Endangered Species Act Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation

Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2014

NMFS Consultation Number: F/WCR-2014-578

Action Agency: Bureau of Indian Affairs (BIA)
U.S. Fish and Wildlife Service (USFWS)
National Marine Fisheries Service (NMFS)

Species/Evolutionarily Significant Units That May Be Affected and Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Puget Sound Chinook Salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	No
Puget Sound Steelhead (*O. mykiss*)	Threatened	Yes	No	No
Puget Sound/Georgia Basin (PS/GB) bocaccio (*Sebastes paucispinis*)	Endangered	Yes	No	No
PS/GB canary rockfish (*S. pinniger*)	Threatened	Yes	No	No
PS/GB yelloweye rockfish (*S. ruberrimus*)	Threatened	Yes	No	No
Southern Resident killer whales (*Orcinus orca*)	Threatened	Yes	No	No

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
Coastal Pelagic Species	No	No
Pacific Coast Groundfish	Yes	Yes

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

Robert Turner for

Issued by: ______________________________
William W. Stelle, Jr.
Regional Administrator

Date: ___May 1, 2014____________ ***(Date expires: April 30, 2015)***

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LIST OF ACRONYMS

BIA	Bureau of Indian Affairs
BRT	Biological Review Team
C&S	Ceremonial and Subsistence
CHART	Critical Habitat Analytical Review Team
CPS	Coastal Pelagic Species
CWT	Coded Wire Tag
DIP	Demographically Independent Populations
DFO	Department of Fisheries and Oceans Canada
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FRAM	Fishery Regulation and Assessment Model
HCSMP	Hood Canal Salmon Management Plan
HOR	Hatchery Origin Recruit
HUC	Hydrologic Unit Code
MPG	Major Population Group
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSY	Maximum Sustained Yield
NMFS	National Marine Fisheries Service
NOR	Natural Origin Recruit
NWFSC	Northwest Fisheries Science Center
NWIFC	Northwest Indian Fisheries Commission
NWR	[NMFS] Northwest Region
ODFW	Oregon Department of Fish and Wildlife
PBDE	Polybrominated diphenyl ethers
PCB	Polychlorinated biphenyls
PCE	Primary Constituent Element(s)
PFMC	Pacific Fishery Management Council
PSIT	Puget Sound Indian Tribes
PSTIT	Puget Sount Treaty Indian Tribes
PSTRT	Puget Sound Technical Recovery Team
PSSMP	Puget Sound Salmon Management Plan
PSSTRT	Puget Sound Steelhead Technical Recovery Team
PST	Pacific Salmon Treaty
PVA	Population Viability Assessment

QET	Quasi-extinction Threshold
RCA	Rockfish Conservation Area
RER	Rebuilding Exploitation Rate
RMP(s)	Resource Management Plan(s)
RPA	Reasonable and Prudent Alternative
ROV	Remotely Operated Vehicle
SUS	Southern United States
USFW	U.S. Fish and Wildlife Service
VSP	Viable Salmonid Populations
WDFW	Washington Department of Fish and Wildlife

1 Introduction

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement 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 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, 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 CFR 600.

The opinion, incidental take statement, and EFH conservation recommendations are each in compliance with the Data Quality Act (44 U.S.C. 3504(d)(1) et seq.) and they underwent pre-dissemination review.

This document constitutes the National Marine Fisheries Service's (NMFS') biological opinion under section 7 of the ESA and Magnuson-Stevens Essential Fish Habitat consultation for the following three federal actions proposed by NMFS, the Bureau of Indian Affairs (BIA) and the U.S. Fish and Wildlife Service (USFWS):

(1) The proposed BIA funding of Puget Sound treaty tribes' management, enforcement, and monitoring projects associated with Puget Sound salmon fisheries implemented during May 1, 2014-April 30, 2015.

(2) The proposed USFWS authorization of fisheries, as party to the Hood Canal Salmon Management Plan (*U.S. v. Washington*, Civil No. 9213, Ph. I (Proc. 83-8)), from August 1, 2014-April 30, 2015.

(3) Two actions associated with the management of the 2014 U. S. Fraser Panel sockeye and pink fisheries under the Pacific Salmon Treaty (PST).

   (a) the U.S. government's relinquishment of regulatory control to the bilateral Fraser Panel within specified time periods and,

   (b) the issuance of orders by the Secretary of Commerce that establish fishing times and areas consistent with the in-season implementing regulations of the U.S. Fraser River Panel. This regulatory authority has been delegated to the Regional Administrator of NMFS' West Coast Region.

NMFS is grouping these three proposed Federal actions in this consultation pursuant to 50 CFR 402.14(c) because they are similar actions occurring within the same geographical area. Puget Sound non-treaty salmon fisheries and related enforcement, research, and monitoring projects associated with fisheries other than those governed by the U.S. Fraser Panel, are included as interrelated and interdependent actions because the state of Washington and the Puget Sound treaty tribes are required under the Puget Sound Salmon Management Plan, implementation plan for *U.S. v Washington*, to jointly manage Puget Sound salmon fisheries (see 384 F. Supp. 312 (W.D. Wash. 1974)).

This opinion considers impacts of the proposed actions on the Puget Sound Chinook salmon Evolutionarily Significant Unit (ESU), the Puget Sound Steelhead Distinct Population Segment (DPS), the Southern Resident killer whale DPS, and three listed Puget Sound rockfish DPS' under the ESA. Other listed species occurring in the Action Area are either covered under existing, long-term ESA opinions or 4(d) determinations, or NMFS anticipates the proposed actions are not likely to adversely affect the species.

On July 10, 2000, NMFS issued the ESA 4(d) Rule establishing take prohibitions for 14 salmon ESUs and steelhead DPSs, including the Puget Sound Chinook Salmon ESU (65 Fed. Reg. 42422, July 10, 2000). The ESA 4(d) Rule provides limits on the application of the take prohibitions, i.e., take prohibitions would not apply to the plans and activities set out in the rule if those plans and activities met the rule's criteria. One of those limits (Limit 6, 50 CFR 223.203(b)(6)) applies to joint tribal and state resource management plans. In 2005, as part of the final listing determinations for 16 ESUs of West Coast salmon, NMFS amended and streamlined the previously promulgated 4(d) protective regulations for threatened salmon and steelhead (70 Fed. Reg. 37160, June 28, 2005). Under these regulations, the same set of 14 limits was applied to all threatened Pacific salmon and steelhead ESUs or DPSs. As a result of the Federal listing of the Puget Sound Steelhead DPS in 2007 (72 Fed. Reg. 26722, May 11, 2007), NMFS applied the 4(d) protective regulations adopted for the other Pacific salmonids (70 Fed. Reg. 37160, June 28, 2005) to Puget Sound steelhead (73 Fed. Reg. 55451, September 25, 2008).

Since 2001, NMFS has received, evaluated ,and approved a series of jointly developed resource management plans (RMP) from the Puget Sound Treaty Indian Tribes (PSIT) and the Washington Department of Fish and Wildlife (WDFW) (collectively the co-managers) under Limit 6 of the 4(d) Rule. These RMPs provided the framework within which the tribal and state jurisdictions jointly managed all recreational and commercial salmon fisheries, and steelhead gillnet fisheries impacting listed Chinook salmon within the greater Puget Sound area. The most recent RMP approved in 2011 expired April 30, 2014 (NMFS 2011b). The Federal actions consulted on in the associated biological opinions included NMFS' 4(d) determinations and BIA program funding and USFWS Hood Canal Salmon Plan related actions.

1.2 Consultation History

The co-managers are negotiating a successor to the 2010-2014 Puget Sound Chinook Harvest RMP[1] but have not yet concluded those discussions. NMFS anticipates receiving the new RMP after the start of the 2014 season but prior to the start of the 2015 season. Accordingly, the action agencies have proposed a separate management plan for the 2014 fishing year (through April 30, 2015), and this consultation considers the impacts of the 2014 plan on listed species.

The BIA formally requested consultation on its administration of programs that support tribal management of 2014 Puget Sound salmon fisheries in a letter to NMFS dated March 7, 2014

[1] The co-managers originally proposed the RMP be in effect through April 30, 2015 but NMFS approved ESA coverage of the RMP through April 30, 2014.

(Speaks 2014a) and amended its request in a letter to NMFS dated March 25, 2014 (Redhorse 2014). The request relies on as its basis the commitments of the 2010-2014 RMP as amended by the summary of harvest management objectives for Puget Sound Chinook salmon for the 2014-2015 season (Grayum and Anderson 2014) and more comprehensive management plans for the Nisqually and Skokomish Chinook populations (Redhorse 2014). The fisheries that are the subject of this opinion (May 1, 2014 through April 30, 2015) were negotiated during the North of Falcon preseason planning process. This planning process implements certain requirements of joint management between the Puget Sound treaty tribes and WDFW under *U.S. v. Washington*. A detailed description of the fisheries is included in the 2014-2015 Co-managers List of Agreed Fisheries subsequently provided to NMFS on April 29, 2014 (WDFW and NWIFC 2014) and reflects the commitments in the documents attached to the BIA requests.

This opinion is based on information provided in the letters and attached documents from the BIA to NMFS requesting consultation described above (Speaks 2014a, Redhorse 2014), the Final Environmental Impact Statement on the 2004 Puget Sound Comprehensive Chinook Harvest Management Plan (NMFS 2004b), discussions with Puget Sound tribal, WDFW and Northwest Indian Fisheries staffs, consultations with Puget Sound treaty tribes, published and unpublished scientific information on the biology and ecology of the listed species in the action area, and other sources of information. A complete record of this consultation is on file at Seattle NMFS West Coast Regional office.

We have previously considered the effects of Puget Sound salmon fisheries on listed species under NMFS' jurisdiction for ESA compliance through completion of biological opinions or the ESA 4(d) Rule evaluation and determination processes. Table 1 identifies those opinions and determinations still in effect that address impacts to salmonids species that are affected by the Puget Sound salmon fisheries considered in this opinion. In each decision listed in Table 1, NMFS concluded that the proposed actions were not likely to jeopardize the continued existence of any of the listed species. NMFS also concluded that the actions were not likely to destroy or adversely modify designated critical habitat for any of the listed species. The Table 1 decisions take into account the anticipated affects of the Puget Sound salmon fisheries each year through pre-season planning and modeling. Because any impacts to the species listed in Table 1 from the proposed actions under consultation here will be accounted for and within the scope of the associated Table 1 decisions, those species are not discussed further in this opinion.

Table 1. NMFS ESA decisions regarding listed species affected by Puget Sound salmon fisheries and duration of the decision (4(d) Limit or biological opinion (BO)). Only the decisions currently in effect and the listed species represented by those decisions are included.

Date (Coverage)	Duration	Citation	ESU considered
March 1996 (BO)*	until reinitiated	NMFS 1996	Snake River spring/summer and fall Chinook and sockeye
April 1999 (BO) *	until reinitiated	NMFS 1999a	S. Oregon/N. California Coast coho Central California Coast coho Oregon Coast coho
April 2000 (BO) *	until reinitiated	NMFS 2000a	California Central Valley spring-run Chinook
April 2001 (4(d) Limit)	until withdrawn	NMFS 2001a	Hood Canal summer-run Chum
April 2001 (BO) *	until withdrawn	NMFS 2001b	Upper Willamette River Chinook Columbia River chum Ozette Lake sockeye Upper Columbia River spring-run Chinook Ten listed steelhead ESUs
June 13, 2005*	until reinitiated	NMFS 2005b	California Coastal Chinook
April 2008 (BO) *	until reinitiated	NMFS 2008a	Lower Columbia River coho
April 2012 (BO)*	until reinitiated	NMFS 2012a	Lower Columbia River Chinook

* Focus is fisheries under PFMC and US Fraser Panel jurisdiction. For ESUs and DPSs from outside the Puget Sound area, the effects assessment incorporates impacts in Puget Sound, and fisheries are managed for management objectives that include impacts that occur in Puget Sound salmon fisheries.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies. 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. Puget Sound non-treaty salmon fisheries and related enforcement, research and monitoring projects associated with fisheries other than those governed by the U.S. Fraser Panel, are included as interrelated and interdependent actions because the state of Washington and the Puget Sound treaty tribes are required under the Puget Sound Salmon Management Plan, implementation plan for *U.S. v Washington*, to jointly manage Puget Sound salmon fisheries (see 384 F. Supp. 312 (W.D. Wash. 1974)). These actions require consultation with NMFS because Federal agencies (BIA, USFWS, NMFS) are funding or authorizing actions that may adversely affect listed species (section 7(a)(2) of the ESA). NMFS is grouping these three proposed Federal actions in this consultation pursuant to 50 CFR 402.14 (c) because they are similar actions occurring within the same geographical area.

BIA Funding of Tribal Management, Enforcement, and Monitoring Projects:
The BIA proposes to fund Puget Sound tribal management, enforcement, and monitoring programs in support of the Puget Sound Salmon Management Plan (PSSMP) during the 2014 fishing year from May 1, 2014 through April 30, 2015 (see Grayum and Anderson 2014; WDFW and NWIFC 2014 for fisheries and associated conservation objectives proposed to occur during this period). This opinion focuses on project funding for programs that may impact listed Puget

Sound species under NMFS' jurisdiction. The co-managers manage Puget Sound fisheries pursuant to the PSSMP, which establishes guidelines for management of all marine and freshwater salmon fisheries from the Strait of Juan de Fuca eastward. The PSSMP was adopted by court order as a sub-proceeding related to *U.S. v. Washington*, Civ. No. C70-9213 (W.D. Wash.) (see 384 F. Supp. 312 (W.D. Wash. 1974)).

USFWS Authorization of Fisheries Consistent with the Hood Canal Salmon Management Plan:
The USFWS proposes to authorize fisheries that are consistent with the implementation of the Hood Canal Salmon Management Plan (HCSMP) (1985) from May 1, 2014 through April 30, 2015. The USFWS, along with the State of Washington and the treaty tribes within the Hood Canal, is party to the HCSMP which is a regional plan and stipulated order related to the PSSMP. The state, tribal, and federal parties to the Hood Canal Plan establish management objectives for stocks originating in Hood Canal including listed Chinook and summer-run chum stocks. Any change in management objectives under the HCSMP requires authorization by the USFWS, as a party to the plan. Management under the HCSMP affects those fisheries where Hood Canal salmon stocks are caught. This opinion focuses on Puget Sound salmon and steelhead fisheries that may impact listed Puget Sound species under NMFS' jurisdiction from May 1, 2014 through April 30, 2015 (see WDFW and NWIFC 2014 for fisheries proposed to occur during this period).

Fisheries Managed under the U.S. Fraser Panel:
The Fraser Panel controls sockeye and pink fisheries conducted in the Strait of Juan de Fuca and San Juan Island regions in the U.S., the southern Georgia Strait in the U.S. and Canada, and the Fraser River in Canada, and certain high seas and territorial waters westward from the western coasts of Canada and the U.S. between 48 and 49 degrees N. latitude. The Fraser Panel assumes control from July 1 through September, although the exact date depends on the fishing schedule in each year. Fisheries in recent years have occurred in late July into August in non-pink salmon years and into September in pink years. These fisheries are commercial and subsistence net fisheries using gillnet, reef net, and purse seine gear to conduct fisheries targeted on Fraser River-origin sockeye and, in odd-numbered years (e.g., 2005, 2007, 2009), pink salmon. Other salmon species are caught incidentally in these fisheries. The U.S. Fraser Panel fisheries are managed in-season to meet the objectives described in Chapter 4 of the PST (the Fraser Annex). The season structure and catches are modified in-season in response to changes in projected salmon abundance, fishing effort or environmental conditions in order to assure achievement of the management objectives, and in consideration of safety concerns. U.S. Fraser Panel fisheries are also managed together with the suite of other Puget Sound and Pacific Fisheries Management Council fisheries to meet conservation and harvest management objectives for Chinook, coho, and chum salmon.

Two Federal actions are taken to allow the Fraser Panel to manage Fraser River sockeye and pink fisheries in Fraser Panel Waters. One action grants regulatory control of the Fraser Panel Area Waters by the U.S. and Canadian governments to the Panel for in-season management. The other action is the issuance of in-season orders by NMFS that give effect to Fraser Panel actions in the U.S. portion of the Fraser Panel Area. The Pacific Salmon Treaty Act of 1985 (16 U.S.C. 3631 et seq.) grants to the Secretary of Commerce authority to issue regulations implementing the Pacific Salmon Treaty. Implementing regulations at 50 CFR 300.97 authorize the Secretary to issue orders that establish fishing times and areas consistent with the annual Pacific Salmon Commission regime and in-season orders of the Fraser River Panel. This authority has been delegated to the Regional Administrator of NMFS' West Coast Region.

