFS, May 15, 2012; M. Culver, WDFW Regional Director, email to Susan Bishop, NMFS, February 13, 2014, regarding halibut fisheries in Washington waters; G. Kirchner, ODFW Section Manager, email to Susan Bishop, NMFS WCR, July 6, 2014, regarding salmon bycatch during halibut fisheries; S. Williams, ODFW Deputy Administrator, letter to Frank Lockhart, NMFS, June 21, 2012, regarding halibut fishery data request). Salmon caught during coincident halibut/salmon openings are considered to be taken in the ocean and Puget Sound salmon fisheries, are counted against any applicable salmon fishery quotas, and thus are accounted for in existing biological opinions on those salmon fisheries. The biological opinions regarding the effects of the Pacific Coast Salmon Fishery Management Plan on salmon ESUs are listed in Table 2-26. The limited recreational halibut fisheries that are open when the salmon fisheries are closed occur on the Washington coast and in the Salish Sea (i.e., Puget Sound and the Strait of Juan de Fuca) in May and June. There is no record of salmon being encountered during the October halibut fishery (G. Kirchner, ODFW Section Manager, email to Susan Bishop, NMFS WCR, July 6, 2014, regarding salmon bycatch during halibut fisheries; S. Williams, ODFW Deputy Administrator, letter to Frank Lockhart, NMFS, June 21, 2012, regarding halibut fishery data request). Salmon caught in halibut fisheries when the salmon fishery is closed are the subject of this opinion and are considered here in more detail. As described below, only Chinook and coho salmon are encountered in recreational halibut fisheries, and the ESA-listed salmon ESUs that are expected to be affected by these recreational halibut fisheries are: Snake River fall Chinook salmon, Puget Sound Chinook salmon, Lower Columbia River Chinook salmon, and Lower Columbia River coho salmon.

Table 2-26. NMFS ESA determinations regarding salmonid ESUs and DPS affected by PFMC Fisheries and the duration of the 4(d) Limit determination or biological opinion (BO) (only those decisions currently in effect are included).

Date (Decision type)	Duration	Citation	Species Considered
March 8, 1996 (BO*)	until reinitiated	(NMFS 1996b)	Snake River spring/summer and fall Chinook, and sockeye
April 28, 1999 (BO)	until reinitiated	(NMFS 1999)	S. Oregon/N. California Coasts coho Central California Coast coho Oregon Coast coho
April 28, 2000 (BO)	until reinitiated	(NMFS 2000)	Central Valley Spring-run Chinook California Coastal Chinook
September 14, 2001 (BO, 4(d) Limit)	until withdrawn	(NMFS 2001a)	Hood Canal summer-run chum
April 30, 2001 (BO)	until reinitiated	(NMFS 2001b)	Upper Willamette River Chinook Columbia River chum Ozette Lake sockeye Upper Columbia River spring-run Chinook Ten listed steelhead DPSs
June 13, 2005 (BO)	until reinitiated	(NMFS 2005a)	California Coastal Chinook
April 29, 2004 (BO)	until reinitiated	(NMFS 2004a)	Puget Sound Chinook
April 26, 2012 (BO)	until reinitiated	(NMFS 2012b)	Lower Columbia River Chinook
April 2010 (BO)	until reinitiated	(NMFS 2010e)	Sacramento River winter-run Chinook
April 2015 (BO)	until reinitiated	(NMFS 2015b)	Lower Columbia River coho

*BO = biological opinion

Salmon caught in the coastal recreational halibut fishery off Washington, Oregon, and California during times that salmon recreational fisheries are open count against the recreational salmon quota or are otherwise taken into account as part of the coastal salmon recreational fishery. Salmon retention is prohibited when the salmon recreational season is closed. As mentioned above, data from the analysis period indicate that only Chinook and coho salmon are encountered in the recreational halibut fishery (Table 2-27).

The non-retention mortality of Chinook salmon in Puget Sound recreational halibut fisheries during the analysis period (2012 to 2015) was very low, ranging from 1.4 to 2.3 Chinook salmon per year, with an average of 1.9 (Table 2-27). The non-retention mortality of Chinook salmon in recreational halibut fisheries on the Washington coast during the analysis period (2007 to 2016) ranged from 0 to 15 Chinook salmon per year, with an average of 3.7 (Table 2-27). ESA-listed Chinook salmon from California are rarely encountered off the north and central Washington coast. Upper Columbia River spring and Snake River spring/summer are likewise rarely observed in the catch of salmon-directed fisheries off the Washington coast. Snake River fall Chinook salmon and Upper Willamette River Chinook salmon are caught on occasion off the Washington coast, but these are far north migrating stocks that do no reside in the area and generally migrate quickly. NMFS used the Fishery Regulation and Assessment model (FRAM) to estimate the likely stock composition of the Chinook salmon caught in the recreational halibut fishery. FRAM is the same model used to estimate stock-specific impacts in the salmon fishery. The estimated catch of ESA-listed Chinook salmon (hatchery and wild) was 0.4 Snake River fall Chinook salmon, 1.5 Puget Sound Chinook salmon, and 2.4 Lower Columbia River Chinook salmon per year (Table 2-28). The FRAM projected that there was an insignificant chance that the proposed halibut fishery would encounter Upper Willamette River Chinook salmon, at a rate of 0.1 fish per year. At this low encounter rate, it is highly unlikely that the proposed halibut fishery would encounter a fish from this ESU, even over a 3-year period. Additionally, although all the fish in the affected ESUs are listed as threatened, the ESA protective 4(d) regulations for these species prohibit take only for natural-origin and hatchery-origin fish with an intact adipose fin (70 FR 37160, June 28, 2005). The intent of the regulation is to enable hatchery fish produced for harvest (adipose fin clipped) to be caught in the salmon fishery and to provide additional protection for natural-origin salmon and hatchery-origin salmon produced for conservation (adipose fin intact). In the case of the Chinook salmon ESUs that are expected to be affected by the halibut fishery, ESA take prohibitions only apply to a low percentage of the salmon in the ESUs. For example, 75 percent to 90 percent of the Chinook salmon in the Puget Sound and Lower Columbia River ESUs are hatchery-origin fish (T. Tynan, pers. comm., NMFS WCR, March 18, 2014; NMFS 2012b), and most have the adipose fin removed. About 40 percent of adult Snake River fall Chinook salmon intercepted at Lower Granite Dam are adipose fin-clipped hatchery-origin fish (N. Myers-Cherry, NMFS WCR, email to Peggy Mundy, NMFS, December 7, 2017). Thus, the catch of an ESA-listed Chinook salmon in the proposed fishery for which take has been prohibited is even lower than predicted by FRAM (0.15 to 0.4 Puget Sound and 0.24 to 0.6 Lower Columbia River Chinook salmon per year). Given the very low level of impacts, different populations within the ESUs would be affected each year.

Non-retention mortality of coho salmon in Puget Sound recreational halibut fisheries during the analysis period (2012 to 2015) was zero, with the exception of one year in which WDFW estimated mortality of 0.01 coho salmon (Table 2-27). The non-retention mortality of coho salmon in recreational halibut fisheries on the Washington coast during the analysis period (2007 to 2016) ranged from 0 to 39 coho per year, with an average of 5.1 (Table 2-27). Based on the known distributions of ESA-listed coho, Lower Columbia River coho salmon are the ESU most likely to be found in the area, but they would be co-mingled with other non-listed coho salmon stocks from Puget Sound, the Washington coast, Canada, and the upper Columbia River. As described above for Chinook salmon, NMFS used FRAM to estimate the likely stock composition of the coho salmon caught in the recreational halibut fishery. The estimated catch of ESA-listed coho salmon (hatchery and wild) was 3.0 Lower Columbia River coho per year (Table 2-28). The FRAM projected that there was a discountable chance that the proposed halibut fishery would encounter Oregon Coast coho salmon, at a rate of 0.1 fish per year. At this low encounter rate, it is highly unlikely that the proposed halibut fishery would encounter a fish from this ESU, even over a 3 year period. As stated above in the discussion of Chinook salmon, although all the fish in the Lower Columbia River coho salmon ESU are listed as threatened, the ESA protective 4(d) regulations for these species prohibit take only for natural-origin and hatchery-origin fish with an intact adipose fin (70 FR 37160, June 28, 2005). Mark rates for coho salmon in the ocean salmon recreational fishery off the Washington coast (2012 to 2017) ranged from a low of 36 percent to a high of 78 percent, depending on the time and location (Pacific

Fishery Management Council Preseason Reports III for 2012, 2013, 2014, 2015, 2016, and 2017). Thus, the catch of an ESA-listed salmon in the proposed fishery for which take has been prohibited is even lower than predicted by FRAM (0.66 to 1.92 unmarked Lower Columbia River coho salmon per year) (Table 2-28). Given the very low level of impacts, different populations within the ESU may be affected each year.

Table 2-27. Total mortality (caught and released) of salmon (number of fish) by year and area in targeted coastal and Puget Sound recreational halibut fisheries. Does not include catch at times or areas when ocean salmon sport fishery was open coincident with the halibut fishery. Data provided by WDFW.

Year	Chinook			Coho		
	Puget Sound	Washington Coast	Total	Puget Sound	Washington Coast	Total
2007		1	1		39	39
2008		2	2		0	0
2009		0	0		5	5
2010		4	4		2	2
2011		2	2		1	1
2012	1.7	2	3.7	0.1	4	4.1
2013	2.3	1	3.3	0	0	0
2014	2.2	15	17.2	0	0	0
2015	1.4	7	8.4	0	0	0
2016		3	3		0	0
Total	7.6	37	44.6	0.1	51	51.1
Annual Average	1.9	3.7	4.5	0	5.1	5.1

Table 2-28. Proportion of estimated impacts on ESA-listed salmon, omitting fin-clipped fish that are exempt from take prohibitions.

ESU	FRAM estimated impacts (marked and unmarked fish)	Estimated marking rate (adult fish in fishery)	Forecast impacts on unmarked fish
Puget Sound Chinook	1.5 fish per year	0.75 – 0.90	0.2 - 0.4 fish per year
Lower Columbia River Chinook	2.4 fish per year	0.75 – 0.90	0.2 – 0.6 fish per year
Snake River fall Chinook	0.4 fish per year	0.4	0.2 fish per year
Total Chinook	**4.3 fish per year**		**0.6 – 1.2 fish per year**
Lower Columbia River coho	3.0 fish per year	0.36 – 0.78	0.7 – 1.9 fish per year
Total Coho	**3.0 fish per year**		**0.7 – 1.9 fish per year**

Steelhead and chum and sockeye salmon have not been observed in the incidental catch associated with the halibut fishery and are rarely observed even in the catch of salmon-directed fisheries in the action area. Therefore, we do not expect these species to be affected by the proposed halibut fisheries.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving federal activities, that are reasonably certain to occur within the action area of the federal action subject to consultation (50 C.F.R. § 402.02). Future federal actions that are unrelated to the Proposed Action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline versus cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in Section 2.4, Environmental Baseline.

Future state, tribal, and local government actions will likely be in the form of legislation, administrative rules, or policy initiatives. Government and private actions may include changes in land and water uses, including ownership and intensity, any of which could impact listed species or their habitat. Government actions are subject to political, legislative, and fiscal uncertainties. These realities, added to the geographic scope of the action area, which encompasses numerous government entities exercising various authorities, make any analysis of cumulative effects difficult and speculative.

A final recovery plan for listed rockfish in the Puget Sound/Georgia basin was released in 2017 (NMFS 2017c). In early 2010, WDFW adopted a series of measures to reduce rockfish mortality from non-tribal fisheries within the Puget Sound/Georgia Basin. These measures include:

1. closure of the entire Puget Sound to the retention of any rockfish species
2. prohibition of fishing for bottom fish deeper than 120 feet (36.6 m)
3. closure of the non-tribal commercial fisheries listed in Section 2.3.4.2

The measures will eliminate future direct harvest of rockfish, and reduce or prevent bycatch from future non-tribal recreational and commercial fisheries within the U.S. portion of the Puget Sound/Georgia Basin.

A recovery plan for Southern DPS green sturgeon is also under development and will address recovery of the species throughout the U.S. West Coast. A recovery outline has been published that summarizes the threats to the species and a preliminary recovery strategy to guide efforts as the plan is being developed (NMFS 2010a).

In addition, there are ongoing recovery programs for other ESA-listed species that may benefit rockfish and green sturgeon. For more information on the various efforts being made at the local, tribal, state, and national levels to conserve ESA-listed species within the action area, see any of the recent status reviews, Federal Register notices of listings, and recovery planning documents, as well as recent consultations on issuance of section 10(a)(1)(A) research permits, including the Puget Sound Salmon Recovery Plan (SSDC 2007), the Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000), the Southern Resident Killer Whale Recovery Plan

(NMFS 2008b), the Southern Oregon/Northern California Coast Coho Salmon Recovery Plan (79 FR 58750, September 30, 2014), and the Eulachon final recovery plan (NMFS 2017g).

NMFS finds it reasonably certain that state-managed fisheries that affect ESA-listed rockfish and green sturgeon will continue into the future, including the recreational bottom fish and shrimp trawl fisheries in Puget Sound and the California halibut bottom trawl fishery off the coast of California. Section 2.4, Environmental Baseline, of this opinion briefly summarizes these fisheries and their effects on ESA-listed species. The take of ESA-listed rockfish in the recreational bottom fish and shrimp trawl fisheries in Puget Sound was addressed in an incidental take permit issued to WDFW in 2012 and WDFW is working on a new incidental take permit application (WDFW 2017). NMFS is working with the CDFW to analyze and address the take of green sturgeon in the California halibut fishery. We expect that these fisheries are likely to continue at baseline levels over the duration of the Proposed Action.