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this opinion, the action area (Figure 1) includes all marine and freshwater fishing areas in Puget Sound and the western Strait of Juan de Fuca to Cape Flattery within the United States; and certain high seas and territorial waters westward from the U.S. coast between 48 and 49 degrees N. latitude during the period of Fraser Panel control (a detailed description of U.S. Panel Area waters can be found at 50 CFR 300.91, Definitions). Within this area, U.S. Fraser Panel fisheries occur in the Strait of Juan de Fuca region (treaty Indian drift net fisheries) Catch Reporting Areas 4B, 5, and 6C, and in the San Juan Islands region (treaty Indian drift net, set net, and purse seine fisheries; and non-treaty drift net, reef net, and purse seine fisheries) Catch Reporting Areas 6, 6A (treaty only), 7, and 7A.

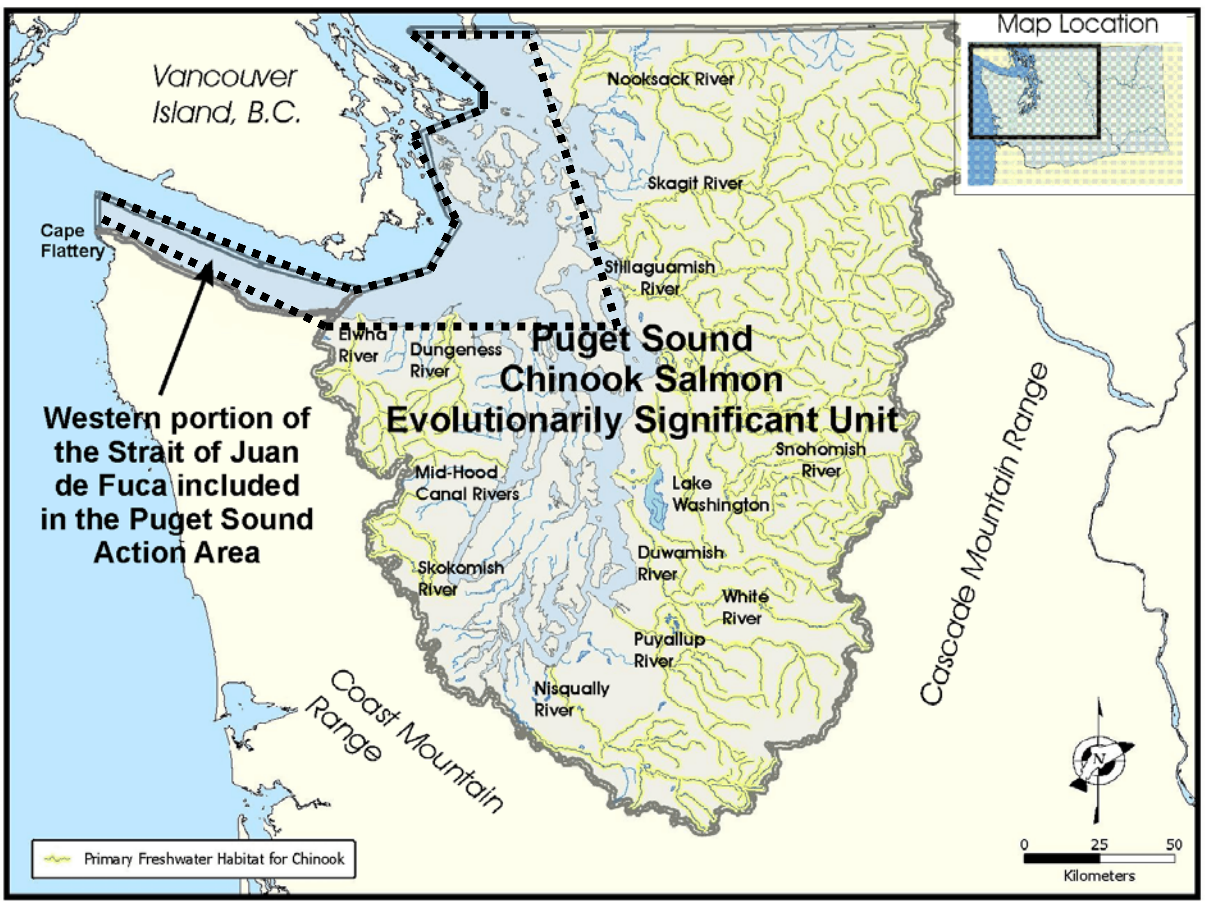

Figure 1. Puget Sound Action Area, which includes the Puget Sound Chinook ESU and the western portion of the Strait of Juan de Fuca in the United States. Dashed area denotes waters in U.S. Fraser Panel jurisdiction.

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. Section 7(a)(2) of the ESA requires Federal agencies to consult with the United States Fish and Wildlife Service, NMFS, or both, to ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species or adversely modify or destroy their designated critical habitat. Section 7(b)(3) requires that at the conclusion of consultation, the Service provide an opinion stating how the agencies' actions will affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires the consulting agency to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures to minimize such impacts.

2.1 Approach to the Analysis

Section 7(a)(2) of the ESA requires Federal agencies, in consultation with NMFS, to insure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. The jeopardy analysis considers both survival and recovery of the species. The adverse modification analysis considers the impacts on the conservation value of designated critical habitat.

"To jeopardize the continued existence of a listed species" means 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 CFR 402.02).

This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 C.F.R. 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[2] That is, we will determine whether critical habitat would remain functional (or retain the current ability for the primary constituent elements (PCEs) to be functionally established) and fulfill its conservation role for the species.

We will use the following approach to determine whether the proposed action is likely to jeopardize listed species or destroy or destroy or adversely modify critical habitat:

- *Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.* Section 2.2 describes the current status of each listed species and its critical habitat relative to the conditions needed for recovery. For listed salmon and steelhead, NMFS has developed specific guidance for analyzing the status of the listed species' component populations in a "viable salmonid populations" paper

[2] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

(VSP; McElhany et al. 2000). Similar criteria are used to analyze the status of ESA-listed rockfish because these parameters are applicable for a wide variety of species. The VSP approach considers the abundance, productivity, spatial structure, and diversity of each population as part of the overall review of a species' status. For listed salmon and steelhead, the VSP criteria therefore encompass the species' "reproduction, numbers, or distribution" (50 CFR 402.02). In describing the rangewide status of listed species, we rely on viability assessments and criteria in technical recovery team documents and recovery plans, and other information where available, that describe how VSP criteria are applied to specific populations, major population groups, and species. We determine the rangewide status of critical habitat by examining the condition of its physical or biological features (also called "primary constituent elements" or PCEs in some designations) which were identified when the critical habitat was designated.

- *Describe the environmental baseline in the action area.* The environmental baseline (Section 2.3) includes the past and present impacts of Federal, state, or private actions and other human activities <u>in the action area</u>. It includes the anticipated impacts of proposed Federal projects that have already undergone formal or early section 7 consultation and the impacts of state or private actions that are contemporaneous with the consultation in process.
- *Analyze the effects of the proposed action on both species and their habitat.* In this step (Section 2.4), NMFS considers how the proposed action would affect the species' reproduction, numbers, and distribution or, in the case of salmon and steelhead, their VSP and other relevant characteristics. NMFS also evaluates the proposed action's effects on critical habitat features.
- *Describe any cumulative effects in the action area.* Cumulative effects (Section 2.5), as defined in our implementing regulations (50 CFR 402.02), are the effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area. Future Federal actions that are unrelated to the proposed action are not considered because they require separate section 7 consultation.
- *Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.* (Section 2.6)
- *Reach jeopardy and adverse modification conclusions.* These conclusions (Section 2.7) flow from the logic and rationale presented in the Integration and Synthesis section (2.6).
- *If necessary, define a reasonable and prudent alternative to the proposed action.* If, in completing the last step in the analysis, we determine that the action under consultation is likely to jeopardize the continued existence of listed species or destroy or adversely modify designated critical habitat, we must identify a reasonable and prudent alternative (RPA) to the action in Section 2.8. The RPA must not be likely to jeopardize the continued existence of listed species nor adversely modify their designated critical habitat and it must meet other regulatory requirements.

This opinion considers impacts of the proposed actions under the ESA on the Puget Sound Chinook salmon ESU, the Puget Sound Steelhead DPS, the Southern Resident killer whale DPS, and the Puget Sound/Georgia Basin (PS/GB) bocaccio, canary rockfish, and yelloweye rockfish DPSs. We concluded that the proposed actions are not likely to adversely affect southern green sturgeon, southern eulachon, and their critical habitat. The analyses for the "Not Likely to Adversely Affect" Determinations are in Section 2.11.

2.2 Southern Resident Killer Whales

The Southern Resident killer whale DPS was listed as endangered under the ESA in 2005 (70 Fed. Reg. 69903, November 18, 2005). Critical habitat was designated in 2006 (71 Fed. Reg. 69054, November 29, 2006). Limiting factors described in the final recovery plan for Southern Resident killer whales include quantity of prey (subsequent data collection and analysis indicated a strong preference for Chinook salmon) (NMFS 2008e). We previously consulted on the effects of the Puget Sound Chinook Resource Management Plan pursuant to section 4(d) of the ESA and analyzed effects to Southern Resident killer whales for fisheries from 2010 through April 2014 (NMFS 2011a). In that biological opinion, NMFS concluded that the proposed fisheries were likely to adversely affect, but not likely to jeopardize the continued existence of Southern Resident killer whales (NMFS 2011a).

Following issuance of that biological opinion, NMFS implemented conservation measures that included convening an independent science panel to critically evaluate the available science about Southern Residents, their feeding habits, and the potential effects of salmon fisheries on the abundance of Chinook salmon available to Southern Residents. Overall, the panel concluded that the impact of reduced Chinook salmon harvest on future availability of Chinook salmon to Southern Residents is not clear, and cautioned against overreliance on correlative studies or implicating any particular fishery (Hilborn et al. 2012). NMFS is in the process of considering the independent science panel's review (Hilborn et al. 2012) and a related comprehensive analysis by Ward et al. (2013) to develop a risk assessment framework to support future consultations that evaluate the effects of changes in Chinook abundance on Southern Resident killer whales, including future harvest consultations. NMFS' ongoing work to develop a risk assessment for this purpose currently remains under development.

As explained below, based on our review of the new information developed subsequent to our 2011 opinion, we have determined that our 2011 conclusions remain valid. We therefore incorporate by reference NMFS' previous biological opinion and NMFS' previous Southern Resident killer whale and critical habitat analysis and findings regarding the Puget Sound Chinook Resource Management Plan as well as the conclusion that the harvest was likely to adversely affect, but not likely to jeopardize the continued existence of Southern Resident killer whales (NMFS 2011a, NMFS Consultation Number: F/NWR/2010/0605). We incorporate the previous analysis and findings by reference (and therefore the status, environmental baseline, effects, and conclusions), as supplemented by the information presented here. The fisheries currently proposed would only have a limited effect on Puget Sound Chinook stocks during the May 30, 2014-April 30, 2015 fishing season, and any effects during this time are not likely to be more than the effects previously considered for three-years of past fishing (NMFS 2011a). The previous opinion incorporated the best available information at the time for the relevant sections, and here we supplement with new information from the independent science panel's review (Hilborn et al. 2012), and an appendix to this biological opinion in which we document summaries of the panel's findings, new science available following the panel process, and future research needs to characterize uncertainty and reduce bias (Appendix A).

Given the short duration of the proposed action (May 1, 2014- April 30, 2015), and that the abundance of Chinook affected by Puget Sound fisheries during this time is within the scope of effects previously analyzed, it is our opinion that the effects would be no greater than those contemplated in the previous opinion. In fact, we anticipate that the effects from the proposed management regime for 2014-14 will be less than those analyzed previously. Exploitation rates for the proposed fisheries will be comparable to or lower than exploitation rates planned for the previous years (Speaks 2014a, also see section 2.4.1.1); the projected Chinook abundance in this year is estimated to be higher than previously estimated Chinook abundance on average; and corresponding impacts to Southern Resident killer whale prey base are also anticipated to be lower than the previously estimated average effects. The abundance of 3-5 year old Chinook during July-September from the final 2014 preseason Fishery Regulation and Assessment Model (FRAM)[3] run is 1,883,912, which is higher than the previously analyzed range of Chinook abundance scenarios assessed in 2011. In the Incidental Take Statement in the 2011 opinion we described the effects of take associated with a range of 3-5 year old Chinook during July-September (873,766 – 1,747,166) which reflected a 6.6% reduction in abundance from proposed fisheries as compared to the No Action scenarios. The 2014 preseason projection exceeds the Chinook abundance referenced in the ITS and also exceeds the No Action scenarios analyzed in the opinion. Ward et al. (2013; figure 22) modeled killer whale extinction risk and the probability of meeting downlisting criteria at different Chinook abundance levels. The analysis was not based on FRAM projections, but an alternate abundance index that included Canadian fall, coastal Washington and Oregon fall, Puget Sound summer/fall and Columbia tule and bright stocks. Ward et al. (2013) analyzed indices ranging from 600,000 to 1.7 million which indicated a low probability of quasi-extinction and a moderate or higher probability of meeting the ESA downlisting criteria at the upper end of the range. We note that the 2014 preseason forecast of fall coastal Washington, Puget Sound fall and Columbia River tule and bright stocks is 2 million (PFMC 2014; Table 1-1) and would be higher if Canadian stock abundance were included, however this information is unavailable at this time. We also note that the 2014 forecast of all southern U.S. Chinook stocks is 3.2 million. This is primarily a forecast of ocean escapement (entering the river or Strait of Juan de Fuca) and does not include Canadian stocks or Oregon coastal stocks. Therefore, the actual abundance available to Southern Resident killer whales as prey in the ocean in 2014, using multiple abundance indices, exceeds the levels analyzed in the previous opinion (NMFS 2011a) and in the more recent analysis (Ward et al. 2013).

Based on the previous analysis, the whale population is expected to grow during the period of the proposed fishing action, particularly if Chinook abundance exceeds long-term averages as projected for 2014. Although the proposed action may result in a small decrease in the rate of growth of the population, the anticipated decrease in growth would be less than previously anticipated, because of both the reduced time period considered and because the underlying relationship between Chinook abundance and killer whale population dynamics used to predicted effects likely overestimates impacts (Hilborn et al. 2012, Ward et al. 2013, Appendix A). We note that the predictive models linking salmon abundance and population growth consider long-term model predictions for specific levels of Chinook abundance, incorporating variation over time. It is therefore difficult to consider how one year of projected Chinook salmon abundance will truly influence population growth using these models.

[3] The primary model used by managers to assess the effects of proposed fishing regimes for salmon fisheries in Puget Sound and ocean fisheries under the jurisdiction of the Pacific Fishery Management Council.

Therefore, NMFS finds that the proposed fisheries are within the scope of effects considered in the previous biological opinion (NMFS 2011a), and the proposed fisheries are likely to adversely affect, but not likely to jeopardize the continued existence of Southern Resident killer whales or adversely modify their critical habitat. Reasonable and prudent measures and terms and conditions developed for killer whales in the NMFS (2011a) opinion are incorporated here by reference and remain in effect. NMFS is actively working to pursue the research recommendations in the independent science panel's report and incorporate new information as it becomes available (Hilborn et al. 2012, Appendix A). New information will be considered as we develop a risk assessment framework to inform future consultations that evaluate the effects of changes in Chinook abundance on Southern Resident killer whales, including future consultations on Puget Sound harvest.

2.3 Range-wide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be affected by the proposed action. The status is the level of risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, listing decisions and other relevant information. The species status section helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 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 physical and biological features that help to form that conservation value.

2.3.1 Status of Listed Species

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 CFR 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; i.e., the number of 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, 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 and 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 and Puget Sound rockfish, and aquatic habitat at large is climate change. The following section describes climate change and other ecosystem effects on Puget Sound Chinook salmon and steelhead. It precedes the status discussion of these species because it applies to both. A similar discussion for listed Puget Sound rockfish is included in the status discussion on those species.

Climate change and other ecosystem effects

The declines in fish populations in Puget Sound in the 1980s and into the 1990s may reflect broad-scale shifts in natural limiting conditions, such as increased predator abundances and decreased food resources in ocean rearing areas compared with previous decades. NMFS has noted that predation by marine mammals has increased as marine mammal numbers, especially harbor seals (*Phoca vitulina*) and California sea lions (*Zalophus californianus*) increase on the Pacific Coast (Jeffries 2011, DFO 2010, Jeffries 2002, Pitcher et al. 2007, Myers et al. 1998). In addition to predation by marine mammals, Fresh (1997) reported that 33 fish species and 13 bird species are predators of juvenile and adult salmon, particularly during freshwater rearing and migration stages.

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. Salmon and steelhead throughout Washington are also likely affected by climate change. Several studies have revealed that climate change has the potential to affect ecosystems in nearly all tributaries throughout the state (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 significant 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. Such changes may restrict our ability to conserve diverse salmon and steelhead life histories and to make recovery targets for these salmon populations more difficult to achieve.

In Washington State, most models project warmer air temperatures, increases in winter precipitation, and decreases in summer precipitation. Average temperatures in Washington State are likely to increase 0.1-0.6ºC per decade (Mote and Salathé 2009). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing stream flow timing and increasing peak river flows, which may limit salmon survival (Mantua et al. 2009) . The largest driver of climate-induced decline in salmon and steelhead populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy salmon eggs (Battin et al. 2007).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmon and steelhead mortality. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmon and steelhead require cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmon and steelhead with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2009).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase steelhead mortality. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Steelhead require cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmonids with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2009). Summer steelhead stocks within the Puget Sound DPS may be more volunerable to climate change since there are few summer run populations that reside in the DPS as compared to winter run populations, they exhibit relatively small abundances, and they occupy limited habitat.

Habitat action can help address the adverse impacts of climate change on salmon and steelhead. Examples include restoring connections to historical floodplains and freshwater and estuarine habitats to provide fish refugia and areas to store excess floodwaters, protecting and restoring riparian vegetation to ameliorate stream temperature increases, and purchasing or applying easements to lands that provide important cold water or refuge habitat (ISAB 2007, Battin et al. 2007). Harvest management regimes and frameworks respond to changing conditions associated with climate change by incorporating uncertainty in environmental conditions and conservative assumptions about steelhead survival in setting management objectives and allowable harvest levels. Managers revise management objectives on a regular basis to incorporate the most recent information on population productivity and capacity where that information is available.

2.3.1.1 Status of Puget Sound Chinook

This ESU was listed as a threatened species in 1999; its threatened status was reaffirmed June 28, 2005 (70 FR 37160). The NMFS issued results of a five-year review on August 15, 2011 (76 FR 50448), and concluded that this species should remain listed as threatened.

The NMFS adopted the recovery plan for Puget Sound Chinook 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' 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;
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). Based on genetic and historical evidence reported in the literature, the TRT also determined that there were 16 additional spawning aggregations or populations in the Puget Sound Chinook Salmon ESU that are now putatively extinct[4] (Ruckelshaus et al. 2006). This ESU includes all naturally spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Straits of Juan De Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington, and fish from 26 artificial propagation programs. Indices of spatial distribution and diversity have not been developed at the population level, though diversity at the ESU level is declining. Abundance is becoming more concentrated in fewer populations and regions within the ESU. Abundance has increased particularly within the Whidbey Basin Region Ford et al. 2001).

Table 2. Extant PS Chinook salmon populations in each geographic region Ford et al. 2011).

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
	Snoqualmie River
	North Fork Stillaguamish River
	South Fork Stillaguamish River
	Upper Skagit River
	Lower Skagit River
	Upper Sauk River
	Lower Sauk River
	Suiattle River
	Upper Cascade River
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 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.

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

[4] 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.

White and Nisqually[5] (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 which considers distinctions in genetic legacy and watershed condition among other factors in assessing the risks to survival and recovery of proposed actions across all populations within the Puget Sound Chinook ESU. 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 historic genetic legacy, then the appropriate course to insure 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 readapt to the existing conditions.

In keeping with this approach, NMFS further classified Puget Sound Chinook 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). 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 (NMFS 2006a, Ruckleshaus et al. 2002). 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 to Tier 1 populations would be more likely to affect the viability of the ESU as a whole than similar impacts to 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 4d determinations and opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005a, NMFS 2008b, NMFS 2008h, NMFS 2010a, NMFS 2011b, NMFS 2012b).

[5] The TRT 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 2006a).

In general, the Strait of Juan de Fuca, Georgia Basin and Hood Canal regions are at greater risk than the other regions due to critically low 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 populations has been substantially reduced or impeded by the loss of access to the upper portions of those tributary basins due to flood control activities and hydropower development. It is likely that genetic diversity has also been reduced by this habitat loss. Habitat conditions conducive to salmon survival in most other watersheds have been reduced significantly by the effects of land use, including urbanization, forestry, agriculture, and development (NMFS 2005d, NMFS 2006b, NMFS 2008d, SSPS 2007).

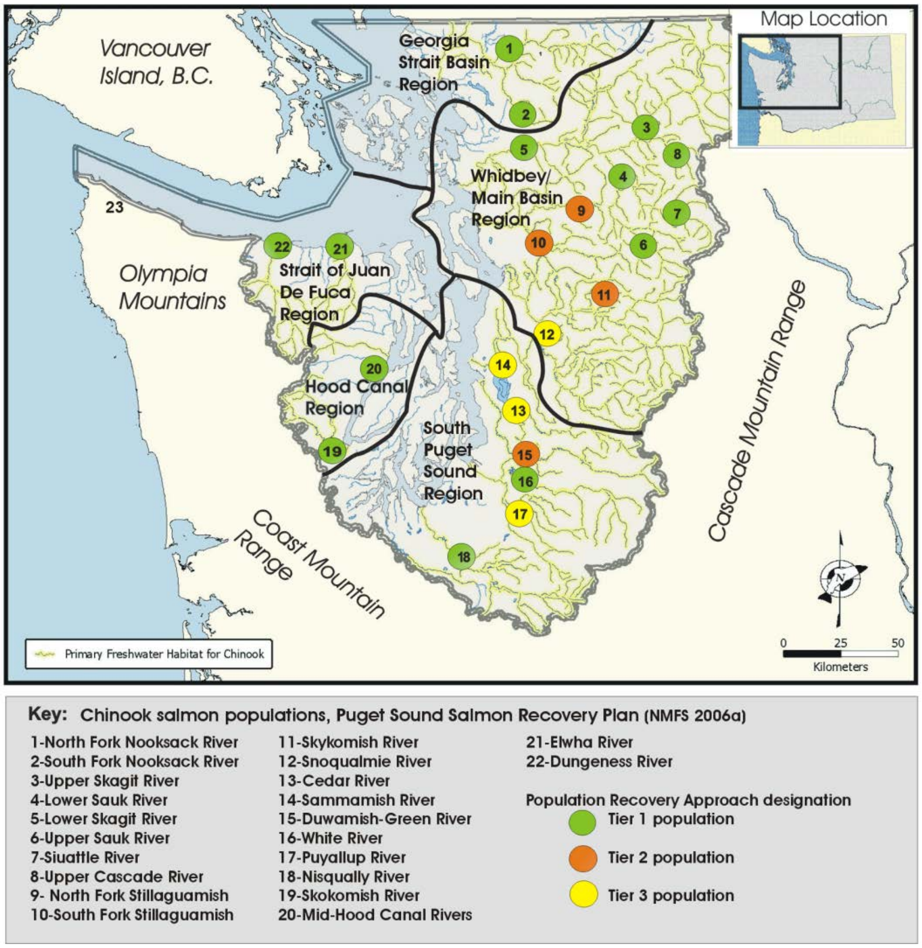

Figure 2. Populations of the Puget Sound Chinook salmon ESU.

Abundance and Productivity

Most Puget Sound Chinook populations are well below escapement levels identified as required for recovery to low extinction risk or current habitat conditions (Table 3). All populations are consistently below productivity goals identified in the recovery plan (Table 3). Although trends vary for individual populations across the ESU, most populations have declined in total natural origin recruit (NOR) abundance (prior to harvest) since the last status review (Ford et al. 2011, Good et al. 2005). However, most populations exhibit a stable or increasing growth rate in natural-origin escapement (after harvest)(Table 4). No clear patterns in trends in escapement or abundance are evident among the five major regions of Puget Sound. No trend was notable for total ESU escapements. Trends in growth rate of natural-origin escapement are generally higher than growth rate of natural-origin abundance indicating some stabilizing influence on escapement

Table 3. Estimates of escapement and productivity for Puget Sound Chinook populations. Natural origin escapement information is provided where available. For several populations, data on hatchery contribution to natural spawning are limited or unavailable.

Region	Population	1999 to 2012 Geometric mean Escapement (Spawners)		NMFS Escapement Thresholds		Recovery Planning Abundance Target in Spawners (productivity)[2]	Average % hatchery fish in escapement 1999-2012 (min-max)[5]
		Natural [1]	Natural-Origin (Productivity[2])	Critical[3]	Rebuilding[4]		
Georgia Basin	Nooksack MU	1,949	280	400	500		
	NF Nooksack	1,550	215[8] (0.7)	*200*[6]	-	3,800 (3.4)	86 (74-94)
	SF Nooksack	399	55[8] (1.0)	*200*[6]	-	2,000 (3.6)	84 (62-96)
Whidbey/Main Basin	Skagit Summer/Fall MU						
	Upper Skagit River	7,924	7,795[8] (1.5)	967	7,454	5,380 (3.8)	15 (4-36)
	Lower Sauk River	560	549[8] (1.1)	*200*[6]	681	1,400 (3.0)	3 (0-10)
	Lower Skagit River	2,059	1,986[8] (1.2)	251	2,182	3,900 (3.0)	11 (0-26)
	Skagit Spring MU						
	Upper Sauk River	483	436[8] (1.6)	130	330	750 (3.0)	1 (0-5)
	Suiattle River	309	300[8] (1.0)	170	400	160 (3.2)	2 (0-5)
	Upper Cascade River	316	306[8] (1.3)	170	*1,250*[6]	290 (3.0)	7 (0-25)
	Stillaguamish MU						
	NF Stillaguamish R.	1,026	654 (0.8)	300	552	4,000 (3.4)	35 (8-62)
	SF Stillaguamish R.	129	128 (0.5)	*200*[6]	300	3,600 (3.3)	NA
	Snohomish MU						
	Skykomish River	3,477	2,111[8] (0.7)	1,650	3,500	8,700 (3.4)	20 (8-36)
	Snoqualmie River	1,726	1,238[8] (1.2)	400	*1,250*[6]	5,500 (3.6)	31 (3-62)
Central/South Sound	Cedar River	819	824[8] (1.8)	*200*[6]	*1,250*[6]	2,000 (3.1)	21 (10-36)
	Sammamish River	1,178	137[8] (0.4)	*200*[6]	*1,250*[6]	1,000 (3.0)	85 (66-95)
	Duwamish-Green R.	3,778	1,336[8] (1.1)	835	5,523	-	57 (36-74)
	White River[9]	1,596	1,387[8] (1.0)	*200*[6]	1,100[7]	-	35 (15-49)
	Puyallup River[10]	1,661	755[8] (0.9)	*200*[6]	522[7]	5,300 (2.3)	50 (18-77)
	Nisqually River	1,719	484[8] (1.4)	*200*[6]	1,200[7]	3,400 (3.0)	74 (53-85)
Hood Canal	Skokomish River	1,319	356 (0.6)	452	1,160	-	60 (7-95)
	Mid-Hood Canal Rivers[11]	162		*200*[6]	*1,250*[6]	1,300 (3.0)	66
Strait of Juan de Fuca	Dungeness River	407	124[8] (0.6)	*200*[6]	925[7]	1,200 (3.0)	71 (39-96)
	Elwha River[12]	1,746	122[8]	*200*[6]	*1,250*[6]	6,900 (4.6)	93 (92-95)

[1] Includes naturally spawning hatchery fish.
[2] Source productivity is Abundance and Productivity Tables from Puget Sound TRT 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 2000b).
[4] Rebuilding natural-origin escapement thresholds under current habitat and environmental conditions (McElhaney et al. 2000; NMFS 2000b).
[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 (PSIT and WDFW 2013, WDFW and PSTIT 2005, 2006, 2007, 2008, 2009, 2010, 2011a, 2012) and the 2010-2014 Puget Sound Chinook Harvest Management Plan (PSIT and WDFW 2010a). North Fork and South Fork Nooksack estimates are through 2011 and 2010, respectively. Skagit estimates are through 2011.
[6] Based on generic VSP guidance (McElhaney et al. 2000; NMFS 2000b).
[7] Based on alternative habitat assessment.
[8] Estimates of natural-origin escapement for Nooksack, Skagit springs and Skagit falls available only for 1999-2011; Snohomish for 1999-2001, 2004, and 2005-2012; Lake Washington for 2003-2012; White River 2005-2012 ; Puyallup for 2002-2012; Nisqually for 2005-2012; Dungeness for 2001-2012; Elwha for 2010-2012.
[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 2010a).
[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 due to inconsistent visibility during spawning ground surveys. Data on the contribution of hatchery fish is very limited; 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 4. Trends in abundance and productivity for Puget Sound Chinook populations. Long-term, reliable data series for natural-origin contribution to escapement are limited in many areas.

Region	Population	Natural Escapement Trend[1] (1990-2011)			Growth Rate[2] (1990-2009)	
		NMFS		Co-manager	Recruitment (Recruits)	Escapement (Spawners)
Georgia Basin	NF Nooksack (early)	1.17	increasing	increasing	1.04	1.03
	SF Nooksack (early)	1.06	increasing	**declining**	1.01	1.00
Whidbey/Main Basin	Upper Skagit River (moderately early)	1.02	stable	increasing	0.96	1.01
	Lower Sauk River (moderately early)	1.00	stable	stable	0.93	1.00
	Lower Skagit River (late)	1.01	stable	stable	0.94	0.99
	Upper Sauk River (early)	1.02	stable	stable	0.95	0.99
	Suiattle River (very early)	0.98	stable	stable	0.92	0.95
	Upper Cascade River (moderately early)	1.03	increasing	stable	0.98	1.02
		1.01	stable	stable	0.92	0.99
	NF Stillaguamish R. (early)	0.95	**declining**	**declining**	0.91	0.97
	SF Stillaguamish R[3] (moderately early)	1.00	stable	stable	0.98	1.01
		1.02	stable	increasing	1.01	1.04
	Skykomish River (late)					
	Snoqualmie River (late)					
Central/South Sound	Cedar River (late)	1.05	increasing	increasing	1.00	1.00
	Sammamish River[4] (late)	1.00	stable	stable	0.88	0.93
	Duwamish-Green R. (late)	0.94	**declining**	**declining**	1.01	1.03
	White River[5] (early)	1.11	increasing	increasing	1.15	1.16
	Puyallup River (late)	0.98	stable	stable	0.97	0.99
	Nisqually River[3] (late)	1.07	increasing	increasing	0.97	0.98
Hood Canal	Skokomish River (late)	1.02	stable	increasing	0.91	0.95
	Mid-Hood Canal Rivers (late)	1.00	stable	**declining**	0.93	0.98
Strait of Juan de Fuca	Dungeness River (early)	1.08	increasing	increasing	1.08	1.08
	Elwha River[3] (late)	0.99	stable	stable	0.95	0.95

[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 Puget Sound TRT 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.

from past reductions in fishing-related mortality (Table 4). Survival and recovery of the Puget Sound Chinook Salmon ESU will depend, over the long term, on necessary actions in all H sectors. 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 significant improvements in natural population attributes, and these trends are consistent with these expectations (Ford et al. 2011).

Limiting factors

Limiting factors described in SSPS (2007) and reiterated in Ford et al. (2011) 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 = -35%, range = -16 to -59%), but weak natural-origin Chinook salmon populations in Puget Sound still require enhanced protective measures to reduce the risk of overharvest.

2.3.1.2 Status of Puget Sound Steelhead

The Puget Sound steelhead DPS was listed as threatened on May 11, 2007 (72 Fed. Reg. 26722). On August 8, 2011, NMFS conducted a five-year review and concluded that the species should remain listed as threatened (76 Fed. Reg. 50448).

As part of the recovery planning process, NMFS convened a technical recovery team to identify historic populations and develop viability criteria for the recovery plan. In May 2013, NMFS released the technical recovery team draft reports describing the proposed historical population structure and viability criteria for Puget Sound steelhead for final review and comments (Myers et al. 2014, Hard et al. 2014). The technical recovery team reports on steelhead historical population structure and viability criteria are currently being finalized for publication as technical memorandums through the Northwest Fisheries Science Center (NWFSC).

New estimates of abundance and trends have been made available in the 5-year status review report (Ford et al. 2011). The Puget Sound Steelhead TRT (PSS TRT) has completed a set of population viability analyses (PVAs) for these draft populations and major population groups (MPGs) within the DPS that are summarized in the 5-year status review and the draft viability criteria report.