NMFS also finds it reasonably certain that state and private actions associated with marine pollution will continue into the future (e.g., state permits for effluent discharges and the status of currently contaminated sites). Although the Puget Sound Partnership may make progress toward reducing marine pollution (Sanga 2015), measurable change is not reasonably certain to occur in the near term.

Activities occurring in the Puget Sound area were considered in the discussion of cumulative effects in the biological opinion on the Puget Sound Chinook Harvest Resource Management Plan (NMFS 2017f). That opinion discussed the types of activities taken to protect listed species through habitat restoration, hatchery and harvest reforms, and water resource management actions.

Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on populations and habitat features, many of which are activities that have occurred in the recent past and had an effect on the environmental baseline. These can be considered reasonably certain to occur in the future because they occurred frequently in the recent past, especially if authorizations or permits have not yet expired. In marine waters within the action area, state, tribal, and local government actions are likely to be in the form of legislation, administrative rules, or policy initiatives, shoreline growth management, and resource permitting. Private activities include continued resource extraction, vessel traffic, development, and other activities that contribute to non-point source pollution and stormwater run-off.

Non-federal actions are likely to continue affecting listed species. The cumulative effects in the action area are difficult to analyze because of this opinion's geographic scope, the different resource authorities in the action area, the uncertainties associated with government and private actions, and the changing economies of the region. Whether these effects will increase or decrease is a matter of speculation; however, based on the trends identified in the baseline, the adverse cumulative effects are likely to increase. Although state, tribal, and local governments have developed plans and initiatives to benefit listed fish, they must be applied and sustained in a comprehensive way before NMFS can consider them "reasonably foreseeable" in its analysis of cumulative effects.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the Proposed Action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the Proposed Action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

2.7.1. Puget Sound/Georgia Basin Rockfish

Effects to Abundance

Bycatch in fisheries is likely a limiting factor for yelloweye rockfish and bocaccio, though there is uncertainty regarding the degree that it impacts population recovery (NMFS 2017c). As detailed in Section 2.4, Environmental Baseline, yelloweye rockfish and bocaccio can be caught by anglers targeting salmon and bottom fish, and the shrimp trawl fishery. To assess if the proposed recreational and commercial halibut fisheries adversely limit the viability of each species, we consider the proposed action in the context of the population-level impact from all fisheries and research combined. Thus we compare the number of individual fish affected by known sources of mortality/injury (fisheries and scientific research) to the overall population.

In order to conduct this analysis, we must assess effects on the overall population of the rockfish DPS of each species. However, as described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, there are no reliable estimates of the abundance of any of the ESA-listed rockfish DPSs, which is particularly acute for bocaccio. The best available abundance data for each species come from the WDFW ROV surveys (Pacunski et al. 2013; WDFW 2017), and we use these surveys as a fundamental source to understand the total abundance of the U.S. portion of the DPSs. The structure of this analysis likely underestimates the total abundance of each species within the U.S. portion of the DPS because: (1) we use the lower confidence interval population estimates available for yelloweye rockfish, and (2) we use the WDFW population estimate of bocaccio for the San Juan Island and Eastern Strait of Juan de Fuca area and note that it is generated within only 46 percent of the estimated habitat of bocaccio within the U.S. portion of the DPS. The rest of the area, including the Main Basin, South Sound and Hood Canal, were likely the most historically common area used by bocaccio (Drake et al. 2010). The structure of these assessments likely underestimates the total abundance of each DPS, resulting in a conservative abundance scenario and evaluation of cumulative fishery bycatch mortality for each species.

To assess the effect of these mortalities on population viability, we adopted the methodology used by the PFMC for rockfish species. The decline of West Coast groundfish stocks prompted the PFMC to reassess harvest management (Ralston 1998, 2002). The PFMC held a workshop in 2000 to review procedures for incorporating uncertainty, risk, and the precautionary approach in establishing harvest rate policies for groundfish. The workshop participants assessed best available science regarding "risk-neutral" and "precautionary" harvest rates (Scientific and Statistical Committee 2000). The workshop resulted in the identification of risk-neutral harvest rates of 0.75 of natural mortality, and precautionary harvest rates of 0.5 to 0.7 (50 to 70 percent) of natural mortality for rockfish species. These rates are supported by published and unpublished literature (Scientific and Statistical Committee 2000; Walters and Parma 1996), and guide rockfish conservation efforts in British Columbia, Canada (Yamanaka and Lacko 2001). Fishery mortality of 0.5 (or less) of natural mortality was deemed most precautionary for rockfish species, particularly in data-limited settings, and was considered a rate that would not hinder population viability (Scientific and Statistical Committee 2000; Walters and Parma 1996).

Given the similarity of the life histories of yelloweye rockfish and bocaccio to the life histories of coastal rockfish managed by the PFMC, we concluded that this method represented the best available scientific information for assessing the effects of fisheries-related mortality on the viability of the listed rockfish.

To assess the population-level effects on yelloweye rockfish and bocaccio from the proposed recreational and commercial halibut fishery, we added the total take estimate from the recreational and commercial sectors (Table 2-29).

Table 2-29. Total annual take for the recreational and commercial halibut fisheries and percentage of the listed rockfish abundance.

Species	Range of Estimated Lethal Take (individuals)[a]	Abundance Scenario	DPS Killed from Proposed Action (percent of population)
Bocaccio	18 to 40	4,606	0.4 to 0.9
Yelloweye Rockfish	134 to 270	143,086	0.09 to 0.19

[a] The recreational component of the lethal bycatch is estimated to be 0 bocaccio and up to 23 yelloweye rockfish (see Table 2-17 and using 28 percent for yelloweye mortality rates in the recreational fishery, from PFMC 2014), the rest of the lethal take estimate is from commercial fisheries/long-line surveys.

Annual natural mortality rate for bocaccio is approximately 8 percent (as detailed in Section 2.2.1, Status of Listed Species) (Palsson et al. 2009); thus, the precautionary level of fishing and research mortality would be 4 percent. Annual natural mortality rates for yelloweye rockfish range from 2 to 4.6 percent (as detailed in Section 2.2.1, Status of Listed Species) (Wallace 2007; Yamanaka and Kronlund 1997); thus, the precautionary range of fishing and research mortality would be 1 to 2.3 percent. For yelloweye rockfish and bocaccio, estimated mortalities from the recreational and commercial halibut fisheries in the range of the DPSs would be below the precautionary level as described above (0.5 (or less) of natural mortality).

To assess the population-level effects on yelloweye rockfish and bocaccio from activities within the environmental baseline and fishery take associated with the Proposed Action, we calculated the total mortalities for all sources (Table 2-30). We include the bycatch from salmon fisheries in the environmental baseline as an estimate of what may occur during the time period of the proposed action even though this fishery has not been reviewed under section 7 of the ESA for the upcoming 2018 fishing seasons and beyond.

Table 2-30. Total annual lethal takes for fisheries and research within the U.S. portion of the DPS.

Species	Total Lethal Take in Baseline (plus halibut fishery estimate)	Abundance Estimate	DPS Killed (percent)
Bocaccio	121[a] (40) = 161	4,606	3.5
Yelloweye Rockfish	204[b] (+270) = 474	143,086	0.33

[a] This includes the following estimated bocaccio mortalities: 77 from the salmon fishery, 27 during research, and 17 in other fisheries.
[b] This includes the following estimated yelloweye rockfish mortalities: 68 from the salmon fisheries, 49 during research, and 87 in other fisheries.

For yelloweye rockfish, the total lethal takes from the recreational and commercial halibut fishery, in addition to previously assessed scientific research and fishery bycatch (detailed in Section 2.4, Environmental Baseline) and potential bycatch from the salmon fishery, would be below the precautionary zone (0.5 to 0.7 of natural mortality). In addition, note that the population estimate for bocaccio is from one area of the DPS (the San Juan Island area, representing approximately 46 percent of their habitat in the U.S. portion of the DPS). Bocaccio exist in the rest of the DPS area (they were recently documented in the Main Basin in fisheries and research efforts) and therefore the population estimate is likely an underestimate and therefore the percent of the DPS killed would be less than calculated and reported in Table 2-30. In addition, the analysis of potential bycatch from the halibut fishery for each species uses precautionary assumptions and thus would likely be lower than estimated. Yelloweye rockfish are likely to be caught at levels below the estimates in Table 2-30. Some portion of the total population of yelloweye rockfish and bocaccio are too small to enter the fishery for the next several years. As these fish grow, they will have greater risk of bycatch.

Potential bycatch and research effects in the environmental baseline also consist of precautionary assumptions and the actual impacts to each species would very likely be less. These precautionary assumptions include that, of the previously analyzed research projects, the actual take of yelloweye rockfish and bocaccio is well below the permitted take. As an example, since bocaccio were listed in 2010, only four fish have been taken in research projects (compared to the permitted take of 58 fish, and 27 mortalities in 2017 alone) within the U.S. portion of the DPS area. Similarly, estimates of take in some fisheries may also be an underestimate as no yelloweye rockfish or bocaccio were reported as caught in the shrimp trawl fishery from 2012 to 2017 (WDFW 2017).

Effects to Productivity, Diversity and Spatial Structure

As discussed in Section 2.5.1, Puget Sound/Georgia Basin Rockfish, bycatch has the potential to impact productivity and diversity and spatial structure of yelloweye rockfish and bocaccio. Bycatch is likely to affect older and more productive yelloweye rockfish and bocaccio. The removal of larger and older fish of each species would have a disproportionate impact on population productivity by reducing the total number of larvae released. Yelloweye rockfish are a common component of longline catch, particularly in areas with maturing and mature fish. Thus, the impacts of the proposed action on yelloweye rockfish demographics and productivity would be more acute than on bocaccio (which are rarely caught in the halibut fishery). Impacts on spatial structure of yelloweye rockfish and bocaccio would not occur in most of the U.S. portion of the DPSs for each species; no bycatch would occur in the South Sound, much of the Main Basin, and all of Hood Canal as the halibut fishery is concentrated in the San Juan and Eastern Strait of Juan de Fuca Area. As such, effects on spatial structure are not likely to be large enough to impact the viability for each species.

Effects of Derelict Fishing Gear

In addition to fishery mortality, rockfish are killed by derelict fishing gear (Good et al. 2010), though we are unable to quantify the number of yelloweye rockfish and bocaccio killed by pre-existing derelict nets or new nets that would occur as part of some on-going commercial fisheries. New derelict fishing gear (recreational hooks and like, and commercial long-lines) associated with the proposed action would occur annually, though as described in Section 2.5.1.3, Fishery Effects on Listed Rockfish Population Demographics and Productivity, of this opinion, this type of derelict gear is only anticipated to result in small and localized adverse effects to rockfish critical habitat.

Despite these data limitations, it is unlikely that mortality associated with derelict gear would cause mortality levels of yelloweye rockfish and bocaccio to exceed the precautionary or risk-adverse levels. This is because: (1) the removal of thousands of nets has restored approximately 650 acres of the benthic habitat of Puget Sound and likely reduced mortality levels for each species; (2) most new derelict gear would become entangled in habitats less than 100 feet (30.5 m) deep (and thus avoid most adult yelloweye rockfish and bocaccio); and (4) the recent and ongoing programs to provide outreach to fishermen are expected to reduce loss of nets.

Effects to Rockfish Critical Habitat

We also assessed the effects of the action on yelloweye rockfish and bocaccio habitat in the context of the status of critical habitat to evaluate whether the effects of the proposed fishing are likely to reduce the value of critical habitat for the conservation of each species. The main potential effect of the proposed fishing on listed rockfish critical habitat would be as the result of lost fishing gear. As discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat, and Section 2.4, Environmental Baseline, of this opinion, critical habitat features in the action area (i.e., prey resources, water quality, and complex bottom habitats) may be affected by non-point source and point source discharges, hypoxia, oil spills, dredging projects and dredged material disposal activities, nearshore construction projects, renewable ocean energy installations, and climate change in addition to lost fishing gear. As described directly above and in Section 2.5.1.3, Fishery Effects on Listed Rockfish Population Demographics and Productivity, of this opinion, we would expect the proposed fishing to result in minimal additional impacts on a subset of these features (complex bottom habitats). Thus, the proposed fishing is not likely to reduce the value of critical habitat for the conservation of yelloweye rockfish and bocaccio of the Puget Sound/Georgia Basin DPSs.

In summary, the effects of the Proposed Action (Section 2.5), when added to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), and taking into account the status of the species and critical habitat (Section 2.2), would not reduce appreciably the likelihood of both the survival and recovery of yelloweye rockfish or bocaccio of the Puget Sound/Georgia Basin DPS in the wild by reducing their numbers, reproduction, or distribution (abundance, productivity, spatial structure, and diversity); or (2) appreciably diminishes the value of designated critical habitat for the conservation of each species.

2.7.2. Southern DPS Green Sturgeon

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, we conclude that Southern DPS green sturgeon are at moderate risk of extinction because of the low estimated adult abundance, restriction of spawning to one segment of the mainstem Sacramento River (and more recently confirmed in the lower Feather River), and potentially reduced productivity and genetic diversity because of the population's low abundance and restricted spawning habitat. However, there is uncertainty regarding the species' status because of the lack of information regarding productivity and abundance.

Effects to Abundance

The Proposed Action could reduce the abundance or productivity of individuals caught in the fishery. We expect this reduction in abundance or productivity to be very small (up to three fish encountered and up to one fish killed per year), with no green sturgeon encountered or killed in most years.