No new estimates of productivity, spatial structure and diversity of Puget Sound steelhead have been made available since the 2007 review, when the BRT concluded that low and declining abundance and low and declining productivity were substantial risk factors for the species (Hard et al. 2007). Loss of diversity and spatial structure were judged to be "moderate" risk factors. The Ford (2011) five year review has retained the risk category for the DPS based upon the extinction risk of the component populations. The NMFS technical recovery team identified population delineation and vaiablity criteria using the limited data available for Puget Sound steelhead populations. In the draft steelhead viability report, the technical recovery team developed viability criteria in order to identify measurable and objective delisting criteria, which included quasi-extinction threshold (QET) analyses for a subset of steelhead populations within Puget Sound (Table 5). Data were insufficient to update productivity, diversity and spatial structure estimates from that in the 2007 BRT review.

Table 5. Puget Sound steelhead populations and risk of extinction (Hard et al. 2014).

Geographic Region (MPGs)	Population (Watershed)	Extinction Risk (probability of decline to an established quasi-extinction threshold (QET) for each population)	Quasi-extinction threshold (number of fish)
Northern Cascades	Drayton Harbor Tributaries (winter)	Insufficient data to calculate percentage	26
	Samish River/Bellingham Bay Tributaries (winter)	Low – about 30% within 100 years	31
	Skagit River (summer/winter)	Low – about 10% within 100 years	157
	Snohomish/Skykomish Rivers (winter)	Low – about 40% within 100 years	73
	Stillaguamish River (winter)	High – about 90% within 25 years	67
	Tolt River (summer)	High – about 80% within 100 years	25
	Snoqualmie River (winter)	High – about 70% within 100 years	58
	Nooksack River (winter)	Insufficient data to calculate percentage	73
	South Fork Nooksack River (summer)	Insufficient data to calculate percentage	27
	Pilchuck River (winter)	Low – about 40% within 100 years	34
	Nookachamps River (winter)	Insufficient data to calculate percentage	27
	North Fork Skykomish River (summer)	Insufficient data to calculate percentage	58
	Baker River (summer/winter)	Insufficient data to calculate percentage	36
	Sauk River (summer/winter)	Insufficient data to calculate percentage	103
	Deer Creek (summer)	Insufficient data to calculate percentage	31
	Canyon Creek (summer)	Insufficient data to calculate percentage	24
Central and Southern Cascades	North Lake Washington /Sammamish River (winter)	Insufficient data to calculate percentage	36
	Cedar River (summer/winter)	High – about 90% within the next few years	35
	Green River (winter)	Moderately High – about 50% within 100 years	69
	Nisqually River (winter)	High – about 90% within 25 years	55

	Puyallup River (winter)	High – about 90% within 30 years	58
	White River (winter)	Low – about 40% within 100 years	64
	South Sound Tributaries (winter)	Insufficient data to calculate percentage	42
Hood Canal and Strait de Fuca	Elwha River (summer/winter)	High – about 90% currently	41
	Dungeness River (winter)	High – about 90% within 20 years	30
	Strait of Juan de Fuca Independents (winter)	High – about 90% within 60 years	26
	South Hood Canal	High – about 90% within 20 years	30
	West Hood Canal (winter)	Low – about 20% within 100 years	32
	East Hood Canal (winter)	Low – about 40% within 100 years	27
	Skokomish River (winter)	High – about 70% within 100 years	50
	Strait of Juan de Fuca Lowland Tributaries (winter)	High – about 90% within 100 years (Snow Creek); about 90% within 100 years (Morse and McDonald creeks)	25 (Snow Creek); 26 (Morse & McDonald creeks)

Spatial Structure, and Diversity

The Puget Sound Steelhead DPS includes all naturally spawned anadromous steelhead populations in streams in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington, bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive), as well as the Green River natural and Hamma Hamma winter run steelhead hatchery stocks. These fish are the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State (Ford et al. 2011). Non-anadromous ‘‘resident’’ *O. mykiss* occur within the range of Puget Sound steelhead but are not part of the DPS due to marked differences in physical, physiological, ecological, and behavioral characteristics (Hard et al. 2007). The Puget Sound steelhead populations are aggregated into three extant MPGs containing a total of 32 Demographically Independent Populations (DIPs) based on genetic, environmental, and life history characteristics (Myers et al. 2014). Populations can include summer steelhead only, winter steelhead only, or a combination of summer and winter run timing (e.g., winter run, summer run or summer/winter run). Extinction risk could only be calculated for a subset of Puget Sound steelhead DIPs due to insufficient data (Table 5). The BRT considered the major risk factors associated with spatial structure and diversity to be: (1) the low abundance of several summer run populations; (2 the sharply diminishing abundance of some winter steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca; and (3) continued releases of out-of-ESU hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Hard et al. 2007). More information on Puget Sound steelhead spatial structure and diversity can be found in NMFS’ BRT report (Hard et al. 2007).

Abundance and Productivity

The 2007 BRT considered the major risk factors facing Puget Sound steelhead to be: (1) widespread declines in abundance and productivity for most natural steelhead populations in the ESU, including those in Skagit and Snohomish rivers (previously considered to be strongholds); (2) the low abundance of several summer run populations; and (3) the sharply diminishing abundance of some steelhead populations, especially in south Puget Sound, Hood Canal, and the Strait of Juan de Fuca (Hard et al. 2007).

Since 1985, Puget Sound steelhead winter run steelhead abundance has shown a widespread declining trend over the majority of the DPS (Ford et al. 2011) (Table 6). For all but a few Puget Sound steelhead populations, estimates of mean population growth rates obtained from observed spawner or redd counts are declining (typically 3 to 10 percent annually). Extinction risk within 100 years for most populations in the DPS is estimated to be moderate to high, especially for steelhead populations in the Central and Southern Cascades and Hood Canal and Strait of Juan de Fuca MPGs. Most populations within the DPS continue downward trends in estimated abundance, a few sharply so (Ford et al. 2011).

Table 6. Estimates of exponential trend in the natural logarithm (ln) of natural spawners for several winter run population of steelhead in the Puget Sound DPS over the entire data series (1985-2009) and since 1995 (1995-2009). Modified from Ford et al. (2011).

	Exponential trend ln (natural spawners) (95 percent CI)	
Population	**1985 - 2009**	**1995 - 2009**
South Sound Tributaries winter run	Not calculated	Not calculated
Dungeness River winter run	0.926 (0.909-0.943)	0.919 (0.786-1.075)
East Hood Canal winter run	1.022 (0.997-1.048)	1.033 (0.976-1.092)
Elwha River winter run	0.840 (0.749-0.943)	0.750 (0.020-28.503)
Green River winter run	0.992 (0.969-1.016)	0.953 (0.892-1.019)
Lake Washington winter run	0.807 (0.770-0.845)	0.731 (0.656-0.815)
Niqually River winter run	0.914 (0.890-0.940)	0.935 (0.876-0.997)
Port Angeles winter run	1.016 (0.983-1.050)	0.964 (0.899-1.031)
Puyallup River winter run	0.919 (0.899-0.938)	0.902 (0.850-0.957)
Samish River winter run	1.008 (0.972-1.045)	0.966 (0.934-0.998)
Skagit River winter run	0.969 (0.954-0.985)	0.978 (0.931-1.029)
Skokomish River winter run	0.956 (0.932-0.979)	1.006 (0.958-1.057)
Snohomish River winter run	0.963 (0.941-0.985)	0.9610 (0.878-1.050)
Stillaguamish winter run	0.910 (0.887-0.934)	0.879 (0.820-0.943)
West Hood Canal winter run	1.101 (1.046-1.160)	1.101 (1.046-1.160)
White River winter run	0.938 (0.923-0.952)	0.933 (0.905-0.963)

Little or no data is available on summer run populations to evaluate extinction risk or abundance trends. Because of their small population size and the complexity of monitoring fish in headwater holding areas, summer steelhead have not been broadly monitored.

Since 1995, Puget Sound winter run steelhead abundance has also shown a widespread declining trend throughout the majority of the DPS (Ford et al. 2011) (Table 6). Only four of the sixteen summer/winter and winter run steelhead populations examined exhibit long-term population growth rates that are positive (i.e., East Hood Canal, Port Angeles, Samish and West Hood Canal winter run); only one population is significantly greater ($P < 0.05$) than 1 (positive population growth), the West Hood Canal population (Ford et al. 2011). All four of these winter run steelhead populations are small. The highest growth rates occur in East and West Hood Canal, Green River, Samish River, Skagit River, and Port Angeles steelhead populations; the lowest growth rates occur in the Elwha River, Lake Washington, Stillaguamish River, Nisqually River, and Puyallup River steelhead populations (Ford et al. 2011). Trends could not be calculated for the South Puget Sound Tributaries winter run population.

Since 2005, Puget Sound winter run steelhead abundance has continued to be low over the majority of the DPS, with a geometric mean less than 250 fish annually for all but eight populations of the 15 examined from 2005 to 2009 (Ford et al. 2011) (Table 7). Four of these populations are in the Northern Cascades MPG (Samish, Skagit, Snohomish, and Stillaguamish Rivers); three populations are in the Central and Southern Cascades MPG (Green, Puyallup, and White River); and one population is in the Hood Canal and Strait of Juan de Fuca MPG (Skokomish River). Only four winter run steelhead populations have a geometric mean greater than 500 (i.e., Green, Samish, Skagit, and Snohomish Rivers); three of these populations are in the Northern Cascades MPG (Ford et al. 2011). The lowest mean abundances (less than 15 fish) occur in the Elwha River, Lake Washington, and South Puget Sound Tributaries winter run populations (Ford et al. 2011). Geometric means could not be calculated for the South Sound Tributaires and Elwha River winter run populations.

Table 7. Geometric means of natural spawners for several winter run steelhead populations in the Puget Sound Steelhead DPS over the most recent years (2005-2009). Modified from Ford et al. (2011).

Population	**Geometric mean (95 percent CI)**
South Sound Tributaries winter run	Not calculated
East Hood Canal winter run	213 (122-372)
Elwha River winter run	Not calculated
Green River winter run	986 (401-2,428)
Lake Washington winter run	12 (3-55)
Nisqually River winter run	402 (178-908)
Port Angeles winter run	147 (53-405)
Puyallup River winter run	326 (178-596)
Samish River winter run	534 (389-732)
Skagit River winter run	4,648 (2,827-7,642)
Skokomish River winter run	355 (183-686)
Snohomish River winter run	4,573 (500-41,865)
Stillaguamish River winter run	327 (100-1,067)
West Hood Canal winter run	208 (118-366)
White River winter run	265 (206-342)

Limiting factors

NMFS, in its listing document of 2011 (76 FR 1392, January 10, 2011), noted that the factors for decline for Puget Sound steelhead also persist as limiting factors:

- In addition to being a factor that contributed to the present decline of Puget Sound steelhead populations, the continued destruction and modification of steelhead habitat is the principal factor limiting the viability of the Puget Sound steelhead DPS into the foreseeable future.
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest in recent years.
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania) inconsistent with wild stock diversity throughout the DPS.
- Declining diversity in the DPS, including the uncertain but weak status of summer run fish in the DPS.
- A reduction in spatial structure for steelhead in the DPS.
- Reduced habitat quality through changes in river hydrology, temperature profile, downstream gravel recruitment, and reduced movement of large woody debris.
- In the lower reaches of many rivers and their tributaries in Puget Sound where urban development has occurred, it has caused increased flood frequency and peak flows during storms, and reduced groundwater-driven summer flows. Altered stream hydrology has resulted in gravel scour, bank erosion, and sediment deposition.
- Dikes, hardening of banks with riprap, and channelization, which have reduced river braiding and sinuosity, have increased the likelihood of gravel scour and dislocation of rearing juveniles.

2.3.1.3 Status of Puget Sound/Georgia Basin Rockfish

We describe the status of each rockfish species with nomenclature referring to specific areas of the Puget Sound. The 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 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 DPSs of yelloweye rockfish and canary rockfish are listed under the ESA as threatened, and bocaccio are listed as endangered (75 Fed. Reg. 22276, April 28, 2010). These DPSs include all yelloweye rockfish, canary rockfish, and bocaccio found in waters of the Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca east of Victoria Sill (Figure 3). Unlike ESA-listed salmonids, we have not identified biological populations of each species below the DPS level; thus, we use the term "populations" to refer to groups of fish within a particular basin. Yelloweye rockfish, canary rockfish, and bocaccio are 3 of 28 species of rockfish in Puget Sound (Palsson et al. 2009).

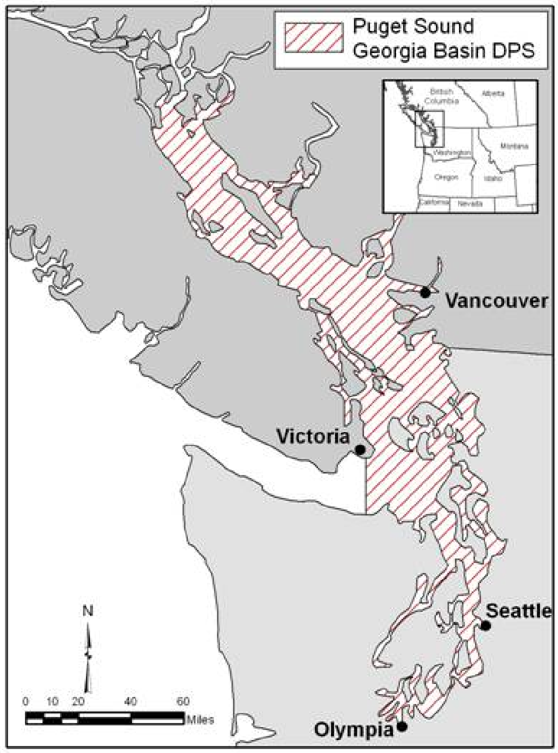

Figure 3. ESA-listed rockfish DPSs.

The life histories of yelloweye rockfish, canary rockfish, and bocaccio include a larval/pelagic juvenile stage followed by a nearshore juvenile stage, and sub-adult and adult stages. Much of the life history and habitat use for these three species is similar, with important differences noted below.

Rockfish fertilize their eggs internally and the young are extruded as larvae. Yelloweye rockfish, canary rockfish, and bocaccio produce from several thousand to over a million eggs (Love et al. 2002). Larvae can make small local movements to pursue food immediately after birth (Tagal et al. 2002), but are likely passively distributed with prevailing currents (NMFS 2003a). 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. 2010b).

When bocaccio and canary rockfish 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 and canary rockfish, 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).

Sub-adult and adult yelloweye rockfish, canary 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 some canary rockfish and 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 canary rockfish is at least 84 years (Love et al. 2002), although 60 to 75 years is more common (Caillet et al. 2000). They reach 50 percent maturity at sizes around 16 inches (40 cm) and ages of 7 to 9 years. The maximum age of bocaccio is unknown, but may exceed 50 years, and they are first reproductively mature near age 6 (FishBase 2010).

In the following section, we summarize the condition of yelloweye rockfish, canary 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. 2010b). There are several common risk factors detailed below at the introduction of each of the viability criteria for each listed rockfish species. Information on species and habitat limiting factors can affect abundance, spatial structure and diversity, and are described.

Abundance and Productivity

There is no single reliable historic or contemporary population estimate for the yelloweye rockfish, canary rockfish, or bocaccio Puget Sound/Georgia Basin DPSs (Drake et al. 2010b). Despite this limitation, there is clear evidence each species' abundance has declined dramatically (Drake et al. 2010b). The total rockfish population in the Puget Sound region is estimated to have declined around 3 percent per year for the past several decades, which corresponds to an approximate 70 percent decline from 1965 to 2007 (Drake et al. 2010b). Catches of yelloweye rockfish, canary rockfish, and bocaccio have declined as a proportion of the overall rockfish catch (Drake et al. 2010b; 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). Canary rockfish occurred in 6.5 percent of the North Sound recreational harvests during the 1960s and then declined to 1.4 percent and to 0.6 percent during the subsequent two periods (Palsson et al. 2009). During the 1960s, canary rockfish were 3.1 percent of the Puget Sound proper rockfish harvest and then declined to 1 percent in 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. 2010b). From 1975 to 1979, bocaccio averaged 4.63 percent of the catch. From 1980 to 1989, they were 0.24 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). In 2008 and 2009, some fish were reported by recreational anglers in the Main Basin (WDFW 2011).

Fishery-independent estimates of population abundance come from spatially and temporally limited research trawls, drop camera surveys, and underwater remotely operated vehicle (ROV) surveys conducted by WDFW. These population estimates included in Table 8 should be interpreted in the context of the sampling design and gear. The trawl surveys were conducted on the bottom to assess marine fish abundance for a variety of species. These trawls generally sample over non-rocky substrates where yelloweye rockfish, canary rockfish, and bocaccio are less likely to occur compared to steep-sloped, rocky habitat (Drake et al. 2010b). The drop camera surveys sampled habitats less than 120 feet (36.6 m), which is potential habitat for juveniles, but less likely habitat for adults of the three listed species. Similarly, because juvenile yelloweye rockfish are less dependent on rearing in shallow nearshore environments, the likelihood of documenting them with drop camera surveys in water shallower than 120 feet (36.6 m) is less than for canary rockfish and bocaccio.

The WDFW ROV surveys were conducted exclusively within the rocky habitats of the San Juan Basin in 2008, and represent the best available abundance estimates to date for one basin of the DPS for each species because of their survey area, number of transects, and stratification methods. Rocky habitats have been mapped within the San Juan Basin, which allows a randomized survey of these areas to assess species assemblages and collect data for abundance estimates. WDFW conducted 200 transects and stratified each rocky habitat survey as either "shallower than" or "deeper than" 120 feet (36.6 m). The total area surveyed within each stratum was calculated using the average transect width multiplied by the transect length. The mean density of yelloweye rockfish, canary rockfish, and bocaccio was calculated by dividing the species counts within each stratum by the area surveyed. Population estimates for each species were calculated by multiplying the species density estimates by the total survey area within each stratum (Pacunski et al. 2013). Because WDFW did not survey non-rocky habitats of the San Juan Basin with the ROV, these estimates do not account for ESA-listed rockfish in non-rocky habitat in 2008. WDFW expanded the survey data to estimate total abundance in the San Juan Basin (Table 8). From the midwater trawl and drop camera surveys, WDFW has reported population estimates in the North Sound and Puget Sound proper (Table 8).

Though the bottom trawl and drop camera surveys did not detect canary rockfish or bocaccio in Puget Sound proper, each species has been historically present there and each has been caught in recent recreational fisheries. The lack of detected canary rockfish and bocaccio from these sampling methods in Puget Sound proper is likely due to the following factors: 1) populations of each species are depleted; 2) the general lack of rocky benthic areas in Puget Sound proper may lead to densities of each species that are naturally less than the San Juan Basin; and 3) the study design or effort may not have been sufficiently powerful to detect each species. Though yelloweye rockfish were detected in Puget Sound proper with bottom trawl surveys, we do not consider the WDFW estimate of 600 fish to be a complete estimate, for the same reasons given above. Thus, there are no reliable abundance estimates of yelloweye rockfish, canary rockfish, or bocaccio within Puget Sound proper.

Table 8. WDFW population estimates for yelloweye rockfish, canary rockfish, and bocaccio.

WDFW Survey Method	**Yelloweye Population Estimate**		**Percent Standard Error (or Variance)**	
	North Sound	**Puget Sound proper**		
Bottom Trawl	Not detected	600	NA	400 (variance)
Drop Camera	Not detected	Not detected	NA	NA
Remotely Operated Vehicle	47,407 (San Juan Basin)		25	
WDFW Survey Method	**Canary Population Estimate**		**Percent Standard Error**	
	North Sound	**Puget Sound proper**		
Bottom Trawl	16,100	Not detected	260.6 (variance)	NA
Drop Camera	2,751	Not detected	89.3	NA
Remotely Operated Vehicle	1,697 (San Juan Basin)		100	
Total Population Estimate	20, 548		na	
WDFW Survey Method	**Bocaccio Population Estimate**		**Percent Standard Error**	
	North Sound	**Puget Sound proper**		
Bottom Trawl	Not detected	Not detected	NA	NA
Drop Camera	Not detected	Not detected	NA	NA
Remotely Operated Vehicle	4,606 (San Juan Basin)		100	

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, canary 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. 2010b; 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 to 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 on only one day each year, 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. 2010b).

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 ESA-listed rockfish population viability (Drake et al. 2010b), 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. Though there is no reliable population census (ROV or otherwise) within the basins of Puget Sound proper, 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.

Canary Rockfish Abundance and Productivity

Historically, the South Sound may have been a population stronghold for the DPS, but it appears to be greatly depleted (Drake et al. 2010b). Natural annual mortality ranges from 6 to 9 percent (Methot and Stewart 2005; Stewart 2007). Life history traits suggest an intrinsically slow growth rate and low rates of productivity for this species, specifically its age at maturity, long generation time, and its maximum observed age (84 years)(Love et al. 2002). Past commercial and recreational fishing may have depressed the DPS to a threshold beyond which optimal productivity is unattainable (Drake et al. 2010b).

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. 2010b). Though bocaccio were never a predominant segment of the multi-species rockfish abundance within the Puget Sound/Georgia Basin (Drake et al. 2010b), their present-day abundance is likely a fraction of their pre-contemporary fishery abundance. Bocaccio abundance may be very low in significant 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. 2010b). 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 summary, though abundance and productivity data for yelloweye rockfish, canary rockfish and bocaccio is relatively imprecise, both abundance and productivity have been reduced largely by fishery removals within the range of the three 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, canary 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 the 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. 2010b). These sills regulate water exchange from one basin to the next, and thus likely moderate the movement of rockfish larvae (Drake et al. 2010b). 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 most acute within the basins of Puget Sound proper. The severe reduction of fish in these basins may eventually result in a contraction of the DPS' range (Drake et al. 2010b). 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. Combined with limited adult movement, yelloweye rockfish population viability may be highly influenced by the probable localized loss of populations within the DPS, which decreases spatial structure and connectivity.

Canary Rockfish Spatial Structure and Connectivity

Canary rockfish were present in each of the major basins in the 1970s (Moulton and Miller 1987), yet were not detected in any WDFW trawl or drop camera survey in Puget Sound proper within the past several years. Several historically large populations in the canary rockfish DPS may be severely reduced, including an area of distribution in South Sound, which has declined because of harvest and perhaps because of low dissolved oxygen (Drake et al. 2010b). The apparent steep reduction of fish in Puget Sound proper leads to concerns about the viability of these populations (Drake et al. 2010b). The ability of adults to migrate hundreds of kilometers could allow the DPS to re-establish spatial structure and connectivity in the future under favorable conditions (Drake et al. 2010b).

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. 2010b) with no documented occurrences in the San Juan Basin until 2008 (WDFW 2011b). 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. 2010b). The apparent reduction of populations of bocaccio in the Main Basin and South Sound represents a further reduction in the historically spatially limited distribution of bocaccio, and adds significant 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 to 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) it 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. Though there is limited genetic data for the ESA-listed rockfish DPSs, the unique oceanographic features and relative isolation of some of its basins may have led to unique adaptations, such as timing of larval release (Drake et al. 2010b).

Yelloweye Rockfish Diversity

Yelloweye rockfish size and age distributions have been truncated (Figure 4). 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. 2010b). 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. did not report a precise size for these fish thus we are unable to provide an 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. 2010b).

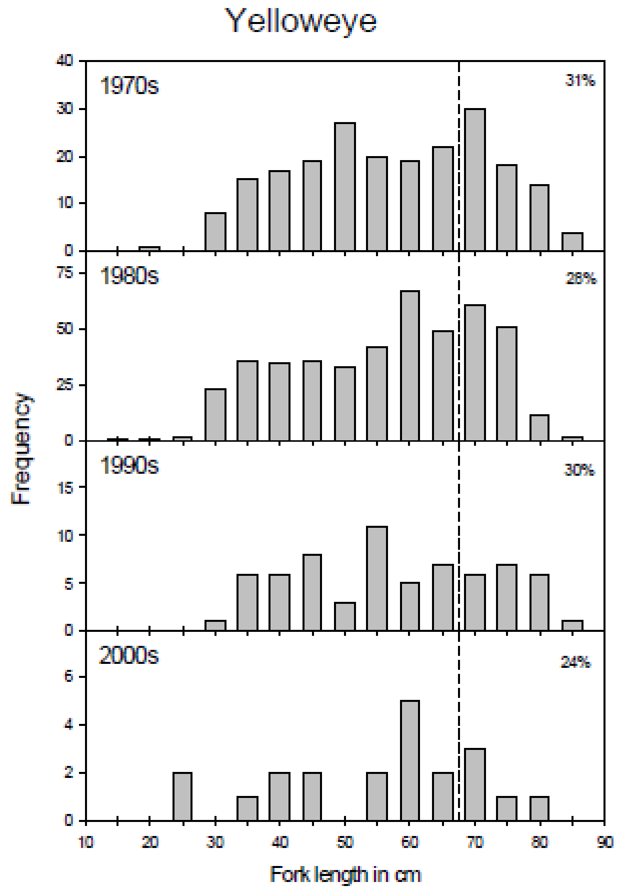

Figure 4. Yelloweye rockfish length frequency distributions (cm) binned within four decades. The vertical line depicts the size at which about 30 percent of the population comprised fish larger than the rest of the population in the 1970s, as a reference point for later decades (figure from Drake et al. 2010b).

Canary Rockfish Diversity

Canary rockfish size and age distributions have been truncated (Figure 5). As a result, the reproductive burden may be shifted to younger and smaller fish. The population of canary rockfish in the 1970s exhibited a broad range of sizes. However, by the 2000s there were far fewer size classes represented and no fish greater than 21.65 inches (55 cm) were recorded in the recreational data (Drake et al. 2010b). Although some of this truncation may be a function of the overall lower number of sampled fish, the data in general suggest few older fish remain in the population. This shift could alter the timing and condition of larval release that may be mismatched with habitat conditions within the range of the DPS, potentially reducing the viability of offspring (Drake et al. 2010b).

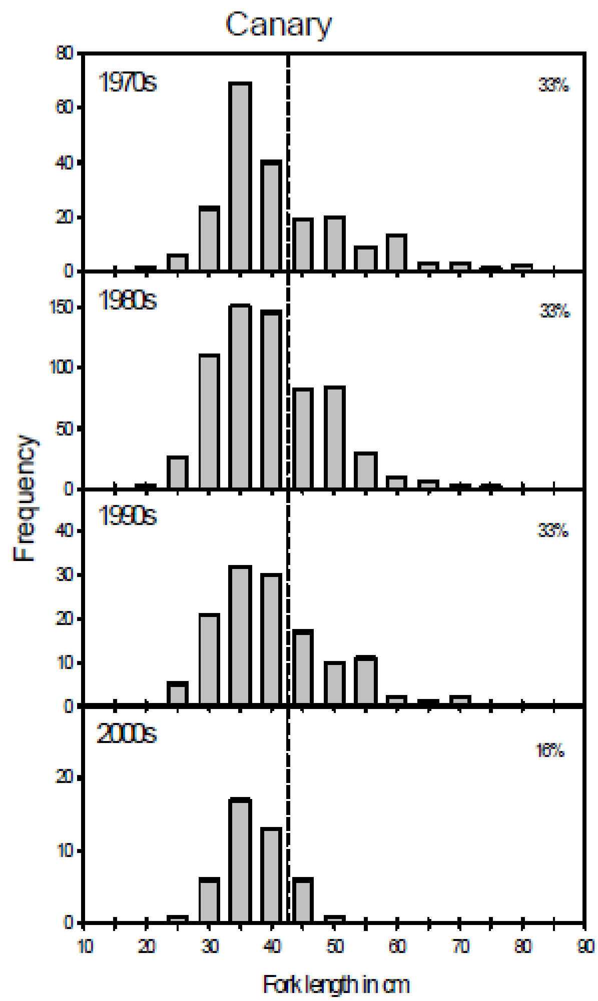

Figure 5. Canary rockfish length frequency distributions (cm) binned within four decades. The vertical line depicts the size at which about 30 percent of the population comprised fish larger than the rest of the population in the 1970s, as a reference point for later decades (figure from Drake et al. 2010b).

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 6). 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. 2010b).

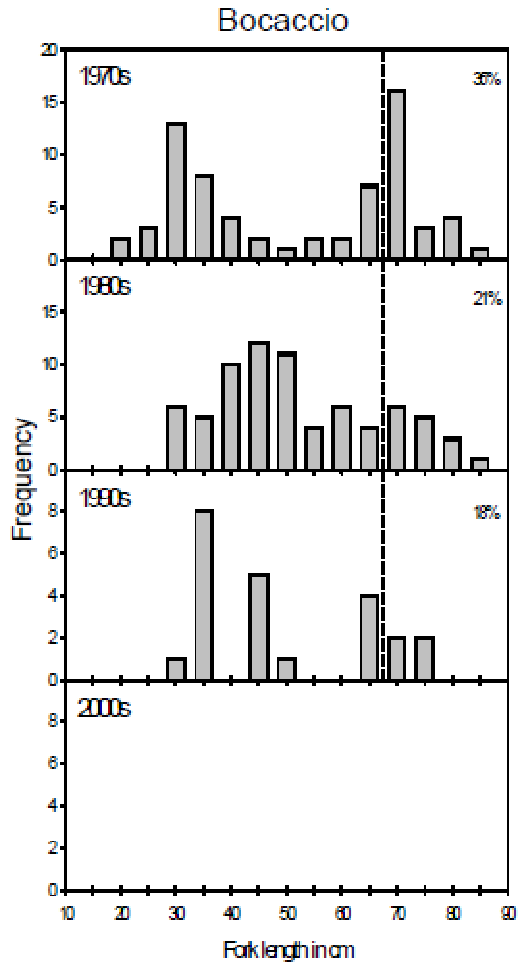

Figure 6. Bocaccio length frequency distributions (cm) binned within four decades. The vertical line depicts the size at which about 30 percent of the population comprised fish larger than the rest of the population in the 1970s, as a reference point for later decades (figure from Drake et al. 2010b).

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 last 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 which 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. OA 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 implications OA may have 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 significantly 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. 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 et al. 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).

Commercial and Recreational Bycatch

Listed rockfish are caught in some recreational and commercial fisheries in the Puget Sound. This bycatch is described in section 2.3.4.2.

Other Limiting Factors

The yelloweye rockfish DPS abundance is much less than it was historically. The fish face several threats, including bycatch in commercial and recreational harvest, 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.

Several factors, both population- and habitat-related, have caused the DPS of canary rockfish to decline to the point that NMFS has listed them as threatened. The general outlook in terms of all five criteria (habitat, spatial structure, diversity, abundance, and productivity) is that the DPS is likely to become in danger of extinction in the foreseeable future throughout all of its range.

The bocaccio DPS exists at very low abundance and observations are 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, canary rockfish, and bocaccio includes their severely reduced abundance from historic times, which in turn hinders productivity and diversity. Spatial structure for each species has also likely been compromised because of the lack of mature fish of each species distributed throughout their historic range within the DPSs (Drake et al. 2010b).

2.3.2 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).

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support[6]; the conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs; NOAA Fisheries 2005) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Thus, even a location that has poor quality of habitat could be ranked with a high conservation value if it were essential due to factors such as limited availability (e.g., one of a very few spawning areas), a unique contribution of the population it served (e.g., a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

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[6] The conservation value of a site depends upon "(1) the importance of the populations associated with a site to the ESU [or DPS] conservation, and (2) the contribution of that site to the conservation of the population through demonstrated or potential productivity of the area" (NOAA Fisheries 2005).

2.3.2.1 Puget Sound Chinook

Critical habitat for the Puget Sound Chinook ESU was designated on September 2, 2005 (70 FR 52630). It includes estuarine areas and specific river reaches associated with the following subbasins: Strait of Georgia, Nooksack, Upper Skagit, Sauk, Lower Skagit, Stillaguamish, Skykomish, Snoqualmie, Snohomish, Lake Washington, Duwamish, Puyallup, Nisqually, Deschutes, Skokomish, Hood Canal, Kitsap, and Dungeness/Elwha (NMFS 2005e). The designation also includes some nearshore areas extending from extreme high water out to a depth of 30 meters and adjacent to watersheds occupied by the 22 populations because of their importance to rearing and migration for Chinook salmon and their prey, but does not otherwise include offshore marine areas. There are 61 watersheds within the range of this ESU. Twelve watersheds received a low rating, nine received a medium rating, and 40 received a high rating of conservation value to the ESU (NMFS 2005d). Nineteen nearshore marine areas also received a rating of high conservation value. Of the 4,597 miles of stream and nearshore habitat eligible for designation, 3,852 miles are designated critical habitat (NMFS 2005e).

Primary constituent elements (PCE) involve those sites and habitat components that support one or more life stages, including general categories of: 1) water quantity, quality, and forage to support spawning, rearing, individual growth, and maturation; 2) areas free of obstruction and excessive predation; and 3) the type and amount of structure and rugosity that supports juvenile growth and mobility. Major management activities affecting PCEs are 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, and forage fish/species harvest. 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 2006b), and consultations on Washington State Water Quality Standards (NMFS 2008c), the National Flood Plain Insurance Program (NMFS 2008d), the Washington State Department of Transportation Preservation, Improvement and Maintenance Activities (NMFS 2013), and the Elwha River Fish Restoration Plan (Ward 2008). These documents provide a more detailed overview of the status of critical habitat in Puget Sound.