Overall fisheries catch of green sturgeon in recent years has been much reduced compared to historical levels and prohibitions on retention of green sturgeon have likely reduced fisheries-related mortality, although incidental catch continues to impose additional mortality on the species. In the fisheries for which data are available (excluding the Pacific halibut fishery), we estimate that 837 to 1,604 Southern DPS green sturgeon (adults and subadults) are incidentally captured each year (Table 2-31). This represents 4.5 to 21 percent of the total subadult and adult population, depending on if the high estimates of abundance (i.e., 18,537 subadults and adults, combined) or the low estimates of abundance (i.e., 7,786 subadults and adults, combined) are used.

Of these incidental captures, we estimate that 48 to 119 Southern DPS green sturgeon (adults and subadults) are killed each year. This represents additional mortality of 0.3 to 1.5 percent on the combined subadult and adult population. This estimated additional mortality imposed by incidental catch in these fisheries (excluding the Pacific halibut fishery) is likely not affecting the continued survival and recovery of Southern DPS green sturgeon. This is because Beamesderfer et al. (2007) estimated that additional mortality of 5 to 10 percent on fish 46 to 72 inches (117 to 183 cm) in length (i.e., subadults and small adults) or additional mortality of 7 to 25 percent on fish greater than 65 inches (165 cm) in length (i.e., adults) would reduce the species' reproductive potential below the minimum needed to maintain (20 percent of maximum potential) (Goodyear 1993) or rebuild (50 percent of maximum potential) (Boreman et al. 1984) sturgeon populations.

There is a high degree of uncertainty regarding these estimates. First, the level of incidental catch in these fisheries may be overestimated, particularly for the Washington State fisheries. We included high estimates in order to be conservative in our analysis. Second, the estimated abundance of adults and subadults is uncertain and in need of further refinement. The population estimates are the best estimates available to date, but do not consider the number of spawning adults that may be in the lower Feather River or potentially in the lower Yuba River each year. Third, individual fish may be recaptured in the same or different fisheries within a year, reducing the number of individual fish actually encountered. Comparing the estimates of abundance and incidental catch of Southern DPS green sturgeon in coast-wide fisheries emphasizes the uncertainty in both estimates. It is possible that the fisheries encounter a large portion of the adult and subadult population, given the high degree of spatial overlap between the fisheries and green sturgeon distribution along the coast, particularly in areas of relatively high green sturgeon presence (e.g., the Columbia River estuary, Willapa Bay, Grays Harbor, San Francisco Bay-Delta and Sacramento River system, and coastal waters adjacent to San Francisco Bay). However, these fisheries are all much reduced and regulated to minimize impacts on green sturgeon. Given these uncertainties, additional information is needed to more accurately assess the effects of the status, environmental baseline, and cumulative effects on the species for future analyses.

Adding the effects of the Proposed Action to the status, environmental baseline, and cumulative effects would result in a comparatively small increase in the mortality imposed on the subadult and adult population. We expect few encounters with green sturgeon in the proposed fishery for 2018 through 2022 (i.e., zero to three encounters per year, with no encounters in most years) and all of the green sturgeon to be released alive and to survive. At the most, we would expect incidental take of up to three Southern DPS adults and/or subadults per year, with 0.078 mortalities (conservatively translated to one mortality) per year. This would result in a relatively small increase in the mortality imposed on the species, compared to the levels estimated by Beamesderfer et al. (2007) that would substantially reduce reproductive potential.

Table 2-31. Summary of estimated incidental catch and mortality of Southern DPS (sDPS) green sturgeon (number of fish) per year in commercial and recreational fisheries occurring within and outside of the action area, excluding the Pacific halibut fishery.

Fishery	Estimated SDPS Incidental Catch		Estimated SDPS Mortalities	
	Low estimate	High estimate	Low estimate	High estimate
California halibut bottom trawl fishery	28	631	3	65
Pacific coast groundfish fishery	22	40	0	4
Central Valley, California, recreational fisheries	89	202	3	5
Oregon recreational fisheries	0	33	0	2
Lower Columbia River recreational fisheries	52	52	7	11
Lower Columbia River commercial fisheries	271	271	14	14
Washington State fisheries	375	375	18	18
Total	**837**	**1,607**	**48**	**119**

Sublethal effects resulting from incidental capture and release in the fishery may also reduce the species' reproductive potential by disrupting the spawning migrations of adults and the growth and reproductive development of subadults. We expect few incidental captures (zero to three per year), only a portion of which would be adults. Given the geographic distribution (northern California to Washington) and general seasonality (March through October) of the proposed fishery, we would expect that adults encountered would most likely be post-spawn adults. The fishing gear used in the proposed fishery (hook-and-line, longline, and troll) would be expected to have lower impacts on green sturgeon than other fishing gear (e.g., bottom trawl).

Effects to Productivity, Diversity and Spatial Structure

The Proposed Action is not likely to further restrict the spatial structure of the species (e.g., extent of spawning habitat, geographic distribution along the coast), but may affect productivity of individual fish by altering or disrupting the spawning migration of adults that are caught incidentally in the fishery and released.

Effects to Critical Habitat

As discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat, and Section 2.4, Environmental Baseline, of this opinion, critical habitat features in the action area (i.e., gear impacts and prey resources) may be affected. We would expect the proposed fishing to result in minimal additional impacts on a subset of these features. Thus, the proposed fishing is not likely to reduce the value of critical habitat for the conservation of green sturgeon.

In summary, the effects of the Proposed Action (Section 2.5), when added to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), and taking into account the status of the species and critical habitat (Section 2.2), would not reduce appreciably the likelihood of both the survival and recovery of Southern DPS green sturgeon in the wild by reducing their numbers, reproduction, or distribution (abundance, productivity, spatial structure, and diversity); or (2) appreciably diminishes the value of designated critical habitat for the conservation of each species. In summary, the lack of substantial impacts on the Southern DPS green sturgeon based on the low expected take and sublethal and lethal impacts of the fishery supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

2.7.3. Puget Sound Chinook Salmon

To assess the effects of the Proposed Action on the survival and recovery of the listed Puget Sound Chinook ESU, we considered the effects on abundance, productivity, spatial structure, and diversity. The Proposed Action is not likely to further restrict the spatial structure or diversity of the species, but could reduce the population abundance or productivity if individuals are killed as a result of being caught in the fishery. We considered these effects within the context of the status of the species and the environmental baseline.

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, all 22 populations are currently at high risk (NMFS 2006b). Three of the five regions (Strait of Juan de

Fuca, Georgia Basin, and Hood Canal) contain only two populations, both of which must be recovered to viability to recover the ESU (NMFS 2006b). In general, the Strait of Juan de Fuca, Georgia Basin, and Hood Canal regions are at greater risk than the other regions. In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha,[10] and Skokomish Rivers populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins because of flood control activities and hydropower development. It is likely that genetic diversity has also been reduced by this habitat loss.

Effects to Abundance and Productivity

The effects of the Proposed Action would result in an extremely small increase in the mortality imposed on the ESU. We expect very low mortality on salmon overall in the proposed fisheries (i.e., zero to four Chinook salmon per year). Of these, the mortality of listed fish (hatchery and wild) is expected to average less than two Puget Sound Chinook salmon per year. The mortality of a listed Puget Sound Chinook salmon in the proposed fishery for which take has been prohibited is even lower (less than one fish). Additionally, the impact would likely affect different populations in each year—the death of up to 5 Chinook salmon, even if accruing to a single population, would not cause any of the populations to fall below critical thresholds. Therefore, the lack of substantial impacts on the Puget Sound Chinook Salmon ESU, based on the low expected impacts of the fishery, supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species. The number of Puget Sound Chinook salmon killed from the halibut fishery are so small, taking into account the environmental baseline and cumulative effects on Puget Sound Chinook, that impacts to this ESU from the halibut fishery are not likely to have any meaningful effects on anyone population of Puget Sound Chinook, and are therefore unlikely to have any effect on the abundance or productivity of the ESU.

Effects to Critical Habitat

We also assessed the effects of the action on Puget Sound Chinook salmon critical habitat in the context of the status of critical habitat, the environmental baseline, and cumulative effects, to evaluate whether the effects of the proposed fishing are likely to reduce the value of designated critical habitat for the conservation of listed Puget Sound Chinook salmon. Marine areas within the action area and outside Puget Sound and the Strait of Juan de Fuca are not part of critical habitat for Puget Sound Chinook salmon. Halibut fisheries within Puget Sound occur in deeper water beyond designated critical habitat along the nearshore. Any impact on water quality from vessels transiting critical habitat areas on their way to the fishing grounds would be very short-term and transitory in nature and minimal compared to the number of other vessels in the area (NMFS 2004b). As discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat, and Section 2.4, Environmental Baseline, of this opinion, critical habitat features in the action area (i.e., forage, water quality, and rearing and spawning habitat) may be affected by forestry; grazing; agriculture; channel/bank modifications; road building/maintenance; urbanization; sand and gravel mining; dams; irrigation impoundments and withdrawals; river, estuary, and ocean traffic; wetland loss; forage fish/species harvest; and climate change. We would expect the proposed fishing to result in minimal additional impacts on these features.

[10] Removal of both dams on the Elwha River began in 2012 and was completed in 2014.

Thus, the proposed fishing is not likely to reduce the value of designated critical habitat for the conservation of the Puget Sound Chinook Salmon ESU.

In summary, the effects of the Proposed Action (Section 2.5), when added to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), and taking into account the status of the species and critical habitat (Section 2.2), would not reduce appreciably the likelihood of both the survival and recovery of the Puget Sound Chinook salmon ESU in the wild by reducing their numbers, reproduction, or distribution (abundance, productivity, spatial structure, and diversity); or (2) appreciably diminishes the value of designated critical habitat for the conservation of the species.

2.7.4. Lower Columbia River Chinook Salmon

To assess the effects of the Proposed Action on the survival and recovery of Lower Columbia River Chinook salmon, we considered the effects on abundance, productivity, spatial structure, and diversity. The Proposed Action is not likely to further restrict the spatial structure or diversity of the species due to the very low estimated mortalities. The Proposed Action could reduce the population abundance or productivity if individuals are killed as a result of being caught in the fishery. We considered these effects within the context of the status of the species and the environmental baseline.

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the Lower Columbia River Chinook Salmon ESU is composed of 32 historical populations. The populations are distributed through three ecological zones and six MPGs. Persistence probabilities are very low for most of the MPGs within the ESU.

Effects to Abundance and Productivity

The effects of the Proposed Action would result in an extremely small additional mortality imposed on the ESU. We expect very low mortality on salmon overall in the proposed fisheries (i.e., zero to four Chinook salmon per year). Of these, the mortality of listed fish (hatchery and wild) is expected to be less than one Lower Columbia River Chinook salmon per year. The impact would likely affect different populations in each year. The loss of one returning adult spawner per year would not result in a measurable effect on any of the populations, and so would not have an effect on any MPG. The lack of substantial impacts on the Lower Columbia River Chinook Salmon ESU based on the low expected impacts of the fishery supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

Effects to Critical Habitat

Marine areas within the action area are not part of critical habitat for Lower Columbia River Chinook salmon. The Proposed Action would have no effect on Lower Columbia River Chinook salmon critical habitat.

In summary, the effects of the Proposed Action (Section 2.5), when added to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), and taking into account the status of the species and critical habitat (Section 2.2), would not reduce appreciably the likelihood of both the survival and recovery of Lower Columbia River Chinook Salmon ESU in the wild by reducing their numbers, reproduction, or distribution (abundance, productivity, spatial structure, and diversity).

2.7.5. Lower Columbia River Coho Salmon

The Proposed Action is not likely to further restrict the spatial structure or diversity of the species, but could reduce the population abundance or productivity if individuals are killed as a result of being caught in the fishery. We considered these effects within the context of the status of the species and the environmental baseline.

Effects to Abundance and Productivity

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the Lower Columbia River coho salmon ESU is composed of 24 historical populations and three MPGs. In the 2011 Status Review, Ford (2011) concluded that 21 of the 24 populations of the ESU were at very high risk. The remaining three (Clatskanie, Clackamas, and Scappoose) were considered at high to moderate risk. The most recent status review (Ford 2011) and recovery plan (NMFS 2013a) used status information available only through 2008.

The effects of the Proposed Action would result in an extremely small additional mortality imposed on the ESU. We expect very low mortality on salmon overall in the proposed fisheries (i.e., zero to four coho salmon per year). Of these, the mortality of listed fish (hatchery and wild) is expected to be fewer than two Lower Columbia River coho per year. A reduction of impacts on Lower Columbia River coho salmon will make a negligible difference to the escapement, status, or exploitation rate on any of the populations within the ESU. Therefore, the lack of substantial impacts on the Lower Columbia River Coho Salmon ESU based on the low expected impacts of the fishery supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

Effects to Critical Habitat

Marine areas within the action area are not part of designated critical habitat for Lower Columbia River coho salmon. The Proposed Action would have no effect on LCR coho salmon critical habitat.

In summary, the effects of the Proposed Action (Section 2.5), when added to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), and taking into account the status of the species and critical habitat (Section 2.2), would not reduce appreciably the likelihood of both the survival and recovery of the Lower Columbia River coho salmon ESU in the wild by reducing their numbers, reproduction, or distribution (abundance, productivity, spatial structure, and diversity).

2.7.6. Snake River Fall Chinook Salmon

To assess the effects of the Proposed Action on the survival and recovery of Snake River fall Chinook salmon, we considered the effects on abundance, productivity, spatial structure, and diversity. The Proposed Action is not likely to further restrict the spatial structure or diversity of the species, but could reduce the population abundance or productivity if individuals are killed as a result of being caught in the fishery. We considered these effects within the context of the status of the species and the environmental baseline.