2.3.2.2 Puget Sound Steelhead

Critical habitat for the Puget Sound Steelhead DPS was proposed for designation on January 14, 2013 (78 Fed. Reg. 2726). The CHART completed a draft report on the designation of critical habitat for Puget Sound steelhead in 2012 (NMFS 2012d; Appendix B). A draft economic analysis (NMFS 2012e) and a draft ESA section 4(b)(2) report (NMFS 2012f) were also completed. All three reports are located on the NOAA Fisheries West Coast Region website: http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/steelhead/puget_sound/puget_sound_steelhead_proposed_critical_habitat_supporting_information.html. The specific areas proposed for designation for Puget Sound steelhead include approximately 1,880 miles (3,026 kilometers) of freshwater and estuarine habitat in Puget Sound (78 Fed. Reg. 2726).

There are 72 HUC5 watersheds occupied by Puget Sound steelhead within the range of this DPS. Eighteen watersheds received a proposed low rating, thirteen received a proposed medium rating, and forty received a proposed high rating of conservation value to the DPS (NMFS 2012d; Appendix B). The Puget Sound steelhead also occupy marine waters in Puget Sound and vast areas of the Pacific Ocean where they forage during their juvenile and subadult life phases before returning to spawn in their natal streams (NMFS 2012d). As described further in the Section 4(b)(2) report (NMFS 2012f), NMFS could not identify "specific areas" within the marine and ocean range that meet the definition of critical habitat. Instead, the CHARTs considered the adjacent marine areas in Puget Sound when designating steelhead freshwater and estuarine critical habitat.

Primary constituent elements (PCE) for Puget Sound steelhead involve those sites and habitat components that support one or more life stages, including general categories of: 1) water quantity, quality, and forage to support spawning, rearing, individual growth, and maturation; 2) areas free of obstruction and excessive predation; and 3) the type and amount of structure and rugosity that supports juvenile growth and mobility. Major management activities affecting PCEs are 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, and forage fish/species harvest.

2.3.2.3 Puget Sound/Georgia Basin Rockfish

We proposed critical habitat for yelloweye rockfish, canary rockfish, and bocaccio of the Puget Sound/Georgia Basin in August 2013 (78 Fed. Reg. 47635; August 6, 2013) and are now in the process of finalizing the designation. The specific areas proposed for designation for canary rockfish and bocaccio include approximately 1,184.75 sq. mi (3,068.5 sq. km) of marine habitat. The specific areas proposed for designation for yelloweye rockfish include approximately 574.75 sq. mi (1,488.6 sq. km) of marine habitat deeper than 30 meters.

For all three listed rockfish, we proposed deep water habitats for sites deeper than 30 meters (98 ft.) that possess or are adjacent to areas of complex bathymetry consisting of rock and/or highly rugose habitat. These features are essential to conservation because they support growth, survival, reproduction, and feeding opportunities by providing the structure for rockfish to avoid predation, seek food, and persist for decades. Several attributes of these sites determine the quality of the habitat and are useful in considering the conservation value of the associated feature, and whether the feature may require special management considerations or protection. These attributes are also relevant in the evaluation of 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) the type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.

For juvenile canary rockfish and bocaccio, we proposed juvenile settlement habitats located in some areas of the nearshore. Most nearshore areas are contiguous with the shoreline from the line of extreme high water out to a depth no greater than 30 meters (98 ft.) relative to mean lower low water. Several nearshore areas proposed as critical habitat are not associated with a beach, but are shallower than 30 meters and can support kelp and rearing habitat. They include areas of Hein Bank, Partridge Bank, Coyote Bank, and Middle Bank, and several areas north of Orcas Island. We proposed specific areas of the nearshore with substrates such as sand, rock and/or cobble compositions that also support kelp. These features are essential for conservation because they provide forage opportunities and refuge from predators and enable behavioral and physiological changes needed for juveniles to occupy deeper adult habitats.

Regulations for designating critical habitat at 50 CFR 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 CFR 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, canary 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 proposed critical habitat in the nearshore is impacted in many areas by the degradation from coastal development and pollution. The status of proposed deepwater critical habitat is impacted by remaining derelict fishing gear, and degraded water quality among other factors. The input of pollutants affect water quality, sediment quality, and food resources in the nearshore and deepwater areas of proposed critical habitat.

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 which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for the species affected by the proposed actions includes the effects of many activities that occur across the broad expanse of the action area considered in this opinion. The status of the species described in section 2.2 of the biological opinion is a consequence of those effects.

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 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 (SSPS 2007) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/PS-Recovery-Plan.cfm and Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan (NMFS 2006a) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/PS-Supplement.pdf). Recovery planning for Puget Sound steelhead is just getting underway. Future consultations will incorporate information from the recovery planning process as it becomes available.

NMFS recognizes the unique status of treaty Indian fisheries and their relation to the environmental baseline. Implementation of treaty Indian fishing rights involves, among other things, application of the sharing principles of *United States v. Washington*, annual calculation of allowable harvest levels and exploitation rates, the application of the "conservation necessity principle" articulated in *United States v. Washington* to the regulation of treaty Indian fisheries, and an understanding of the interaction between treaty rights and the ESA on non-treaty allocations. Exploitation rate calculations and harvest levels to which the sharing principles apply, in turn, are dependent upon various biological parameters, including the estimated run sizes for the particular year, the mix of stocks present, the allowable fisheries and the anticipated fishing effort. The treaty fishing right itself exists and must be accounted for in the environmental baseline, although the precise quantification of treaty Indian fishing rights during a particular fishing season cannot be established by a rigid formula.

If, after completing this ESA consultation, circumstances change or unexpected consequences arise that necessitate additional Federal action to avoid jeopardy determinations for ESA listed species, such action will be taken in accordance with standards, principles, and guidelines established under *United States v. Washington*, Secretarial Order 3206, and other applicable laws and policies. The conservation principles of *United States v. Washington* will guide the determination of appropriate fishery responses if additional harvest constraints become necessary. Consistent with the September 23, 2004 Memorandum for the Heads of Executive Departments and Agencies pertaining to Government-to-Government Relationship with Tribal Governments and Executive Order 13175, Departmental and agency consultation policies guiding their implementation, and administrative guidelines developed to implement Secretarial

Order 3206, these responses are to be developed through government-to-government discourse involving both technical and policy representatives of the West Coast Region and affected Indian tribes prior to finalizing a proposed course of action.

2.4.1 Puget Sound Chinook and Steelhead

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. Recent evidence suggests that marine survival among salmonids fluctuates in response to 20 to 30-year cycles of climatic conditions and ocean productivity. The fluctuations in salmon survival that occur with these changes in climate conditions can also affect species that depend on salmon for prey such as Southern Resident killer whales. More detailed discussions about the likely effects of large-scale environmental variation on salmonids, including climate change, are found in Section 2.2.1 of this opinion, and biological opinions on the 2008 Pacific Salmon Treaty Agreement (NMFS 2008b) and the Pacific Coast Salmon Plan effects on Lower Columbia River Chinook (NMFS 2012a).

Harvest

Salmon and steelhead fisheries

In the past, fisheries in Puget Sound were generally not managed in a manner appropriate for the conservation of naturally spawning Chinook salmon populations. Fisheries exploitation rates were in most cases too high—even in light of the declining pre-harvest productivity of natural Chinook salmon stocks. In response, over the past one to two decades, the co-managers implemented several strategies to manage fisheries to reduce harvest impacts and to implement harvest objectives that are consistent with the underlying productivity of the natural population. Time and area closures are implemented to reduce catches of weak stocks and to reduce Chinook salmon bycatch in fisheries targeting other salmon species. Other regulations, such as size limits, bag limits, mark-selective fisheries and requirements for the use of barbless hooks in all recreational fisheries are also used to achieve these objectives while providing harvest opportunities. Exploitation rates for most of the Puget Sound Chinook management units have been reduced substantially since the late 1990s when compared to years prior to listing (average = -35%, range = -16 to -59%). The effect of these overall reductions in harvest has been to improve the baseline condition and help to alleviate the effect of harvest as a limiting factor. Since 2010, the state and Tribal fishery co-managers managed Chinook mortality in Puget Sound salmon and Tribal steelhead net fisheries to meet the conservation and allocation objectives described in the jointly-developed 2010-2014 Puget Sound Chinook Harvest RMP, which expired April 30, 2014 (PSIT and WDFW 2010a). The 2010-2014 Puget Sound Chinook Harvest RMP was adopted as the harvest component of the Puget Sound Salmon Recovery Plan which includes the Puget Sound Chinook ESU (NMFS 2011). Recent year exploitation rates are summarized in Table 9.

Forty percent or more of the harvest of most Puget Sound Chinook stocks occurs in salmon fisheries outside the Action Area, primarily in Canadian waters (Table 9). These fisheries are managed under the terms of the Pacific Salmon Treaty Agreement and the Pacific Fisheries Management Council. The effects of these fisheries were assessed in previous biological opinions (NMFS 2004a, NMFS 2008b).

Table 9. Average 2008 to 2010 total and southern U.S. (SUS) exploitation rates for Puget Sound Chinook management units (see Table 3 for correspondence to populations).

Management Unit	% AK/CAN	SUS Exploitation Rate	Total Exploitation Rate
Nooksack early	83%	4%	23%
Skagit spring	56%	11%	25%
Skagit summer/fall	58%	21%	50%
Stillaguamish	59%	7%	17%
Snohomish	44%	14%	25%
Lake Washington	53%	18%	38%
Duwamish-Green River	41%	30%	51%
White River	11%	16%	18%
Puyallup River	38%	34%	55%
Nisqually River	21%	62%	78%*
Skokomish River	23%	48%	62%*
Mid-Hood Canal rivers	56%	11%	25%
Dungeness River	83%	7%	42%
Elwha River	85%	6%	41%

Steelhead are caught in marine areas and in river systems throughout Puget Sound. In marine areas, the majority of fisheries target salmon species other than steelhead. However Puget Sound treaty marine salmon fisheries encounter listed summer and winter steelhead. An annual average of 126 (hatchery and wild combined)(range = 7 – 266) summer and winter steelhead were landed incidentally in treaty marine fisheries (commercial and ceremonial and subsistence) from all Puget Sound marine areas combined during the 2001/2002 to 2006/2007 time period (NMFS unpubl. data 2010). An annual average of 53 (hatchery and wild combined) (range = 15 – 109) summer and winter steelhead were landed incidentally in treaty marine fisheries from all Puget Sound marine areas combined during the 2008/2009 to 2012/2013 time period (NMFS unpubl. data 2014, W. Beattie pers. comm. 2014). Not all tribal catch is sampled for marks so these estimates represent catch of both ESA-listed steelhead and ESA-listed and unlisted hatchery steelhead (W. Beattie pers. comm. 2014).

In marine areas, the retention of steelhead in non-treaty salmon commercial fisheries is prohibited (RCW 77.12.760 1993). Encounters of steelhead in non-treaty commercial fisheries targeting other salmon species in marine areas of Puget Sound are rare. In an observer study by WDFW to estimate the incidental catch rate of steelhead in non-treaty commercial salmon fisheries, 20 steelhead were encountered in 5,058 net sets over an 18 year period (i.e., 1991 to 2008) (i.e., 1 fish annually, J. Jording, pers. comm., 2010). Over the most recent five year period from 2009 to 2013, 26 steelhead were encountered in 2,093 net sets estimated at 5 steelhead per year (K. Henry pers. comm. 2014). Over the 23 year observer time period from 1991 to 2013, 92 steelhead were encountered in 14,302 net sets averaging 2 steelhead encounters annually (K. Henry, pers. comm. 2014).); indicating that encounters of steelhead in these fisheries remains rare. Incidental catch of steelhead is not sampled for marks in order to return the bycatch to the water as quickly as possible (K. Henry, pers. comm., 2014). In marine recreational fisheries, an annual average of 198 (range = 102 – 352) hatchery summer and winter steelhead were landed incidentally from all Puget Sound marine areas combined during the 2001/2002 to 2006/07 time period (B. Leland pers. comm. 2010c). An annual average of 132 (range = 62 – 202) hatchery summer and winter steelhead were landed incidentally in non-treaty marine recreational fisheries from all Puget Sound marine areas combined during the 2008/2009 to 2012/2013 time period (E. Kraig pers. comm. 2014). Three natural-origin steelhead were landed in 2010/2011 as a result of illegal retention (WDFW and PSTIT 2011b). Applying a catch-and-release mortality rate of 10 percent, an average estimated 14 natural-origin steelhead mortalities have occurred annually from 2003/2004 to 2012/2013.

In summary, an average of 325 steelhead have been encountered in marine treaty and non-treaty commercial, ceremonial and subsistence, and recreational fisheries (i.e., 126 treaty marine; 1 non-treaty commercial; 198 non-treaty commercial) during the 2001/2002 to 2006/2007 time period at the time of listing. An average of 190 steelhead have been encountered in marine treaty and non-treaty commercial, ceremonial and subsistence, and recreational fisheries (i.e., 53 treaty marine; 5 non-treaty commercial; 132 non-treaty commercial) for the most recent time period (2008/2009 to 2012/2013). Since not all fish in marine area fisheries are sampled for marks, this annual estimate includes both encounters (fish that will be caught and released) and incidental mortality of listed natural and listed and non-listed hatchery origin steelhead.

In Puget Sound freshwater areas, the non-treaty harvest of steelhead occurs in recreational hook-and-line fisheries targeting adipose fin-clipped hatchery summer run and winter run steelhead. Washington State prohibits the retention of natural-origin steelhead (those without a clipped adipose fin) in recreational fisheries as well. Treaty fisheries retain both natural-origin and hatchery steelhead. The treaty freshwater fisheries for winter steelhead target primarily hatchery steelhead by fishing during the early winter months when hatchery steelhead are returning to spawn and natural-origin steelhead are at low abundance. Fisheries capture natural-origin summer run steelhead incidentally while targeting other salmon species, but are presumed to have limited impact because the fisheries start well after the summer spawning period, and are located primarily in lower and mid-mainstem rivers where natural-origin summer steelhead (if present) are believed not to hold for an extended period (PSTIT and WDFW 2010b). However, some natural-origin late winter and summer run steelhead, including winter run kelts (repeat spawners), are intercepted in Skagit River salmon and steelhead marine and freshwater fisheries. A small number of natural-origin summer steelhead are also encountered in Nooksack River spring Chinook salmon fisheries.

Available data on escapement of summer, winter, and summer/winter steelhead stocks in Puget Sound are limited. Complete long-term time series of escapement and catch to complete run reconstruction are available for none of the five Puget Sound summer run populations, four out of the twenty-five winter run populations, and one out of the five summer/winter run populations (A. Marshall pers. comm. 2012). Data are currently insufficient to to provide a full run reconstruction of natural-origin steelhead populations in order to assess exploitation or harvest rates on summer run steelhead populations as well as most summer/winter and winter run populations. NMFS used a subset of Puget Sound winter steelhead populations to calculate terminal harvest rates on natural-origin steelhead. Using the limited information available, NMFS calculated that the harvest rate on a subset of watersheds for natural-origin steelhead averaged 4.2 percent annually in Puget Sound fisheries during the 2001/2002 to 2006/2007 time period (NMFS unpubl. data, 2010c)(Table 10). Average harvest rates on the same subset of watersheds for natural-origin steelhead demonstrated a reduction at 1.9 percent in Puget Sound fisheries during the 2007/2008 to 2012/2013 time period (NMFS unpubl. data, 2014a)(Table 10). These estimates include sources of non-landed mortality such as hooking mortality and net dropout, 10 percent and 2 percent respectively.

Table 10. Annual terminal harvest rate (HR) percentages (%) of natural-origin steelhead take for a subset of Puget Sound winter steelhead populations for which catch and run size information are available (NMFS unpubl. data 2014; WDFW and PSTIT 2011b; WDFW and PSTIT 2013; WDFW and PSTIT 2014).