As described above in Section 2.2, Rangewide Status of the Species and Critical Habitat, the Snake River fall Chinook salmon ESU is composed of one MPG, with an extant natural-origin population (Lower Snake River population) and one extirpated population (Middle Snake River population). The Lower Snake River fall Chinook salmon population is currently rated as viable, with a low risk of extinction within 100 years.

Effects to Abundance and Productivity

The effects of the Proposed Action would result in an extremely small increase in the mortality imposed on the ESU. We expect very low mortality on salmon overall in the proposed fisheries (i.e., zero to four Chinook salmon per year). Of these, the mortality of listed fish (hatchery and wild) is expected to be less than one Snake River fall Chinook salmon per year. The catch of a listed Snake River fall Chinook salmon in the proposed fishery for which take has been prohibited is even lower. The impact would likely affect different populations in each year. A reduction of impacts on Snake River fall Chinook salmon will make a negligible difference to the escapement, status, or exploitation rate on any of the populations within the ESU. Therefore, the lack of substantial impacts on the Snake River Fall Chinook Salmon ESU based on the low expected impacts of the fishery supports the conclusion that the proposed fishing will not appreciably reduce the likelihood of survival and recovery of the species.

Effects to Critical Habitat

Marine areas within the action area are not part of critical habitat for Snake River fall Chinook salmon. The Proposed Action would have no effect on Snake River fall Chinook salmon critical habitat.

In summary, the effects of the Proposed Action (Section 2.5), when added to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), and taking into account the status of the species and critical habitat (Section 2.2), would not reduce appreciably the likelihood of both the survival and recovery of the of Snake River fall Chinook salmon ESU in the wild by reducing their numbers, reproduction, or distribution (abundance, productivity, spatial structure, and diversity).

2.8. Conclusion

After reviewing the current status of the listed species, the environmental baseline within the action area, the effects of the Proposed Action, any effects of interrelated and interdependent activities and cumulative effects, it is NMFS's biological opinion that the Proposed Action is not likely to jeopardize the continued existence of the Puget Sound/Georgia Basin DPSs of yelloweye rockfish and bocaccio, the Southern DPS for green sturgeon, the Puget Sound Chinook salmon ESU, the Lower Columbia River Chinook salmon ESU, the Snake River fall Chinook salmon ESU or Lower Columbia River coho salmon ESU. We reach this conclusion because the mortality resulting from the Proposed Action, when combined with the mortality from other fishing and research within the environmental baseline, is unlikely to exceed levels that would hinder population viability for the 5-year duration of the activities assessed within the Proposed Action.

Further, it is NMFS's biological opinion that the Proposed Action is not likely to destroy or adversely modify the critical habitat of the Puget Sound/Georgia Basin DPSs of yelloweye rockfish and bocaccio, the Southern DPS for green sturgeon, and the Puget Sound Chinook salmon ESU. The Proposed Action would have no effect to the designated critical habitat of the Snake River fall Chinook salmon ESU, the Lower Columbia River Chinook salmon ESU or Lower Columbia River coho salmon ESU.

2.9. Incidental Take Statement

Section 9 of the ESA and federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 C.F.R. § 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 C.F.R. § 402.02). Section 7(b)(4) and section 7(o)(2) provide that take that is incidental to an otherwise lawful agency action is not considered to be prohibited take under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1. Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

2.9.1.1. Puget Sound/Georgia Basin Rockfish

We anticipate that take of yelloweye rockfish and bocaccio of the Puget Sound/Georgia Basin DPSs will occur as a result of the proposed operation of the Pacific halibut fishery. Incidental take of each species is expected to occur in the form of fatal injury as a result of incidental capture and handling in the fishery resulting from encounters with fishing gear and/or removal of captured fish from the water. Incidental take of each species under the proposed fishing is not expected to exceed 270 yelloweye rockfish and 40 bocaccio annually, all killed.

2.9.1.2. Southern Green Sturgeon

We anticipate that take of threatened Southern DPS green sturgeon will occur as a result of the proposed operation of the Pacific halibut fishery from 2018 to 2022. Incidental take of Southern DPS green sturgeon is expected to occur in the form of injury as a result of incidental capture and handling in the fishery, and with death resulting from encounter with fishing gear and/or removal of captured fish from the water. We expect incidental take of both adult and subadult Southern DPS green sturgeon. Incidental take of Southern DPS green sturgeon under the proposed fishing is not expected to exceed three fish per year. Lethal take of Southern DPS green sturgeon in the proposed fishing is not expected to exceed one fish per year. Lethal takes are expected to be delayed mortalities after release of the fish back into the water.

2.9.1.3. Puget Sound Chinook Salmon, Lower Columbia River Chinook and Coho Salmon, and Snake River Fall Chinook Salmon

We anticipate that take of listed Chinook and coho salmon will occur as a result of the proposed operation of the Pacific halibut fishery 2018 to 2022. Salmon may be caught on the same fishing trip as halibut when both seasons coincide, but impacts to listed salmon stocks from that harvest are covered under biological opinions for those salmon fisheries. We expect incidental take to occur in the form of injury and death from encounters with fishing gear and handling during times and areas where salmon fishing is otherwise closed. As discussed in Sections 2.7.3 through 2.7.6, and table 2-27 encounters at this level are expected to result in the expected take of ESA-listed Puget Sound Chinook salmon, Lower Columbia River Chinook, and Snake River fall Chinook salmon is 4.3 fish (of each ESU) per year. The expected take of ESA-listed Lower Columbia River coho is three fish per year. However, of the total Chinook and coho salmon that may be caught, only a small subset would involve take of ESA-listed Puget Sound Chinook salmon, Lower Columbia River Chinook and coho salmon, and Snake River fall Chinook salmon. It is not practicable to monitor the take of listed fish, as opposed to Chinook and coho generally, for the following reasons: 1) fish are more likely to survive if released as soon as possible after hooking; 2) because salmon are not being retained, genetic sampling to determine whether fish are listed would need to be done on-board, and would require keeping the fish out of water for a longer period and causing further injury. Therefore, we are using the overall number of Chinook and coho caught in the halibut fisheries outside of salmon fishing season as a proxy for the numbers of listed species taken. We expect that, over the five-year period of the proposed action, 2018 to 2022, the halibut fishery will encounter a running average of 20 Chinook and 10 coho per year in times and areas not coincident with salmon fisheries; historically, these are recreational halibut fisheries in Puget Sound and on the Washington coast and in the Columbia River.

2.9.2. Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the Proposed Action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 C.F.R. § 402.02).

2.9.3.1. Puget Sound/Georgia Basin Rockfish

(1) NMFS shall coordinate and track monitoring of listed rockfish encounters in the proposed fisheries and research.
(2) NMFS shall continue to coordinate the assessment of the efficacy of fishing regulations for halibut to support listed rockfish survival and recovery.

2.9.3.2. Green Sturgeon

We include the following reasonable and prudent measure to improve our knowledge of the incidental take of Southern DPS green sturgeon in the Proposed Action. Although the expected incidental capture and associated mortality of Southern DPS green sturgeon per year is relatively low, there are uncertainties regarding the number of encounters per year and the life stage and DPS of the green sturgeon encountered.

(1) NMFS shall coordinate and track monitoring of green sturgeon encounters in the proposed fisheries and research.

2.9.3.3. Puget Sound Chinook Salmon, Lower Columbia River Chinook and Coho Salmon, and Snake River Fall Chinook Salmon

We include the following reasonable and prudent measure to improve our knowledge of the incidental take of Puget Sound Chinook salmon, Lower Columbia River Chinook and coho salmon, and Snake River fall Chinook salmon in the Proposed Action. Although the expected take of each ESU per year is extremely low, monitoring is important to assess any changes in the level or distribution of take.

(1) NMFS shall continue to coordinate monitoring and documentation of salmon caught in the proposed fisheries and research.

2.9.4. Terms and Conditions

The terms and conditions described below are non-discretionary, and NMFS or any applicant must comply with them in order to implement the RPMs (50 C.F.R. § 402.14). NMFS or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 C.F.R. § 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the Proposed Action would likely lapse.

2.9.4.1. Puget Sound/Georgia Basin Rockfish

Terms and conditions specific to the above identified reasonable and prudent measures for rockfish are identified below.

(1) NMFS shall coordinate with the relevant entities (e.g., tribes, state fishery management agencies, IPHC) to develop and implement consistent methods to monitor, document, and report listed rockfish encounters in the proposed fisheries. The report should be sent to NMFS by December 31st of each year and include species compositions and locations of encounters (i.e., Marine Catch Areas as defined by WDFW).

(2) NMFS shall continue to coordinate with the relevant entities (e.g., tribes, state fishery management agencies, IPHC) to assess the efficacy of fishing regulations for halibut that support the survival and recovery of listed rockfish. These assessments shall include commercial and recreational sector compliance with regulations, reporting of rockfish bycatch, and spatial analysis of fishing effort and fishing methods.

2.9.4.2. Green Sturgeon

Terms and conditions specific to the above identified reasonable and prudent measure for green sturgeon are identified below.

(1) NMFS shall coordinate with the relevant entities (e.g., tribes, state fishery management agencies, IPHC) to develop and implement consistent methods to monitor, document, and report green sturgeon encounters in the proposed fisheries. At a minimum, a description of the monitoring methods and the following data should be recorded and reported to NMFS for the proposed fisheries each year: the number of green sturgeon encountered (including if no green sturgeon were encountered that year); the disposition of the fish (e.g., retained, released dead, released alive); and the date, location, fishery sector, gear used, and any other available information about the capture (e.g., depth fished, fish length).

2.9.4.3. Puget Sound Chinook Salmon, Lower Columbia River Chinook and Coho Salmon, and Snake River Fall Chinook Salmon

Terms and conditions specific to the above identified reasonable and prudent measure for listed Puget Sound Chinook salmon, Lower Columbia River Chinook and coho salmon, and Snake River fall Chinook salmon are identified below.

(1) NMFS shall coordinate with the relevant entities (e.g., tribes, state fishery management agencies, IPHC) to develop and implement consistent methods to monitor, document, and report salmon caught in the proposed fisheries. At a minimum, a description of the monitoring methods and the following data should be recorded and reported to NMFS for the proposed fisheries each year: the number of salmon encountered (including if none were encountered that year); the disposition of the fish (e.g., retained, released dead, released alive); and the date, location, fishery sector, and gear used. This requirement should be coordinated with the similar term and condition for rockfish and green sturgeon described above for efficiency in reporting and workload.

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a Proposed Action on listed species or critical habitat or regarding the development of information (50 C.F.R. § 402.02).

2.10.1. Listed Rockfish

The following two conservation recommendations are provided to better understand the incidental take of listed rockfish in the proposed fishery and its effects.

(1) NMFS should work with the appropriate entities (e.g., tribes, state fishery management agencies, IPHC) to collect information on precisely where the fishery occurs within the rockfish DPSs area. This information would further enable an assessment of the future bycatch risk of the fishery, as well as the future need to develop Rockfish Conservation Areas and other measures to avoid and reduce bycatch to a level that enables population survival and recovery.

(2) NMFS should work with the appropriate entities (e.g., tribes, state fishery management agencies, IPHC) on the feasibility of collecting biological samples from any yelloweye rockfish and bocaccio captured in the proposed Pacific halibut fishery in Puget Sound. Information to collect for each fish would include: fork length, weight, external tags, and a tissue sample (i.e., a small fin clip for genetic analysis).

2.10.2. Green Sturgeon

The following conservation recommendation is provided to better understand the incidental take of Southern DPS green sturgeon in the proposed fishery and its effects.

(1) NMFS should work with the appropriate entities (e.g., tribes, state fishery management agencies, IPHC) on the feasibility of collecting biological sampling information from any green sturgeon captured in the proposed Pacific halibut fishery. Information to collect for each fish would include: fork length, a tissue sample (a small fin clip, for genetic analysis), and fish condition (e.g., alive, dead, any injuries). A photograph of the animal on a length board is also considered useful when feasible. This information would allow determination of whether the fish is an adult or subadult and to which DPS it belongs.

2.11. "Not Likely to Adversely Affect" Determinations

2.11.1. Southern DPS Green Sturgeon Critical Habitat

Designated critical habitat for Southern DPS green sturgeon includes coastal marine waters shallower than 60 fathoms (approximately 360.89 feet or 110 m) from Monterey Bay, California to the Canadian border, including Monterey Bay and the Strait of Juan de Fuca (74 FR 52300, October 9, 2009). The physical and biological features, or PBFs, essential for species conservation are: (a) a migratory pathway necessary for the safe and timely passage of Southern DPS green sturgeon within marine habitat and between estuarine and marine habitats; (b) suitable water quality (e.g., adequate dissolved oxygen levels and acceptably low levels of contaminants that may disrupt the normal behavior, growth, and viability of subadult and adult green sturgeon); and (c) food resources, likely to include benthic invertebrates and fish species similar to those fed upon by green sturgeon in bays and estuaries, including crangonid and callianasid shrimp, Dungeness crab, mollusks, amphipods, and small fish such as sand lances (*Ammodytes* spp.) and anchovies (Engraulidae) (Moyle 2002; Dumbauld et al. 2008).

The recreational and commercial fisheries described in the Proposed Action would occur in designated critical habitat for green sturgeon, but would not be expected to measurably change the PBFs or disrupt the ability of Southern DPS green sturgeon to use these habitats for feeding and migration. Jigs, weights, and hooks used by recreational anglers and commercial fishermen have the potential to alter benthic habitats by snagging structure, and some gear could be lost. However, we expect impacts on benthic habitat to be minimal, short-term, transitory, and limited to very small spatial scales given the gear used in the fishery. Pacunski et al. (2013) evaluated the effects of lost recreational fishing gear in WDFW habitat surveys in Puget Sound and did not observe adverse effects on the seafloor from this gear. We would also expect little to no effects on benthic habitat in coastal marine waters. In addition, we would expect minimal impacts of the proposed fishing on green sturgeon prey resources, because the fish species typically caught in the fishery are not species preyed upon by green sturgeon. We conclude that any effects on green sturgeon critical habitat would be insignificant, and therefore the Proposed Action is not likely to adversely affect designated green sturgeon critical habitat.

2.11.2. Salmon and Steelhead (15 Salmon ESUs and 11 Steelhead DPSs) and Designated Critical Habitat

As described in previous sections of the opinion, fishing effort and distribution associated with proposed fishing are anticipated to be similar to that observed during the period of analysis over the broad expanse of the U.S. west coast. Fishing vessels and gear would have a short-term presence in any specific location. Commercial fishing seasons are very short, and operate in waters up to 150 fathoms (274 m) in open waters.

Based on the low potential for exposure, as described in the effects analysis in Section 2.5.3, Chinook and Coho Salmon, except for the Snake River fall Chinook salmon, Puget Sound Chinook salmon, Lower Columbia River Chinook salmon, and Lower Columbia River coho salmon ESUs, no other listed salmon ESUs or steelhead DPSs (Table 2-32) are expected to be taken or otherwise adversely affected in the proposed fisheries. Therefore, we determine that the proposed fishing may affect, but is not likely to adversely affect, any of those salmon ESUs or steelhead DPSs or their critical habitat.

Marine areas within the action area are not part of designated or proposed critical habitat for any of the listed salmon ESUs or steelhead DPSs except for the Puget Sound Chinook Salmon and the Hood Canal summer run chum salmon ESUs. As a result, the proposed fisheries will have no effect on the critical habitat of those salmon ESUs or steelhead DPSs.

Table 2-32. Listing status and critical habitat designations for salmon species considered in this opinion (listing status: 'T' means listed as threatened under the ESA; 'E' means listed as endangered). Bolded rows are considered further in this Biological Opinion in Section 2.

Species	Listing Status	Critical Habitat
Chinook salmon (*Oncorhynchus tshawytscha*)		
Puget Sound	**T: 6/28/05 (70 FR 37160)**	**09/02/05 (70 FR 52488)**
Upper Columbia River spring-run	E: 6/28/05 (70 FR 37160)	09/02/05 (70 FR 52488)
Snake River spring/summer run	T: 6/28/05 (70 FR 37160)	10/25/99 (64 FR 57399)
Snake River fall-run	**T: 6/28/05 (70 FR 37160)**	**12/28/93 (58 FR 68543)**
Upper Willamette River	T: 6/28/05 (70 FR 37160)	09/02/05 (70 FR 52488)
Lower Columbia River	**T: 6/28/05 (70 FR 37160)**	**09/02/05 (70 FR 52488)**
California Coastal	T: 6/28/05 (70 FR 37160)	09/02/05 (70 FR 52488)
Central Valley spring-run	T: 6/28/05 (70 FR 37160)	09/02/05 (70 FR 52488)
Sacramento River winter-run	E: 6/28/05 (70 FR 37160)	06/16/93 (58 FR 33212)
Chum salmon (*O. keta*)		
Hood Canal summer-run	T: 6/28/05 (70 FR 37160)	09/02/05 (70 FR 52488)
Columbia River	T: 6/28/05 (70 FR 37160)	09/02/05 (70 FR 52488)
Coho salmon (*O. kisutch*)		
Lower Columbia River	**T: 6/28/05 (70 FR 37160)**	**02/24/16 (81 FR 9252)**
Oregon Coast	T: 2/11/08 (73 FR 7816)	2/11/08 (73 FR 7816)
S. Oregon/ N. California Coast	T: 6/28/05 (70 FR 37160)	05/5/99 (64 FR 24049)
Central California Coast	E: 6/28/05 (70 FR 37160)	05/5/99 (64 FR 24049)
Sockeye salmon (*O. nerka*)		
Ozette Lake	T: 6/28/05 (70 FR 37160)	09/02/05 (70 FR 52488)
Snake River	E: 6/28/05 (70 FR 37160)	12/28/93 (58 FR 68543)
Steelhead *(O. mykiss)*		
Puget Sound Steelhead	T: 5/11/07 (72 FR 26722)	02/24/16 (81 FR 9252)
Upper Columbia River	T: 8/24/09 (74 FR 42605)	09/02/05 (70 FR 52488)
Snake River Basin	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)
Middle Columbia River	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)
Upper Willamette River	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)

Lower Columbia River	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)
Northern California	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)
California Central Valley	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)
Central California Coast	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)
South-Central California Coast	T: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)
Southern California	E: 1/5/06 (71 FR 834)	09/02/05 (70 FR 52488)

2.11.3. Marine Mammals and Sea Turtles

In this section, effects are analyzed for ESA-listed marine mammals and sea turtles (blue whales, fin whales, humpback whales, Northern Pacific right whales, sei whales, sperm whales, Southern Resident killer whales and their critical habitat, Western North Pacific (WNP) gray whales, Guadalupe fur seals, green sea turtles, olive ridley sea turtles, loggerhead sea turtles, and leatherback sea turtles and their critical habitat) (Table 2-33). We first discuss the status and the likelihood of occurrence for ESA-listed marine mammals and sea turtles in the action area, and second discuss the potential effects of the Proposed Action.

Table 2-33. ESA-listed marine mammals and sea turtles occurring in the action area and not likely to be adversely affected.

ESA-Listed Species	Status
Blue whales (*Balaenoptera musculus*)	Endangered
Fin whales (*Balaenoptera physalus*)	Endangered
Humpback whales (*Megaptera novaeangliae*) Central American DPS	Endangered
Humpback whales (*Megaptera novaeangliae*) Mexico DPS	Threatened
North Pacific right whales (*Eubalaena japonica*)	Endangered
Sei whales (*Balaenoptera borealis*)	Endangered
Southern Resident killer whales (*Orcinus orca*)	Endangered
Sperm whales (*Physeter microcephalus*)	Endangered
Western North Pacific Gray whales (*Eschrichtius robustus*)	Endangered
Guadalupe fur seals (*Arctocephalus townsendi*)	Threatened
Green sea turtles (*Chelonia mydas*) East Pacific DPS	Endangered
Leatherback sea turtles (*Dermochelys coriacea*)	Endangered
Loggerhead sea turtles (*Caretta caretta*) North Pacific DPS	Threatened
Olive ridley sea turtles (*Lepidochelys olivacea*)	Endangered

2.11.3.1. Status and Occurrence within the Action Area

Blue Whales—Blue whales were listed as endangered worldwide under the precursor to the ESA, the Endangered Species Conservation Act (ESCA) of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 1973. Currently, there is no designated critical habitat for blue whales. We issued the final recovery plan for blue whales in July 1998 (NMFS 1998).

Blue whales make seasonal migrations between feeding and breeding locations, with their distribution often being linked to the patterns of aggregated prey. Like other baleen whales, the seasonal and inter-annual distribution of blue whales is strongly associated with both the static and dynamic oceanographic features such as upwelling zones that aggregate their prey (krill, *Euphausia pacifica*) (see Croll et al. 2005 for a recent review).

Blue whales are currently separated into two populations, the eastern and western north Pacific (Carretta et al. 2017). Their population structure has been studied through photo identification, acoustic, and genetic analyses showing both geographic isolation and overlap of some subpopulations. The blue whales most likely to be observed within the action area are identified as part of the Eastern North Pacific (ENP) stock. The ENP stock of blue whales ranges from the northern Gulf of Alaska to the eastern tropical Pacific (Carretta et al. 2017). Nine biologically important areas for blue whale feeding are identified off the California coast (Calambokidis et al. 2015). Most of this stock is believed to migrate south to spend the winter and spring in high productivity areas off Baja California, in the Gulf of California, and on the Costa Rica Dome. Blue whales occur primarily in offshore deep waters (but sometimes near shore, e.g., the deep waters in Monterey Canyon, CA) and feed almost exclusively on euphausiids.

The best estimate of blue whale abundance in the U.S. West Coast feeding stock component of the Eastern North Pacific stock is 1,647 for 2008 to 2011 (Calambokidis and Barlow 2013; Carretta et al. 2017). The minimum population size is approximately 1,551 blue whales with a calculated potential biological removal (PBR, which is defined by the MMPA as the maximum number of animals, not including natural mortalities, that may be removed from a marine mammal stock while allowing that stock to reach or maintain its optimum sustainable population) allocation for U.S. waters of 2.3 whales per year (Carretta et al. 2017). The observed annual incidental mortality and serious injury rate from ship strikes (0.9 per year) is less than the calculated PBR for this stock. This rate, however, does not include unidentified large whales struck by ships, nor does it include undetected and unreported ship strikes of blue whales. In the California Current, the number of blue whales struck by ships likely exceeds the PBR for this stock (Redfern et al. 2013). To date, no blue whale mortality has been associated with U.S. west coast fisheries; therefore, total fishery mortality is approaching a zero mortality and serious injury rate (a standard under the MMPA) (Carretta et al. 2017). However, in 2015 and 2016, NMFS received the first confirmed reports of entangled blue whales along the U.S. west coast, although the ultimate fate of these animals is unknown, and these events have not yet been evaluated for potential mortality and serious injury (NMFS WCR stranding data, 2017).

Fin Whales—Fin whales were listed as endangered worldwide under the precursor to the ESA, the ESCA of 1969, and remained on the list of threatened and endangered species after the passage of the ESA in 197. Currently, there is no designated critical habitat for fin whales. We issued the final recovery plan for fin whales in July 2010 (NMFS 2010c).

Fin whales are distributed widely in the world's oceans and occur in both the Northern and Southern Hemispheres. In the northern hemisphere, they migrate from high Arctic feeding areas to low latitude breeding and calving areas. The North Pacific population summers from the Chukchi Sea to California, and winters from California southward. Fin whales have also been observed in the waters around Hawaii. Fin whales can occur year-round off California, Oregon, and Washington (Carretta et al. 2017), with recent information suggesting that fin whales are present year-round in southern California waters, as evidenced by individually identified whales being photographed in all four seasons (Falcone and Schorr 2013). The fin whales most likely to be observed within the action area are identified as part of the CA/OR/WA stock.

The best estimate of fin whale abundance in California, Oregon, and Washington waters out to 300 nautical miles is 9,029 whales for 2014, based on trend-model analysis of line-transect data from 1991 through 2014 (Nadeem et al. 2016). The minimum population estimate is 8,127 fin whales with a calculated PBR of 81 whales per year (Carretta et al. 2017). The total documented incidental mortality and serious injury (2.0 per year) because of fisheries (0.2 per year) and ship strikes (1.8 per year) is less than the PBR (Carretta et al. 2017).

Humpback Whales (Central American DPS, Mexico DPS)—Humpback whales were listed as endangered under the ESCA in June 1970 (35 FR 18319, December 2, 1970), and remained on the list of threatened and endangered species after the passage of the ESA in 1973. A recovery plan for humpbacks was issued in November 1991 (NMFS 1991).

On September 8, 2016, NMFS published a final rule to divide the globally listed endangered humpback whale into 14 DPSs and listed four DPSs as endangered and one as threatened (81 FR 62259). NMFS has identified three DPSs of humpback whales that may be found off the coasts of Washington, Oregon, and California. These are the Hawaiian DPS (found predominately off Washington and southern British Columbia [SBC]) which is not listed under the ESA; the Mexico DPS (found all along the U.S. west coast), which is listed as threatened under the ESA; and the Central America DPS (found predominantly off the coasts of Oregon and California), which is listed as endangered under the ESA. Humpback whales are found in all oceans of the world and migrate from high latitude feeding grounds to low latitude calving areas. Humpbacks primarily occur near the edge of the continental slope and deep submarine canyons where upwelling concentrates zooplankton near the surface for feeding. Humpback whales feed on euphausiids and various schooling fishes, including herring, capelin, sand lance, and mackerel (Clapham 2009).

Current MMPA Stock Assessment Reports (SARs) for humpback whales on the west coast of the United States do not reflect the new ESA listings; thus, we will refer in part to the status of the populations that are found in the action area using the existing SARs (Carretta et al. 2017). The CA/OR/WA stock spends the winter primarily in coastal waters of Mexico and Central America, and the summer along the West Coast from California to British Columbia. As a result, both the endangered Central America DPS and the threatened Mexico DPS both at times travel and feed off the U.S. west coast. The Central North Pacific stock primarily spends winters in Hawaii and summers in Alaska, and its distribution may partially overlap with that of the CA/OR/WA stock off the coast of Washington and British Columbia (Clapham 2009). There is some mixing between these populations, though they are still considered distinct stocks. Seven biologically important areas for humpback whale feeding are identified by Calambokidis et al. (2015), including five in California, one in Oregon, and one in Washington.

Based on the presence of both listed DPSs along the West Coast of the U.S. (Wade et al 2016) this analysis evaluates impacts on both the Central American and Mexico DPSs of humpback whales as both are expected to occur in the action area.

Current estimates of abundance for the Central America DPS range from approximately 400 to 600 individuals (Bettridge et al. 2015; Wade et al. 2016). The size of this population is relatively low compared to most other North Pacific breeding populations. The population trend for the Central America DPS is unknown (Bettridge et al. 2015). The Mexico DPS, which also occurs in the action area, is estimated to be 6,000 to 7,000 from the SPLASH project (Calambokidis et al. 2008) and in the status review (Bettridge et al. 2015). The estimate for the abundance of the CA/OR/WA stock, which combines members of several different humpback whale DPSs, is 1,918 animals (Carretta et al 2017).