	Steelhead Population				
Year	**Skagit**	**Snohomish**	**Green**	**Puyallup**	**Nisqually**
2001-02	4.2	8.0	19.1	15.7	N/C[a]
2002-03	0.8	0.5	3.5	5.2	N/C[a]
2003-04	2.8	1.0	0.8	2.2	1.1
2004-05	3.8	1.0	5.8	0.2	3.5
2005-06	4.2	2.3	3.7	0.8	2.7
2006-07	10.0	N/A[b]	5.5	1.7	5.9
Average HRs 01-07	**4.3%**	**2.6%**	**6.4%**	**4.3%**	**3.3%**
Total Average HR	**4.2%** total average harvest rate across populations from 2001-02 to 2006-07				
2007-08	5.9	0.4	3.5	1.0	3.7
2008-09	4.9	1.1	0.3	0.0	3.7
2009-10	3.3	2.1	0.4	0.0	1.2
2010-11	3.4	1.5	1.6	0.6	1.8
2011-12	2.9	0.9	2.0	0.4[c]	2.5[c]
2012-13	2.3	1.1[c]	2.4	0.7[c]	1.1[c]
Average HRs 08-13	**3.8%**	**1.2%**	**1.7%**	**0.5%**	**2.3%**
Total Average HR	**1.9%** total average harvest rate across populations from 2007-08 to 2012-13				

[a] Escapement methodology for the Nisqually River was changed in 2004; previous estimates are not comparable.
[b] Catch estimate not available in 2006-07 for Snohomish River.
[c] Preliminary catch estimates; subject to change.

NMFS concluded in the final steelhead listing determination that previous harvest management practices likely contributed to the historical decline of Puget Sound steelhead, but that the elimination of the directed harvest of wild steelhead in the mid-1990s largely addressed the threat of decline to the listed DPS posed by harvest (72 Fed Reg. 26722, May 11, 2007). NMFS evaluated the 2010-2014 Puget Sound Chinook Harvest RMP and found that it met the requirements of section 7 of the ESA for incidental impacts on listed steelhead, and that fisheries managed consistent with the terms of the RMP would not jeopardize the survival and recovery of the DPS.

NMFS conducted an informal review of a comprehensive harvest management plan for Puget Sound steelhead jointly developed by WDFW and the Puget Sound treaty tribes in 2010. NMFS anticipates a separate co-manager steelhead harvest plan in the near future, which may encompass the entire Puget Sound Steelhead DPS or a component of the DPS. As described in the Status of Puget Sound Steelhead (Section 2.2.1.2), NMFS convened a technical recovery team to identify historic populations and develop viability criteria for a steelhead recovery plan. These reports are currently being finalized. In May 2013, NMFS convened a Puget Sound Steelhead Recovery Planning Science Workshop. NMFS expects that both Federal and State steelhead recovery and management efforts will provide new tools, data and technical analyses, refine Puget Sound steelhead population structure and viability, and better define the role of individual populations in the DPS. In addition, fisheries change from year to year to respond to changing abundances in both the species targeted in the fisheries and those caught incidentally in fisheries targeted at other species. For example, sockeye and spring Chinook abundance in the Skagit River is anticipated to increase in the next several years providing increased fishing opportunity on those species. Consequently, the co-managers may propose increased incidental catch of steelhead in those fisheries in subsequent years.

Halibut fisheries

Commercial and recreational halibut fisheries occur in the Strait of Juan de Fuca and San Juan Island areas of Puget Sound. In a recent biological opinion, NMFS concluded that salmon are not likely to be caught incidentally in the commercial or tribal halibut fisheries when using halibut gear (NMFS 2014b). The total estimated non-retention mortality of Chinook and coho salmon in Puget Sound recreational halibut fisheries is extremely low, averaging two Chinook salmon per year. Of these, the estimated catch of listed fish (hatchery and wild) is 1.16 Puget Sound Chinook per year. No coho or steelhead salmon have been caught. Additionally, although almost all the Chinook in the ESU are listed, the ESA protective salmon and steelhead 4(d) regulations prohibit take only for natural-origin and hatchery-origin fish with an intact adipose fin (70 FR 37160, June 28, 2005). Thus, the catch of a listed Puget Sound Chinook in the halibut fishery for which take has been prohibited is estimated at 0.24 Puget Sound Chinook per year (NMFS 2014b). Given the very low level of impacts, different populations within the ESUs would be affected each year.

Puget Sound bottomfish and shrimp trawl fisheries

Recreational fishers targeting bottom fish and the shrimp trawl fishery in Puget Sound can incidentally catch listed Puget Sound Chinook. In 2012 we issued an incidental take permit to the WDFW for listed species caught in these two fisheries, including Puget Sound Chinook salmon (NMFS 2012c). The permit will be in effect for 5 years and authorizes the total incidental take of up to 92 Puget Sound Chinook salmon annually. Some of these fish will be released. Some released fish are expected to survive; thus, of the total takes, we authorized a subset of lethal take of up to 50 annually.

Hatcheries

Hatcheries can provide benefits by reducing demographic risks and preserving genetic traits for populations at low abundance in degraded habitats; providing harvest opportunity is an important contributor to upholding the meaningful exercise of treaty rights for the Northwest tribes. However, hatchery-origin fish potentially also pose risks to naturally-produced salmon and steelhead in four primary ways: 1) ecological effects; 2) genetic effects; 3) harvest effects; and 4) masking effects (Good et al. 2005; Hard et al. 2007; Myers et al. 1998). Beginning in the 1990s, state and tribal co-managers took steps to reduce risks identified for Puget Sound hatchery programs as better information became available (PSTT and WDFW 2004), in response to reviews of hatchery programs (e.g., Busack and Currens 1995; HSRG 2000; HSRG 2002), and as part of the region-wide Puget Sound salmon recovery planning effort (SSPS 2007). The intent of hatchery reform is to reduce negative effects of artificial propagation on natural populations while retaining proven production and potential conservation benefits. The goals of conservation programs are to restore and maintain natural populations. Hatchery programs in the Pacific Northwest are in the process of phasing out use of dissimilar broodstocks, such as out-of-basin or out-of-ESU stocks, replacing them with fish derived from, or more compatible with, locally adapted populations. Producing fish that are better suited for survival in the wild is now an explicit objective of many salmon hatchery programs. Hatchery programs are also incorporating improved production techniques, such as NATURES-type rearing protocols[7] and limits on the duration of conservation hatchery programs. The changes proposed are to ensure that existing natural salmonid populations are preserved, and that hatchery-induced genetic and ecological effects on natural populations are minimized.

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). New supplementation or re-introduction programs are under development for early Chinook in the South Fork Nooksack River, fall Chinook in the South Fork Stillaguamish River (T. Tynan pers. comm, 2010) and spring and late-fall Chinook in the Skokomish River (Redhorse 2014).

Hatchery steelhead stocks are artificially propagated through 15 programs in Puget Sound. Six programs propagate Chambers Creek lineage ("early winter") fish for fisheries harvest augmentation purposes. Three other harvest augmentation programs propagate summer-run fish derived from Columbia River, Skamania stock that have become localized to their Puget Sound release sites. The operational status of these Skamania summer-run programs beyond the 2014 release year is uncertain. The Chambers and Skamania steelhead stocks are considered more than moderately diverged from any natural-origin steelhead stocks in the region and were therefore excluded from the Puget Sound Steelhead DPS (Hard et al. 2005; 72 FR 26722, July 11, 2007). The 9 programs propagating these out-of-DPS hatchery stocks account for the majority of the hatchery steelhead production in the Puget Sound region. Of particular importance to this harvest evaluation is that Chambers Creek lineage steelhead have been artificially selected to return in peak abundance as adults earlier in the winter than natural-origin, natural-origin Puget Sound winter run steelhead stocks. The earlier return timing for these hatchery-origin steelhead provides hatchery and natural-origin stock separation, and natural-

[7] A fundamental assumption is that improved rearing technology will reduce environmentally induced physiological and behavioral deficiencies presently associated with cultured salmonids. NATURES-type rearing protocols includes a combination of underwater feed-delivery systems, submerged structure, overhead shade cover, and gravel substrates, which have been demonstrated in most studies to improve instream survival of Chinook salmon (*O. tshawytscha*) smolts during seaward migrations.

origin steelhead protection, in hatchery fish harvest areas (Crawford 1979). Currently there are six steelhead supplementation programs operating for natural-origin winter run steelhead conservation purposes in Puget Sound: Green River, White River, Dewatto, Duckabush, North Fork Skokomish, and Elwha rivers (Tynan 2014). Fish produced through these conservation programs are considered part of the listed Puget Sound Steelhead DPS, and are protected with their associated natural-origin counterparts from take.

Habitat

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 which 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 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 polluting 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; changing sediment transport patterns and reducing important juvenile habitat (SSPS 2005b). 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 2005b). 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 2005b, SSPS 2007). There are substantial habitat blockages by dams in the Skagit and Skokomish River basins, in the Elwha until 2013, 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.

Habitat utilization by steelhead in the Puget Sound area has been dramatically affected by large dams and other manmade barriers in a number of drainages, including the Nooksack, Skagit, White, Nisqually, Skokomish, and Elwha[8] river basins (NMFS 2012d; Appendix B). In addition to limiting habitat accessibility, dams affect habitat quality through changes in river hydrology, altered temperature profile, reduced downstream gravel recruitment, and the reduced recruitment of large woody debris. Such changes can have significant negative impacts on salmonids (e.g.,

[8] The Elwha dams are still in the process of being removed, which will significantly change the Elwha River's hydrology and allow steelhead and salmon access to miles of historical habitat upstream.

increased water temperatures resulting in decreased disease resistance)(Spence et al. 1996; McCullough 1999).

Many upper tributaries in the Puget Sound region have been affected by poor forestry practices, while many of the lower reaches of rivers and their tributaries have been altered by agriculture and urban development (NMFS 2012d; Appendix B). Urbanization has caused direct loss of riparian vegetation and soils, significantly altered hydrologic and erosional rates and processes (e.g., by creating impermeable surfaces such as roads, buildings, parking lots, sidewalks etc.), and polluted waterways with stormwater and point-source discharges (NMFS 2012d; Appendix B). The loss of wetland and riparian habitat has dramatically changed the hydrology of many streams, with increases in flood frequency and peak low during storm events and decreases in groundwater driven summer flows (Moscrip and Montgomery 1997; Booth et al. 2002; May et al. 2003). River braiding and sinuosity have been reduced in Puget Sound through the construction of dikes, hardening of banks with riprap, and channelization of the mainstem (NMFS 2012d). Constriction of river flows, particularly during high flow events, increases the likelihood of gravel scour and the dislocation of rearing juveniles. The loss of side-channel habitats has also reduced important areas for spawning, juvenile rearing, and overwintering habitats. Estuarine areas have been dredged and filled, resulting in the loss of important juvenile rearing areas (NMFS 2012d). In addition to being a factor that contributed to the present decline of Puget Sound steelhead populations, the continued destruction and modification of steelhead habitat is the principal factor limiting the viability of the Puget Sound steelhead DPS into the foreseeable future (72 Fed. Reg. 26722, May 11, 2007). Because of their limited distribution in upper tributaries, summer run steelhead may be at higher risk than winter run steelhead from habitat degradation in larger, more complex watersheds (NMFS 2012d; Appendix B).

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 2006b), and consultations on Washington State Water Quality Standards (NMFS 2008c), Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013), the National Flood Plain Insurance Program (NMFS 2008d), and the Elwha River Fish Restoration Plan (Ward 2008). 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 distinct population segment 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 HCPs, 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 and are incorporated here by reference.

2.4.2 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).

Listed rockfish are linked to numerous other fish species in Puget Sound through the food web. Groundfish (often referred to as demersal fish, or bottom fish), make up the majority of the estimated 211 species of fish within Puget Sound (Donnelly and Burr 1995) and comprise the largest number of species in the action area. Groundfish collectively occupy habitats ranging from intertidal zones to the deepest waters of the region. WDFW has estimated that the biomass of benthic bottom fishes in Puget Sound is 220 million pounds (WDFW 2010).

Most of the benthic deepwater (e.g., deeper than 90 feet) 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. 2010b; 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, including one canary rockfish (within a net)(NRC 2010). Because habitats deeper than 100 feet (30.5 m) are most readily used by adult yelloweye rockfish, canary 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 may 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). About 32 percent of the sediments in the Puget Sound region are considered to be moderately or highly contaminated (Puget Sound Action Team 2007), though some areas are undergoing clean-up operations that have improved benthic habitats (Puget Sound Partnership 2010).

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, 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, canary 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, 2002; Palsson 1998, 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 ESA-listed rockfish because these effects are poorly understood. However, there is sufficient evidence to indicate that ESA-listed rockfish productivity may be negatively impacted from the habitat structure and water quality stressors discussed above (Drake et al. 2010b).

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. In addition, we briefly summarize fisheries management in Canadian waters of the DPSs, as it is relevant to ESA-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. 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 ESA-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 (up to 240 days), and WDFW permanently closed them in February 2011. The pelagic trawl fishery was closed by permanent rule on the same date.

Recreational fishers targeting bottom fish and the shrimp trawl fishery in Puget Sound can incidentally catch listed rockfish. In 2012 we issued an incidental take permit to the WDFW for listed rockfish caught in these two fisheries. The permit will be in effect for 5 years and authorizes the total incidental take of up to152 yelloweye rockfish, 138 canary rockfish, and 43 bocaccio annually (all of these fish would be released). Some released fish are expected to survive; thus, of the total takes, we authorized a subset of lethal take of up to 75 yelloweye rockfish, 79 canary rockfish, and 25 bocaccio annually (consultation number F/NWR/2012/1984). Recreational and commercial halibut fishermen can incidentally catch listed rockfish. In 2014 we assessed the bycatch associated with the halibut fishery in Puget Sound. We estimated that up to 265 yelloweye rockfish, 31 canary rockfish, and 10 bocaccio would be caught annually in the 2014, 2015, and 2016 fishing seasons. Of these, it is anticipated that all caught listed rockfish would be killed (consultation number 2014/F/WCR/403).

Fisheries management in British Columbia, Canada (also partially overlapping with the DPSs' boundary) 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). 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.[9] A recent study found that studied RCAs in Canada had 1.6 times the number of rockfish compared to unprotected areas (Cloutier 2011). Outside the RCAs, recreational fishermen in Canada may keep one rockfish per day from May 1 to September 30.

2.4.3 Scientific Research

The listed salmon, steelhead 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

[9] Recreational fishing allowed in RCAs: invertebrates by hand picking or dive, crab by trap, shrimp/prawn by trap, smelt by gillnet. Commercial fishing allowed in RCAs: invertebrates by hand picking or dive, crab and prawn by trap, scallops by trawl, salmon by seine or gillnet, herring by gillnet, seine and spawn-on-kelp sardine by gillnet, seine, and trap, smelt by gillnet, euphausiid (krill) by mid-water trawl, opal squid by seine groundfish by mid-water trawl. (http://www.pac.dfo-mpo.gc.ca/fm-gp/maps-cartes/rca-acs/permitted-permis-eng.htm)

benefits and risks. Research on the listed species in the Action Area is currently provided coverage under Section 7 of the ESA or the 4(d) research Limit 7, or included in the estimates of fishery mortality discussed in the Effects of the Proposed Action in this opinion.

For the year 2012 and beyond, NMFS has issued several section 10(a)(1)(A) scientific research permits allowing lethal and non-lethal take of listed species (Table 11). In a separate process, NMFS also has completed the review of the state and tribal scientific salmon and research programs under ESA section 4(d) Limit 7. Table 11 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A) for Puget Sound Chinook salmon, Puget Sound steelhead and the listed Puget Sound/Georgia Basin rockfish species. Annual take allotments for research represent the 2013 baseline. The 4(d) Limit 7 research program for Washington State is an annual process, thus estimates are subject to change. However, NMFS expects future years to be similar to the 2013 baseline and reflective of research take for these listed species through 2016.

Table 11. Annual take allotments for research on listed species in 2012-2016 (Rule 2014).

Species	Life Stage	Production/Origin	Total Take	Lethal Take[a]
Puget Sound Chinook	Juvenile	Natural	413,806	11,626
		Listed hatchery intact adipose	145,410	5,176
		Listed hatchery clipped adipose	125,900	11,610
	Adult	Natural	788	48
		Listed hatchery intact adipose	168	10
		Listed hatchery clipped adipose	2,052	167
Puget Sound steelhead	Juvenile	Natural	70,652	1,676
		Listed hatchery intact adipose	155	4
		Listed hatchery clipped adipose	7,082	250
	Adult	Natural	1,410	31
PS/GB Bocaccio	Adult	Natural	52 (31)[b]	49 (29)[b]
PS/GB Canary Rockfish	Adult	Natural	94 (91)[b]	46 (44)[b]
PS/GB Yelloweye Rockfish	Adult	Natural	74 (71)[b]	33 (31)[b]

a Lethal take is a subset of the total take for each species, as applicable.
b For year 2015.

Actual take levels associated with these activities are almost certain to be substantially lower than the permitted levels. There are two reasons for this. First, most researchers do not handle the full number of outmigrants (or adults) 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.

2.5 Effects of the Action on Species and Designated Critical Habitat

"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 CFR 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.