Along the U.S. west coast, the estimated annual mortality and serious injury of the CA/OR/WA stock of humpback whales because of commercial fishery entanglements (5.3 per year), and non-fishery entanglements (0.2 per year), plus ship strikes (1.0 per year), equals 6.5 animals, which is less than the PBR allocation of 11 for U.S. waters (Carretta et al. 2017). Most data on human-caused serious injury and mortality for this population is based on opportunistic stranding and at-sea sighting data and represents a minimum count of total impacts. There is currently no estimate of the fraction of anthropogenic injuries and deaths to humpback whales that are undocumented on the U.S. west coast. Based on strandings and at-sea observations, annual humpback whale mortality and serious injury in commercial fisheries (5.3 per year) is greater than 10 percent of the PBR; therefore, total fishery mortality and serious injury is not approaching zero mortality and serious injury rate (Carretta et al. 2017). In 2015 (34 entanglements) and 2016 (54 entanglements), humpback whales were observed and reported entangled at record levels that will receive additional evaluation in upcoming SARs (NMFS WCR stranding data).

North Pacific Right Whales—We listed northern right whales as endangered under the ESCA in December 1970 (35 FR 18319, December 2, 1970). In 2008, NMFS reclassified the northern right whale as two separate endangered species, North Pacific right whale (*E. japonica*) and North Atlantic right whale (*E. glacialis*) (73 FR 12024, March 6, 2008). We issued the final recovery plan for North Pacific right whales in June 2013 (NMFS 2013b).

Right whales primarily occur in coastal or shelf waters, although movements over deep waters are known. Sightings have been reported as far south as central Baja California in the eastern North Pacific, as far south as Hawaii in the central North Pacific, and as far north as the subarctic waters of the Bering Sea and Sea of Okhotsk in the summer (Herman et al. 1980; Berzin and Doroshenko 1982; Brownell et al. 2001). However, most recent sightings have occurred in the southeast Bering Sea and in the Gulf of Alaska (Waite et al. 2003; Shelden et al. 2005; Wade et al. 2011a, 2011b). Migratory patterns of the North Pacific right whale are unknown, although it is thought the whales spend the summer on high-latitude feeding grounds and migrate to more temperate waters during the winter, possibly well offshore (Braham and Rice 1984; Scarff 1986; Clapham et al. 2004).

Mark-recapture estimates of abundance of rights whales in the Bering Sea and Aleutian Islands using photographic and genotype data through 2008 resulted in 31 and 28 right whales, respectively (Wade et al. 2011a). The minimum population estimate is 26 whales with a calculated PBR of 0.05 (Muto et al. 2017). Although gillnets were implicated in the death of a right whale off Russia in 1989 (Kornev 1994), a photograph in the catalogue shows potential fishing gear entanglement (A. Kennedy, NMFS-AFSC-MML, pers. comm., September 21, 2011), and a photograph from October 2013 off British Columbia and northern Washington State showed potential fishing gear entanglement (Ford et al. 2016a), there are no records of fisheries mortalities of eastern North Pacific right whales. However, given the remote nature of the known and likely habitats of North Pacific right whales, it is very unlikely that any mortality in this population would be observed. Consequently, it is possible that the current absence of reported deaths in this stock is not a reflection of the true situation (Muto et al. 2017).

Sei Whales—We listed sei whales as endangered under the ESCA in December 1970 (35 FR 18319, December 2, 1970). The ESA replaced the ESCA in 1973 and continued to list sei whales as endangered. We issued the final recovery plan for sei whales in December 2011 (NMFS 2011d).

Sei whales have a worldwide distribution, but are found primarily in cold temperate to subpolar latitudes rather than in the tropics or near the poles (Horwood 2009). Sei whales spend the summer months feeding in subpolar higher latitudes and return to lower latitudes to calve in the winter. There is some evidence from whaling catch data of differential migration patterns by reproductive class, with females arriving at and departing from feeding areas earlier than males. For the most part, the location of winter breeding areas is unknown (Horwood 2009). Sei whales are most often found in deep, oceanic waters of the cool temperate zone. They appear to prefer regions of steep bathymetric relief, such as the continental shelf break, canyons, or basins situated between banks and ledges. On feeding grounds, the distribution is largely associated with oceanic frontal systems (Horwood 2009). In the North Pacific, sei whales feed along the cold eastern currents (Perry et al. 1999). Prey includes calanoid copepods, krill, fish, and squid.

Sei whales in the Eastern North Pacific are considered a separate stock (Carretta et al. 2017). The best estimate of abundance for California, Oregon, and Washington waters out to 300 nautical miles is 519 sei whales, the unweighted geometric mean of the 2008 and 2014 estimates (Barlow 2016). The minimum population estimate is 374, with a calculated PBR of 0.75 sei whales per year (Carretta et al. 2017). Total estimated fishery mortality is zero and therefore is approaching zero mortality and serious injury rate. One ship strike death was reported in Washington in 2003. Although sei whales may account for some of the unidentified large whales reportedly injured by ship strikes, the average observed annual mortality due to ship strikes is zero for the period 2010 to 2014 (Carretta et al. 2017).

Southern Resident Killer Whales— The Southern Resident killer whale DPS was listed as endangered on February 16, 2006 (70 FR 69903), and a recovery plan was completed in 2008 (NMFS 2008b). A 5-year review under the ESA completed in 2016 concluded that Southern Residents should remain listed as endangered and includes recent information on the population, threats, and new research results and publications (NMFS 2016d). Critical habitat in inland waters of Washington was designated on November 29, 2006 (71 FR 69054).

Several factors identified in the final recovery plan for Southern Resident killer whales may be limiting recovery including quantity and quality of prey, toxic chemicals that accumulate in top predators, and disturbance from sound and vessels. Oil spills are also a risk factor. It is likely that multiple threats are acting together to impact the whales. Although it is not clear which threat or threats are most critical to the survival and recovery of Southern Residents, all of the threats identified are potential limiting factors in their population dynamics (NMFS 2008b).

Southern Resident killer whales consist of three pods (J, K, and L) and inhabit coastal waters off Washington, Oregon, and Vancouver Island and are known to travel as far south as central California and as far north as Southeast Alaska (NMFS 2008b; Hanson et al. 2013, Carretta et al. 2017). During the spring, summer, and fall months, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Hauser et al. 2007, Bigg 1982; Ford 2000; Krahn et al. 2002; Hanson and Emmons 2010; Whale Museum unpubl. data). All three pods generally remain in the Georgia Basin through October and make frequent trips to the outer coasts of Washington and southern Vancouver Island and are occasionally sighted as far west as Tofino and Barkley Sound (Ford 2000; Hanson and Emmons 2010, Whale Museum unpubl. data).

By late fall, all three pods are seen less frequently in inland waters. In recent years, several sightings and acoustic detections of Southern Residents have been obtained off the Washington and Oregon coasts in the winter and spring (Hanson et al. 2010, Hanson et al. 2013, NWFSC unpubl. data). Satellite-linked tag deployments have also provided more data on the Southern Resident killer whale movements in the winter indicating that K and L pods use the coastal waters along Washington, Oregon, and California during non-summer months. Detection rates of K and L pods on the passive acoustic recorders indicate Southern Residents occur with greater frequency off the Columbia River and Westport and are most common in March (Hanson et al. 2013). J pod has also only been detected on one of seven passive acoustic recorders positioned along the outer coast (Hanson et al. 2013). The limited range of the sightings/ acoustic detections of J pod in coastal waters, the lack of coincident occurrence during the K and L pod sightings, and the results from satellite tagging in 2012–2016 (NWFSC unpubl. data) indicate J pod's limited occurrence along the outer coast and extensive occurrence in inland waters, particularly in the northern Georgia Strait.

Southern Resident killer whales consume a variety of fish species (22 species) and one species of squid (Ford et al. 1998; Ford 2000; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016b), but salmon are identified as their primary prey. Southern Residents are the subject of ongoing research, including direct observation, scale and tissue sampling of prey remains, and fecal sampling. Scale and tissue sampling from May to September indicate that their diet consists of a high percentage of Chinook salmon (monthly proportions as high as >90%) (Hanson et al. 2010; Ford et al. 2016b). The diet data also indicates that the whales are consuming mostly larger (i.e., older) Chinook. DNA quantification methods are also used to estimate the proportion of different prey species in the diet from fecal samples (Deagle et al. 2005). Recently, Ford et al. (2016b) confirmed the importance of Chinook salmon to the Southern Residents in the summer months using DNA sequencing from whale feces. Salmon and steelhead made up to 98% of the inferred diet, of which almost 80% were Chinook salmon. Coho salmon and steelhead are also found in the diet in spring and fall months when Chinook salmon are less abundant. Specifically, coho salmon contribute to over 40% of the diet in late summer, which is evidence of prey shifting at the end of summer towards coho salmon (Ford et al. 1998; Ford and Ellis 2006; Hanson et al. 2010; Ford et al. 2016b). Less than 3% each of chum salmon, sockeye salmon, and steelhead were observed in fecal DNA samples. Observations of whales overlapping with salmon runs (Wiles 2004, Zamon et al. 2007, Krahn et al. 2009) and collection of prey and fecal samples have also occurred in the winter months. Preliminary analysis of prey remains and fecal samples sampled during the winter and spring in coastal waters indicated the majority of prey samples were Chinook salmon (80% of prey remains and 67% of fecal samples were Chinook salmon), with a smaller number of steelhead, chum salmon, and halibut (NWFSC unpubl. data). The occurrence of K and L pods off the Columbia River in March suggests the importance of Columbia River spring Chinook salmon in their diet (Hanson et al. 2013). Chinook genetic stock identification included 12 U.S. west coast stocks, and over half the Chinook salmon consumed originated in the Columbia River (NWFSC unpubl. data).

NMFS has continued to fund the Center for Whale Research to conduct an annual census of the Southern Resident population. As of July 2017, Southern Residents totaled 77 individuals (24 in J pod, 18 in K pod, and 35 in L pod). Since the July census, an additional member died and the current population totals 76 individuals. The NWFSC continues to evaluate changes in fecundity and mortality rates, and has updated the work on population viability analyses conducted for the 2004 Status Review for Southern Resident Killer Whales and a science panel review of the effects of salmon fisheries (Krahn et al. 2004; Hilborn et al. 2012; Ward et al. 2013). Following from that work, the data now suggests a downward trend in population growth projected over the next 50 years. As the model projects out over a longer time frame (50 years) there is increased uncertainty around the estimates, however, if all of the parameters in the model remain the same the overall trend shows a decline in later years. This downward trend is in part due to the changing age and sex structure of the population, but also related to the relatively low fecundity rate observed over the period from 2011 to 2016 (Figure 2-15, NMFS 2016d). Recent evidence indicates pregnancy hormones (progesterone and testosterone) can be detected in Southern Resident killer whale feces and have indicated several miscarriages, particularly in late pregnancy (Wasser et al. 2017). The authors suggest this reduced fecundity is largely due to nutritional limitation.

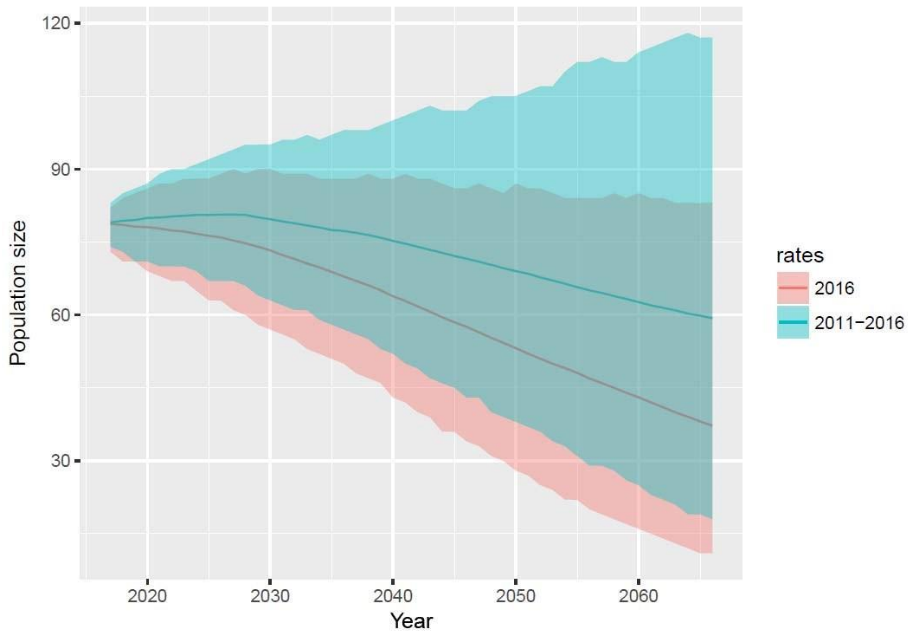

Figure 2-15. Southern Resident killer whale population size projections from 2016 to 2066 using 2 scenarios: (1) projections using demographic rates held at 2016 levels, and (2) projections using demographic rates from 2011 to 2016. The pink line represents the projection assuming future rates are similar to those in 2016, whereas the blue represents the scenario with future rates being similar to 2011 to 2016. (NMFS 2016d)

To explore potential demographic projections, Lacy et al. (2017) constructed a population viability assessment that considered sublethal effects and the cumulative impacts of threats (contaminants, acoustic disturbance, and prey abundance). They found that over the range of scenarios tested, the effects of prey abundance on fecundity and survival had the largest impact on the population growth rate. Furthermore, they suggested in order for the population to reach the recovery target of 2.3% growth rate, the acoustic disturbance would need to be reduced in half and the Chinook abundance would need to be increased by 15% (Lacy et al. 2017).

The most recent PBR level for this stock is 0.14 whales per year, which was based on the minimum population size of 81 whales from the 2015 census. Total observed fishery mortality and serious injury for this stock is zero. There were no non-fishery human-caused mortalities or serious injuries reported from 2008 to 2014. The total estimated annual human-caused mortality and serious injury for this stock is, therefore, zero and does not exceed PBR (Carretta et al. 2017). In December 2016, a young adult male from J pod was struck and killed by a vessel in inland waters of British Columbia (DFO 2016).

Sperm Whales—We listed sperm whales as endangered under the ESCA in June 1970 (35 FR 18319, December 2, 1970). The ESA replaced the ESCA in 1973 and continued to list sperm whales as endangered. We issued the final recovery plan for sperm whales in December 2010 (NMFS 2010d).

As described by Carretta et al. (2017, and citations therein), populations of sperm whales exist in waters of the California Current Ecosystem throughout the year. They are distributed across the entire North Pacific and into the southern Bering Sea in summer, but the majority are thought to be south of 40^{o}N in winter. Sperm whales are found year-round in California waters, but they reach peak abundance from April through mid-June and from the end of August through mid-November. Acoustic detections of sperm whales in the offshore waters of the outer Washington coast occurred all months of the year, with peak occurrence April to August. Detections inshore from April to November were generally faint enough to suggest that the whales were offshore (Oleson et al. 2009). Sperm whales consume numerous varieties of deepwater fish and cephalopods.

The most recent abundance estimates for sperm whales off California, Oregon, and Washington out to 300 nautical miles were derived from trend-model analysis of line-transect data collected during six surveys from 1991 to 2008. Using this method, estimates ranged from 2,000 to 3,000 animals (Moore and Barlow 2014). The best estimate for the California Current (2,106 sperm whales) is the trend-estimate that corresponds with the 2008 survey (Carretta et al. 2017). The minimum population estimate is 1,332 whales and the calculated PBR is 2.7 sperm whales per year (Carretta et al. 2017; Moore and Barlow 2014). The mean annual estimated mortality and serious injury attributable to commercial fisheries interactions was 1.7 sperm whales per year, based on observer and stranding data from 2001 to 2012. There were no documented mortalities or serious injuries of sperm whales because of ship strikes from 2008 to 2012. The annual fishery-related and ship strike mortality and serious injury is less than PBR, but greater than 10 percent of PBR (Carretta et al. 2017).

Western North Pacific Gray Whales—Western North Pacific (WNP) gray whales were originally listed as endangered under the Endangered Species Conservation Act in June 1970 (35 FR 18319, December 2, 1970). WNP gray whales remain listed as endangered under the ESA (35 FR 8491). Currently, there is no recovery plan for this population.

There are two recognized gray whale stocks in the North Pacific, the WNP and the eastern North Pacific (ENP) which is no longer listed under the ESA after being delisted June 16, 1994 (59 FR 31094). Gray whales occur along the eastern and western margins of the North Pacific, generally migrating between summer feeding grounds in high latitudes and winter breeding grounds in lower latitudes. Gray whale migration is typically limited to relatively near shore areas along the North American west coast during the winter and spring months (November-May). Gray whales are bottom feeders, sucking in sediment and eating benthic amphipods.

Historically, the WNP gray whales were considered geographically isolated from the ENP stock; however, recent information is suggesting more overlap exists between these two stocks with WNP gray whales migrating along the U.S. west coast along with ENP gray whales. During the summer and fall, the WNP stock of gray whales feeds in the Okhotsk Sea, Russia and off Kamchatka in the Bering Sea (Carretta et al. 2017). Known wintering areas include waters off Korea, Japan, and China. However, recent tagging, photo-identification, and genetics studies found some WNP gray whales migrate to the eastern North Pacific in winter, including off Canada, the U.S., and Mexico (Lang et al. 2011; Mate et al. 2011; Weller et al. 2012; Urbán et al. 2013). Combined, these studies have identified 27 individual WNP gray whales in the Eastern

North Pacific (Carretta et al. 2017). As a result, a portion of the WNP gray whale population is assumed to have migrated, at least in some years, to the eastern North Pacific during the winter breeding season.

Guadalupe Fur Seals—In the U.S., Guadalupe fur seals were listed as threatened under the ESA on December 16, 1985 (50 C.F.R. § 51252) and consequently are listed as depleted and a strategic stock under the MMPA. The population is considered a single stock because all are recent descendants from one breeding colony at Guadalupe Island, Mexico. Critical habitat has not been designated for this species in the U.S.

Guadalupe fur seals prefer shorelines with abundant large rocks and lava blocks and are often found at the base of steep cliffs and in caves and recesses, which provide protection and cooler temperatures, particularly during the summer breeding season (Aurioles-Gamboa 2015). There is little information on feeding habits of the Guadalupe fur seal, but it is likely that they feed on deep-water cephalopods and small schooling fish like their northern fur seal (*Callorhinus ursinus*) relatives (Seagars 1984). Researchers know little about the whereabouts of Guadalupe fur seals during the non-breeding season from September through May, but they are presumably solitary when at sea. While distribution at sea was relatively unknown until recently, Guadalupe fur seals are known to migrate at least 373 miles (600 km) from the rookery sites, based on observations of individuals by Seagars (1984). Recently, in 2016, satellite tags were attached to five pups on Guadalupe Island. Three pups that departed the island traveled north, from 124 to 808 miles (200 to 1,300 km) before the tags stopped transmitting. One of those pups was eventually found dead and emaciated in Coos Bay, Oregon (Norris et al. 2017). In recent years, Guadalupe fur seals have been increasing in numbers in the Channel Islands and several strandings have been observed along Washington, Oregon, and California coasts (Carretta et al. 2017).

Surveys conducted between 2008 and 2010 resulted in a total estimated population size of approximately 20,000 animals, with a PBR of 542 Guadalupe fur seals per year (Carretta et al. 2017). Between 2010 and 2014 there were 16 records of human-related deaths and/or serious injuries to Guadalupe fur seals from stranding data (Carretta et al. 2017). These strandings included entanglement in marine debris and gillnet of unknown origin, and shootings. The total U.S. fishery mortality and serious injury for this stock (≥ 3.2 animals per year) is less than 10 percent of the calculated PBR for the entire stock, but it is not currently possible to calculate a prorated PBR for U.S. waters with which to compare serious injury and mortality from U.S. fisheries.

Green Sea Turtle—On April 6, 2016, NMFS revised the listing of green sea turtles worldwide to 11 DPSs, including listing the East Pacific DPS as threatened (81 FR 20058). As summarized in the 2015 status review (Seminoff et al. 2015), increases in nesting females from the East Pacific DPS have been seen at the Mexican mainland nesting beaches, and the trend appears to be slightly increasing to stable at other major nesting beaches (e.g., Galápagos Islands, Ecuador). NMFS is currently reviewing the three green sea turtle DPSs found in U.S. waters (including the East Pacific DPS) to determine whether critical habitat should be designated.

Green sea turtles are found throughout the world, occurring primarily in tropical, and to a lesser extent, subtropical waters. The eastern Pacific population includes turtles that nest on the Pacific coast of Mexico, which have been historically listed under the ESA as endangered. Green sea turtles forage coastally from southern California in the northern latitudes to Mejillones, Chile, in the south. Green sea turtles rarely occur in the action area where the proposed fishing would occur.

NMFS and USFWS (2007a) provided population estimates and trend status for 46 green sea turtle nesting beaches around the world. Of these, twelve sites had increasing populations (based upon an increase in the number of nests over 20 or more years ago), four sites had decreasing populations, and ten sites were considered stable. For twenty sites there are insufficient data to make a trend determination or the most recently available information is too old (15 years or older). A complete review of the most current information on green sea turtles is available in the 2015 Status Review (Seminoff et al. 2015).

Leatherback Sea Turtle—The leatherback sea turtle is listed as endangered under the ESA throughout its global range. On January 26, 2012, NMFS revised critical habitat for leatherback sea turtles to include additional areas within the Pacific Ocean (77 FR 4170). Leatherbacks are found throughout the world and populations and trends vary in different regions and nesting beaches. In the Pacific, leatherback nesting aggregations are found in the eastern and western Pacific. In the eastern Pacific, major nesting sites are located in Mexico, Costa Rica, and to a lesser extent, Nicaragua. Leatherback sea turtles are highly migratory, exploiting convergence zones and upwelling areas for foraging in the open ocean, along continental margins, and in archipelagic waters. Migratory routes of leatherback sea turtles originating from eastern and western Pacific nesting beaches are not entirely known for the entire Pacific population; however, satellite tracking of post-nesting females and foraging males and females, as well as genetic analyses of leatherback sea turtles caught in U.S. Pacific fisheries or stranded on the West Coast of the U.S. indicate that leatherbacks found off the U.S. West Coast are from the western Pacific nesting populations, specifically boreal summer nesters.

In 1980, the leatherback population was estimated at approximately 115,000 (adult females) globally (Pritchard 1982). By 1995, one estimate claimed this global population of adult females had declined to 34,500 (Spotila et al. 1996). In the Pacific, leatherback sea turtle populations are declining at all major Pacific basin nesting beaches, particularly in the last two decades (Spotila et al. 1996; Spotila et al. 2000; NMFS and USFWS 2007b). In the eastern Pacific, nesting counts indicate that the population has continued to decline since the mid-1990s, leading some researchers to conclude that leatherback sea turtles are on the verge of extirpation (Spotila et al. 1996; Spotila et al. 2000). Steep declines have been documented in Mexico and Costa Rica, the two major nesting sites for eastern Pacific leatherbacks. Recent estimates of the number of nesting females/year in Mexico and for Costa Rica is approximately 200 animals or fewer for each county per year (NMFS and USFWS 2013). Estimates presented at international conferences show the numbers declining even more in all of the major nesting sites in the eastern Pacific.

Loggerhead Sea Turtles, North Pacific DPS—Loggerhead sea turtles are circumglobal, inhabiting continental shelves, bays, estuaries, and lagoons in temperate, subtropical, and tropical waters. Major nesting grounds are generally located in temperate and subtropical regions, with scattered nesting in the tropics. On September 22, 2011, the USFWS and NMFS published a final rule listing nine DPSs of loggerhead sea turtles (76 FR 58868). The North Pacific Ocean DPS of loggerheads, which is the population of loggerheads likely to be exposed to the proposed actions, was listed as endangered.

Loggerhead sea turtles that have been documented off the U.S. west coast are primarily found south of Point Conception, California in the Southern California Bight. Important juvenile turtle foraging areas have been identified off the coast of Baja California Sur, Mexico (Peckham and Nichols 2006; Peckham et al. 2007; Conant et al. 2009). Considerable effort has been spent studying the movements and relationships of juvenile loggerhead sea turtles in the central Pacific and off Baja and the west coast of the U.S. to understand migrations and/or developmental patterns across the North Pacific, but the ecology of juvenile loggerheads in the eastern Pacific is still not well understood.

The North Pacific loggerhead sea turtles DPS nests primarily in Japan (Kamezaki et al. 2003), although low level nesting may occur outside of Japan in areas surrounding the South China Sea (Conant et al. 2009). As discussed in the 2011 final ESA listing determination, current nesting in Japan represents a fraction of historical nesting levels (Conant et al. 2009; 76 FR 58868, September 22, 2011). Nesting declined steeply from an initial peak of approximately 6,638 nests in 1990 to 1991, to a low of 2,064 nests in 1997. Kamezaki et al. (2003) concluded a substantial decline (50 to 90 percent) in the size of the annual loggerhead nesting population in Japan since the 1950s. At the November 2011 Sea Turtle Association of Japan annual sea turtle symposium, the 2011 nesting numbers were reported to be slightly lower at 9,011 (Asuka Ishizaki, pers. comm. November 2011). The total number of adult females in the population was estimated at 7,138 for the period 2008-2010 by Van Houtan and Halley (2011).

Olive Ridley Sea Turtles—A 5-year status review of olive ridley sea turtles was completed in 2014 (NMFS and USFWS 2014). Although the olive ridley sea turtle is regarded as the most abundant sea turtle in the world, olive ridley nesting populations on the Pacific coast of Mexico are listed as endangered under the ESA; all other populations are listed as threatened. The status may be revised if and when the Services consider the significance and discreteness of olive ridleys on a global scale in order to determine whether there may be multiple DPSs.

Olive ridley sea turtles occur throughout the world, primarily in tropical and sub-tropical waters. Like leatherback turtles, most olive ridley sea turtles lead a primarily pelagic existence, migrating throughout the Pacific from their nesting grounds in Mexico and Central America to the deep waters of the Pacific that are used as foraging areas. While olive ridley sea turtles generally have a tropical to subtropical range with a distribution from Baja California, Mexico to Chile, individuals do occasionally venture north, some as far as the Gulf of Alaska. Olive ridleys live within two distinct oceanic regions, including the subtropical gyre and oceanic currents in the Pacific. The gyre contains warm surface waters and a deep thermocline preferred by olive ridley sea turtles.

Globally, olive ridleys are the most abundant sea turtle, but population structure and genetics are poorly understood for this species. It is estimated that there are over 1 million females nesting annually (NMFS and USFWS 2014). According to the Marine Turtle Specialist Group of the International Union for Conservation of Nature and Natural Resources (IUCN), there has been a 50 percent decline in olive ridleys worldwide since the 1960s, although there have recently been substantial increases at some nesting sites (NMFS and USFWS 2007c). The eastern Pacific population is thought to be increasing, while there is inadequate information to suggest trends for other populations. Eastern Pacific olive ridleys nest primarily in large *arribadas* on the west coasts of Mexico and Costa Rica. Since reduction or cessation of egg and turtle harvest in both countries in the early 1990s, annual nest totals have increased substantially. On the Mexican coast alone, in 2004 to 2006, the annual total was estimated at 1,021,500 to 1,206,000 nests annually (NMFS and USFWS 2007c). Eguchi et al. (2007) analyzed sightings of olive ridley sea turtles at sea, leading to an estimate of 1,150,000 to 1,620,000 turtles in the eastern tropical Pacific in 1998 to 2006.

2.11.3.2. Effects on ESA-Listed Marine Mammals and Sea Turtles and their Critical Habitat

The above ESA-listed marine mammals and sea turtles that may occur in the action area may be directly affected by the Proposed Action by interaction with vessels or gear or indirectly affected by reduced prey availability. Below, we describe these direct and indirect effects.

Entanglement of ESA-listed marine mammals is known to be an issue with commercial fishing gear on the U.S. west coast (Saez et al. 2013). Sea turtles are also vulnerable to bycatch in a variety of fisheries, including longline, that are operated on the high seas or in coastal areas throughout the species' range (e.g., Lewison et al. 2004; Peckham et al. 2007). For ESA-listed marine mammals and sea turtles that are likely to co-occur with the proposed fishery, there is a risk of becoming captured/entangled in longline gear. Interactions could result from direct predation of bait or depredation on fish that are already captured by the longline. Although sperm whales and killer whales are known to remove fish caught on longline hooks, potentially making them more susceptible to entanglement or other types of human-interaction (summarized in NWFSC 2012), this kind of depredation behavior is not known or observed to be a widespread problem off the U.S. west coast.

Interactions could also result from marine mammals and sea turtles unknowingly swimming into the gear and becoming entangled. Bottom longlines do present some risk of entanglement because of vertical lines running from the surface to the bottom, but gangions and hooks are relatively low in profile on the bottom and likely less vulnerable to hooking or predation by marine mammals than the profile of hooks suspended in the water column in pelagic longline gear. The general configuration of setting gear at bottom depths in coastal waters of Washington and Oregon also presents very little risk of sea turtle bycatch—sea turtles that may be in the area during the proposed fishing are not likely to spend any time at those bottom depths, and are only really at limited risk of entangling in the buoy lines at each of the longline strings. In a recent study, Saez et al. (2013) ranked the entanglement risk for the Pacific halibut longline fishery relatively low for blue whales, fin whales, humpback whales, and sperm whales (whales considered in their model). They suggested the fishery has a low entanglement risk to these species because of the relatively little overlap between the whales' presence and the fishing effort.

While there is a slight risk for marine mammal and sea turtle interactions with Pacific halibut longline gear, including entanglement in lines and/or being hooked during depredation on the bait or fish captured on the line, there have been no recorded incidents of ESA-listed marine mammal and sea turtle interactions in this fishery to date. The List of Fisheries for 2017 classified the North Pacific halibut longline fishery as a category III (i.e., remote likelihood of/no known incidental mortality or serious injury of marine mammals) as identified in the Federal Register (82 FR 3655, January 12, 2017). The prediction of future events occurring that have never occurred before, given that no incidental captures or entanglements with ESA-listed marine mammals or sea turtles has ever been documented, is challenging because these risks cannot be completely eliminated. At this time, we conclude that the lack of historical incidental capture or entanglements between survey gear and ESA-listed marine mammal and sea turtle species, even when risks of such interactions have been and continue to remain possible, is a reflection of the low co-occurrence of the species and the fishing effort. Given the historical performance of the Pacific halibut fishery, we conclude that the likelihood of incidental capture or entanglement of ESA-listed marine mammals and sea turtles is discountable.

Vessel traffic and fishing effort associated with the proposed fishery are anticipated to be similar to past levels over the broad expanse of the west coast and inland waters of Washington. Vessels and gear would have a short-term presence in any specific location and it is anticipated that this will continue. Furthermore, the vessels involved in the activities will not target marine mammals or sea turtles. Therefore, it is extremely unlikely that the proposed fishing effort will result in interactions with any of the above marine mammal or sea turtle species and the potential for effects are discountable.

The proposed fishing may indirectly affect Southern Resident killer whales by reducing their primary prey, Chinook salmon. The Proposed Action is not anticipated to affect prey quality; however, the project may affect the quantity of prey available to Southern Resident killer whales. This reduction is negligible and an extremely small percent of the total prey available to the whales in the action area. Therefore, NMFS anticipates that any salmonid take up to the aforementioned maximum extent would result in an insignificant reduction in prey resources for Southern Residents that may intercept salmonid species within their range.

Therefore, we find that the potential adverse effects of the proposed fishing on the above identified marine mammal and sea turtle species would be either discountable or insignificant and therefore the proposed fishing may affect, but is not likely to adversely affect, blue whales, fin whales, humpback whales (Central America DPS, Mexican DPS), Northern Pacific right whales, sei whales, sperm whales, Southern Resident killer whales, WNP gray whales, Guadalupe fur seals, green sea turtles, olive ridley sea turtles, loggerhead sea turtles, and leatherback sea turtles.

Leatherback Sea Turtle Critical Habitat

We revised the critical habitat for leatherback sea turtles by designating areas within the Pacific Ocean on January 26, 2012. This designation includes approximately 16,910 square miles along the California coast from Point Arena to Point Arguello east of the 1,640-fathom (3,000-m) depth contour, and 25,004 square miles from Cape Flattery, Washington to Cape Blanco, Oregon east of the 1,094-fathom (2,000-m) depth contour. The designated areas compose approximately

41,914 square miles of marine habitat and include waters from the ocean surface down to a maximum depth of 262 feet (80 m). Based on the natural history of leatherback sea turtles and their habitat needs, we identified the feature essential to conservation as the occurrence of prey species, primarily scyphomedusae of the order Semaeostomeae (e.g., *Chrysaora*, *Aurelia*, *Phacellophora*, and *Cyanea*), of sufficient condition, distribution, diversity, abundance, and density necessary to support individual as well as population growth, reproduction, and development of leatherbacks.

There are no records of bycatch to indicate that the proposed fishing affects the condition, distribution, diversity, abundance, or density of leatherback sea turtle prey. Based on the extremely low potential for scyphomedusae to become bycatch in the proposed fishery, it is extremely unlikely that the proposed fishing effort will result in interactions with leatherback sea turtle critical habitat. Therefore, we find that the potential adverse effects of the proposed fishing on leatherback sea turtle critical habitat would be discountable, and therefore the proposed fishing may affect, but is not likely to adversely affect, leatherback sea turtle critical habitat.

Southern Resident Killer Whale Critical Habitat

Southern Resident killer whale critical habitat includes approximately 2,560 square miles of Puget Sound, excluding areas with water less than 20 feet (6 m) deep relative to extreme high water. The physical and biological features for Southern Resident killer whale critical habitat are: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development as well as overall population growth, and (3) passage conditions to allow for migration, resting, and foraging.

On January 21, 2014, NMFS received a petition requesting that we revise critical habitat, citing recent information on the whales' habitat use along the west coast of the United States. Center for Biological Diversity proposes that the critical habitat designation be revised and expanded to include areas of the Pacific Ocean between Cape Flattery, Washington, and Point Reyes, California, extending approximately 47 miles (76 km) offshore. NMFS published a 90-day finding on April 25, 2014 (79 FR 22933) that the petition contained substantial information to support the proposed measure and that NMFS would further consider the action. We also solicited information from the public. Based upon our review of public comments and the available information, NMFS issued a 12-month finding on February 24, 2015 (80 FR 9682) describing how we intended to proceed with the requested revision, which is still in development.

The Proposed Action is likely to adversely affect Chinook salmon (the primary prey of Southern Resident killer whales). Any salmonid take up to the aforementioned maximum extent and amount described in the Incidental Take Statement would result in an insignificant reduction in prey resources for Southern Residents that may intercept salmonid species within their range. Therefore, NMFS anticipates that direct or indirect effects on Southern Resident killer whale prey quantity would be insignificant. Additionally, the potential for vessels engaged in the proposed fishing to interfere with Southern Resident killer whale passage is expected to be discountable and insignificant (i.e., fishing vessels will be slow moving and would not target the whales). Therefore, we find that the potential adverse effects of the proposed fishing on Southern

Resident killer whale critical habitat are discountable or insignificant and determine that the proposed fishing may affect, but is not likely to adversely affect, Southern Resident killer whale critical habitat.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within or outside of EFH and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 C.F.R. § 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by NMFS and descriptions of EFH for Pacific Coast salmon (PFMC 2014) fisheries contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

EFH has been designated by NMFS for various species and life stages of groundfish, coastal pelagic fish, and Pacific salmonids in the Puget Sound in sections of Area 2A.

3.2. Adverse Effects on Essential Fish Habitat

The biological opinion above describes effects on habitat (including but not necessarily restricted to, habitat designated as critical under the ESA) that is essentially identical to EFH. Consistent with that analysis, and summarized here, the longline fishery would result in short-term adverse effects for groundfish EFH in the action area, but not Pacific salmon or coastal pelagic EFH.

Benthic habitat EFH would be altered in several ways by the longline fishery. Gear used in commercial halibut fisheries could result in small adverse effects on some deepwater (greater than 98 feet (30 m)) areas. Alteration to bottom habitats from longline fisheries is likely minimal because the gear is limited in weight and area fished (Morgan and Chuenpagdee 2003). When hauling longlines, there is potential for the hooks to snag structural organisms such as sponges and thus move rocks and/or cause small areas of turbidity (Morgan and Chuenpagdee 2003).

Longline gear that is lost can result in longer-term habitat alterations, though these would be expected to decrease over time as sediments and biota cover the lines. Some longlines can be snagged and lost on the sea floor and thus have the potential to alter habitat in localized areas. However, only five longlines have been documented in the extensive derelict gear surveys or removal efforts in Puget Sound (Antonelis 2014), though analogous data is not available for the rest of the action area, though it is likely that derelict halibut long-lines are similarly rare in the rest of Area 2A.

For the reasons described here, the proposed action would have adverse effects on EFH in the action area, as a result of the alteration of benthic habitat during use of longlines, including long lines that become derelict. Similar adverse effects to Pacific salmon or coastal pelagic EFH are not expected from the use of long-lines.

3.3. Essential Fish Habitat Conservation Recommendations

Small and short-term adverse effects on EFH would occur from the use of longlines associated with the Proposed Action. In order to track the loss and enable eventual removal of lost longlines, such losses should be reported to appropriate authorities. Locations of the fishery should be systematically recorded and provided to fishery managers and NMFS in order to enable further analysis of risk of adverse effects on EFH from the longline fishery in the action area.

3.4. Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Federal agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS.

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5. Supplemental Consultation

NMFS must reinitiate EFH consultation if the Proposed Action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS's EFH Conservation Recommendations (50 C.F.R. § 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended user of this opinion is NMFS. Other interested users could include tribal, commercial, and recreational fishermen, and state and local fishery managers. This opinion will be posted on the Public Consultation Tracking System website (*https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts*, consultation number WCR-2017-8426). The format and naming adheres to conventional standards for style.

4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 C.F.R. § 402.01 *et seq.*, and the MSA implementing regulations regarding EFH, 50 C.F.R. § 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. References

Federal Register Notices

June 2, 1970 (35 Fed. Reg. 8491). Proposed Rule: Conservation of Endangered Species and Other Fish or Wildlife.

December 2, 1970 (35 Fed. Reg. 18319). Final Rule: Conservation of Endangered Species and Other Fish or Wildlife. List of Endangered Foreign Fish and Wildlife.

April 22, 1992 (57 Fed. Reg. 14653). Final Rule: Endangered and Threatened Species; Threatened Status for Snake River Spring/Summer Chinook Salmon, Threatened Status for Snake River Fall Chinook Salmon.

June 16, 1993 (58 Fed. Reg. 33212). Final Rule: Designated Critical Habitat; Sacramento River Winter-Run Chinook Salmon.

December 28, 1993 (58 Fed. Reg. 68543). Final Rule: Designated Critical Habitat; Snake River Sockeye Salmon, Snake River Spring/Summer Chinook Salmon, and Snake River Fall Chinook Salmon.

June 16, 1994 (59 Fed. Reg. 31094). Final Rule: Endangered and Threatened Wildlife and plants; Final Rule to Remove the Eastern North Pacific Population of the Gray Whale from the list of Endangered Wildlife. Effective June 16, 1994.

March 24, 1999 (64 Fed. Reg. 14308). Endangered and Threatened Species; Threatened Status for Three Chinook Salmon Evolutionarily Significant Units (ESUs) in Washington and Oregon, and Endangered Status for One Chinook Salmon ESU in Washington. Effective May 24, 1999.

May 5, 1999 (64 Fed. Reg. 24049). Final Rule: Designated Critical Habitat; Central California Coast and Southern Oregon/Northern California Coasts Coho Salmon.

September 16, 1999 (64 Fed. Reg. 50406). Final Rule: Endangered and threatened Species; Threatened Status FOR Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California. Effective November 15, 1999.

October 25, 1999 (64 Fed. Reg. 57399). Final Rule: Designated Critical Habitat: Revision of Critical Habitat for Snake River Spring/Summer Chinook Salmon.

June 28, 2005 (70 Fed. Reg. 37160). Final Rule: Endangered and Threatened Species; Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs.

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