2.5.1 Puget Sound Chinook

2.5.1.1 Assessment Approach

In assessing the effects of harvest actions on the Puget Sound Chinook salmon ESU, NMFS first analyzes the effects on individual salmon populations within the ESU using quantitative analyses where possible (i.e., where a sufficiently reliable time series of data is available) and more qualitative considerations where necessary. Risk to the survival and recovery of the ESU is then determined by assessing the distribution of risk across the populations within each major geographic region and then accounts for the relative role of each population to the viability of the ESU).

The Viable Risk Assessment Procedure (VRAP) provides estimates of the maximum population-specific exploitation rates (called Rebuilding Exploitation Rates or RERs) that are thought to be consistent with survival and recovery of that population based on the assumptions made in deriving the rates for individual populations (Appendix B). In deriving the RERs, NMFS accounts for and makes conservative assumptions regarding management error, environmental uncertainty and parameter variability. NMFS has established RERs for 11 individual populations within the ESU and for the Nooksack Management Unit. The RERs are converted to FRAM-based (Fishery Regulation and Assessment Model) equivalents (Table 12) for the purposes of assessing proposed harvest actions, since FRAM is the analytical tool used to assess proposed fishery actions. Surrogate standards are identified for those populations where data are currently insufficient or NMFS has not completed population-specific analysis to establish RERs. Surrogates are based on similarities in population size, life history, productivity, watershed size, and hatchery contribution with other populations in the ESU for which RERs have been derived.

Table 12. Rebuilding Exploitation Rates by Puget Sound Chinook population. Surrogate RERs are italicized.

Region	Management Unit	Population	Rebuilding Exploitation Rate	FRAM-based Rebuilding Exploitation Rate
Strait of Georgia	Nooksack Early	N.F. Nooksack S.F. Nooksack	21%	23%
Whidbey/Main Basin	Skagit Spring	Upper Skagit River Lower Skagit River Lower Sauk River	54% 36% 33%	60% 51% 49%
	Skagit Summer/Fall	Upper Sauk River Suiattle River Upper Cascade	46% 50%	38% 41% 38-41%
	Stillaguamish	N.F. Stillaguamish River S.F. Stillaguamish River	45% 28%	30% 18%
	Snohomish	Skykomish River Snoqualmie	24%	18% 18%
South Sound	Lake Washington	Sammamish[a]		*30%*
		Cedar[a]		*30%*
	Green-Duwamish	Duwamish-Green	62%	46%
	White	White[b]		*23%*
	Puyallup	Puyallup[c]		*33-46%*
	Nisqually	Nisqually[c]		*33-46%*
Hood Canal	Mid-Hood Canal	Mid-Hood Canal[d]		*18-23%*
	Skokomish	Skokomish	36%	33%
Strait of Juan de Fuca	Dungeness Elwha	Dungeness[b] Elwha[b]		*23%* *23%*

[a]Uses North Fork Stillaguamish RER as a surrogate for the Cedar (30%) and the Sammamish given similarity of current abundance and escapement trends.
[b] Uses Nooksack early Chinook as surrogate.
[c] Uses range encompassing Skokomish (33%) and Green River (46%) as surrogates.
[d] Uses range including Nooksack early Chinook (23%) and South Fork Stillaguamish (18%) as surrogates.

Although component populations contribute fundamentally to the structure and diversity of the ESU, it is the ESU, not an individual population, which is the listed species under the ESA. NMFS uses the FRAM-equivalent RERs, and the critical and rebuilding escapement thresholds[10]

[10] After taking into account uncertainty, the critical threshold is defined as a point below which: (1) depensatory 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 due to demographic stochasticity becomes a substantial source of risk (NMFS 2000b). The rebuilding threshold is defined as the escapement that will

in addition to other relevant information and the guidance described below to assist it in evaluating the effects of the proposed actions on survival and recovery of the populations within the ESU.[11] The rates that would result from the proposed fisheries are compared to the relevant RERs. Generally speaking, where estimated impacts of the proposed fisheries are less than or equal to the RERs, NMFS considers the fisheries to present a low risk to that population (NMFS 2004c). However, the RERs for individual populations are not jeopardy standards.

The risk to the ESU associated with an individual population not meeting its RER must be considered within the broader context of other information such as guidance on the number, distribution, and life-history representation within the regions and across the ESU; the role of associated hatchery programs; observed population status, and trend; and the effect of further constraints on the proposed action. Derivation of an RER is based on conservative assumptions regarding environmental conditions, and uncertainty in management performance and population dynamics based on observed patterns over a 25 year period (Appendix B). The objectives of the RER are to achieve escapement levels consistent with the rebuilding threshold and minimize escapements below the critical threshold over a given time frame. The VRAP model identifies the RER that meets specific probabilities based on these assumptions when compared with the same conditions and no harvest. The RER analyses are updated on a regular basis to incorporate the most recent information, and assumptions are made conservatively (e.g., assuming low marine survival) to protect against overly optimistic future projections of population performance. However, the observed data may indicate that the population status or environmental conditions are actually better than the conservative assumptions anticipated in the RER derivation. For example, the observed information may indicate that marine survival is better than assumed or that a population's escapement has achieved its rebuilding threshold under exploitation rates higher than the RER. Therefore, it is important to consider the anticipated exploitation rates and escapements relative to the RERs and thresholds, and the observed information on population status, environmental conditions, and exploitation rate patterns. A population will be identified in this opinion as having an increased level of risk[12] when the expected escapement of that population does not meet its critical threshold. We will then examine the effects of the Proposed Actions on the status of the populations and the degree to which the effects contribute that that status.

The Supplement to the Puget Sound Recovery Plan and the Puget Sound TRT provides general guidelines for assessing recovery efforts across individual populations within Puget Sound and determining whether they are sufficient for delisting and recovery of the ESU (NMFS 2006a, Ruckelshaus 2002). As described in section 2.2.1.1, an ESU-wide recovery scenario should include at least two viable Chinook salmon populations in each of the five geographic regions

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achieve Maximum Sustained Yield (MSY) under current environmental and habitat conditions (NMFS 2000b). Thresholds were based on population-specific data where available.

[11] For most populations, the rebuilding thresholds are well below the escapement levels associated with recovery, but achieving these goals under current conditions is a necessary step to eventual recovery when habitat and other conditions are more favorable. Therefore, NMFS has evaluated the future performance of populations in the ESU under recent productivity conditions; i.e., assuming that the impact of hatchery and habitat management actions remain as they are now.

[12] When compared to a population otherwise at or above its critical threshold.

identified within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region (NMFS 2006a, Ruckelshaus 2002). Unlike other ESUs (e.g., Lower Columbia River (NMFS 2012b)), however, the Puget Sound Recovery Plan and TRT guidance did not define the role of each population to the survival and recovery of the ESU which is important in assessing the distribution of risk from specific proposed actions in such a complex ESU. Therefore, NMFS developed the Population Recovery Approach (PRA; see section 2.2.1.1) to use as further guidance in its consultations. Guidance from the TRT, the Supplement, and the PRA provide the framework to assess risk to the Puget Sound Chinook salmon ESU. The distribution of risk across populations based on the weight of information available in the context of this framework is then used in making the jeopardy determination for the ESU as a whole.[13] For a more detailed explanation of the technical approach see NMFS (2000b) and NMFS (2004c and 2011).

In addition to the biological information, NMFS' federal trust responsibilities to treaty Indian tribes are also considered in NMFS' conclusions. In recognition of treaty right stewardship, NMFS, as a matter of policy, has sought not to entirely eliminate tribal harvest (Secretarial Order 3206). Instead, NMFS' approach is to accept some fisheries impacts that may result in increased risk to the listed species in order to provide limited tribal fishery opportunity. This approach recognizes that the treaty tribes have a right and priority to conduct their fisheries within the limits of conservation constraints (Garcia 1998). Because of the Federal government's trust responsibility to the tribes, NMFS is committed to considering the tribal co-managers' judgment and expertise regarding conservation of trust resources. However, the opinion of the tribal co-managers and their immediate interest in fishing must be balanced with NMFS' responsibilities under the ESA. The discussion in the following section summarizes the results of the impact analysis of the proposed actions across populations within each of the five major bio-geographical regions in the ESU.

2.5.1.2 Effects on the Species

Effects of the Proposed Actions on listed species occur through implementation of the Puget Sound salmon fisheries (including U.S. Fraser Panel fisheries) and associated research as described earlier (see sections 1.2 and 1.3). Escapements and exploitation rates expected to result from these fisheries during May 1, 2014 through April 30, 2015 are summarized in Table 13. Exploitation rates are reported by management units and escapements by populations based on the information that the FRAM model provides. Impacts in PST and PFMC fisheries are included in actions previously consulted on by NMFS (2004a, NMFS 2008b) and are therefore part of the Environmental Baseline (see Section 2.4.1). However, the harvest objectives proposed by the co-managers to manage Puget Sound Chinook take into account impacts in these other fisheries. Thus, Table 13 represents the sum of fishing-related mortality anticipated under the proposed action together with that approved under the existing PFMC and PST consultations. Also included in Table 13 are the RERs and critical and rebuilding thresholds discussed above that NMFS uses as some of the benchmarks to evaluate the effects of the proposed actions on

[13] NMFS has used RERs as part of its assessment of proposed harvest actions on the Puget Sound Chinook ESU in biological opinions and application of take limits under the ESA 4(d) Rule since 1999 (NMFS 1999b, NMFS 2000d, NMFS 2001c; NMFS 2003b; NMFS 2005c; NMFS 2008b), NMFS 2010b).

survival and recovery of populations within the ESU. For management units comprised of multiple populations, Table 13 provides the range of RERs associated with the populations within that management unit. For example, the range of RERs summarized for the Skagit Spring Management Unit represents the Suiattle (38%) and the Upper Sauk (41%).[14] All of the population specific RERs are shown in Table 12.

NMFS' critical and rebuilding escapement thresholds represent natural-origin spawners. However, long-term time series of data on the contribution of natural-origin fish to escapement are limited for all Puget Sound populations; particularly those historically dominated by hatchery production. The co-managers are refining abundance forecasts and modeling tools like the FRAM as better information becomes available. Several historically hatchery-dominated populations are transitioning to natural-origin management and, for others, hatchery production will continue to contribute significantly to escapement depending on their role in ESU recovery.

Consequently, the preseason expectations of natural-origin escapements compared to the escapement thresholds in Table 13 were derived from several sources and represent a variety of different levels of hatchery contribution depending on the available information. NMFS expects the treatment of escapements to become more refined over time as information improves, as decisions are made regarding the treatment of hatchery- and natural-origin fish in an individual watershed, and as the role of individual populations in ESU recovery becomes better defined.

Test, research, update, and evaluation fisheries that inform fishery management decisions are included as part of the fishery-related mortality in FRAM model run Chin2814 and included in the estimates of exploitation rates discussed in the following paragraphs. These activities are therefore part of the actions addressed in this opinion. Other research activities informing Puget Sound salmon fishery management are permitted under section 7 of the ESA or Limit 7 of the 4(d) Rule and are part of the Environmental Baseline.

[14] Data were insufficient to develop a RER for the Upper Cascade population; the third population in the Skagit Spring Management Unit.

Table 13. FRAM adult equivalent exploitation rates in 2014 ocean and Puget Sound fisheries and escapements expected after these fisheries occur for Puget Sound management units compared with their RERs and escapement thresholds (surrogates in *italics*). Outcomes expected to exceed RERs or fall below critical escapement thresholds are bolded.

Region	Management Unit	Ocean (PST, PFMC)	Puget Sound	Ocean + Puget Sound	RER or RER surrogate
Georgia Basin	Nooksack early	29.8%	5.3%	**35.1%**	23%
Whidbey/ Main Basin	Skagit spring	15.2%	17.7%	32.8%	38-41%
	Skagit summer/fall	24.5%	18.1%	42.6%	49-60%
	Stillaguamish	13.1%	5.2%	18.3%	18-30%
	Snohomish	14.0%	6.4%	**20.3%**	18%
Central/South Sound	Lake Washington	24.5%	15.5%	**40.0%**	*30%*
	Duwamish-Green	24.5%	8.2%	32.7%	46%
	R	2.9%	16.3%	19.3%	*23%*
	White River	24.5%	25.1%	**49.5%**	*33-46%*
	Puyallup River	23.8%	28.2%	**52%**	*33-46%*
	Nisqually River				
Hood Canal	Mid-Hood Canal R.	19.9%	6.6%	**26.5%**	*18-23%*
	Skokomish River	19.8%	30.0%	**49.8%**	33%
Strait of Juan de Fuca	Dungeness River	53.7%	2.6%	**56.3%**	*23%*
	Elwha River	53.0%	2.1%	**55.1%**	*23%*

Escapement		Natural (HOR+NOR)	NOR	Critical	Rebuilding
Georgia Basin	Nooksack Management Unit		**260**		500
	NF Nooksack (early)	NA	**176**	*200*	-
	SF Nooksack (early)	NA	**85**	*200*	-
Whidbey/ Main Basin	Upper Skagit River (moderately early)	11,866	11,606	967	7,454
	Lower Sauk River (moderately early)	649	649	200	681
	Lower Skagit River (late)	2,556	2,556	251	2,182
	Upper Sauk River (early)	635	635	130	330
	Suiattle River (very early)	300	300	170	400
	Upper Cascade River (moderately early)	308	308	170	*1,250*
	NF Stillaguamish R. (early)	1,129	682	300	552
	SF Stillaguamish R. (moderately early)	233	**141**	*200*	300
	Skykomish River (late)		2,790	1,650	3,500
	Snoqualmie River (late)		1,637	400	*1,250*
Central/South Sound	Cedar River (late)	654	545	*200*	*1,250*
	Sammamish River (late)	944	**96***	*200*	*1,250*
	Duwamish-Green R. (late)	2,746	1,502	835	5,523
	White River (early)	1,516	785	*200*	1,100
	Puyallup River (late)	1,683	620	*200*	522
	Nisqually River (late)	3,542	896	*200*	1,200
Hood Canal	Mid-Hood Canal Rivers (late)	469	469*	*200*[3]	*1,250*
	Skokomish River (late)	1,544	1,544*	452	1,160
Strait of Juan de Fuca	Dungeness River	287	**127**	*200*	925
	Elwha River	5,518	303	*200*	*1,250*

Source: FinalChin2814.xls (L. Lavoy, pers. comm., April 10, 2014). Model output escapements adjusted to reflect natural-origin (NOR) or natural (hatchery-origin (HOR)+NOR) escapement as closely as possible using FRAM 2814 inputs, preseason forecasts or postseason data from previous years; those not reported directly from FRAM are underlined.

*Information not available to assess 2014 natural origin escapement for the Mid-Hood Canal or Skokomish populations. Previous postseason reports indicate NOR Chinook contribute approximately 65% (Mid-Hood Canal) and 38% (Skokomish) to natural escapement for these populations since 2004. Sammamish escapement based on 2004-2013 contribution to Lake Washington natural-origin escapement.

Georgia Basin: There are two populations within the Strait of Georgia Basin: the North Fork Nooksack River and the South Fork Nooksack River early Chinook salmon populations (Figure 2). Both are classified as PRA Tier 1 populations and both are essential to recovery of the Puget Sound Chinook ESU (NMFS 2006a). The two populations form the Nooksack Early Management Unit.

Natural-origin average escapement is near the critical threshold for the North Fork Nooksack and well below the critical threshold for the South Fork Nooksack (Table 3) indicating additional risk for this stock. Natural-origin escapement estimates are unavailable since 2011, but parent brood escapements contributing to 2012 and 2013 returns were very low (<50 spawners) so the actual average NOR escapement to the South Fork may be even lower than shown in Table 3. When hatchery-origin spawners are included, average spawning escapement of both populations is significantly higher. Hatchery contribution to natural escapement from the conservation program at the Kendall Creek Hatchery on the North Fork Nooksack is significant (North Fork average NOR=215, North Fork average NOR+HOR=1,550; Table 3) and these fish retain the native profile of North Fork Nooksack early Chinook. The Kendall Creek program is intended to assist in recovery of the North Fork Nooksack population by contributing to spawning escapement, thus increasing escapements and potentially productivity in order to buffer risks while necessary improvements in habitat occur. Total natural escapement to the South Fork Nooksack is also higher (South Fork average NOR=55, South Fork average NOR+HOR=399; Table 3) although most of the additional spawners are strays from the North Fork Nooksack and do not retain the South Fork Nooksack early Chinook native profile and likely do not provide the same buffer against risk. However, an aggressive captive brood stock program to enhance returns of native South Fork Nooksack Chinook began in 2007 and is essential to preservation of the population. The first substantial adult returns that will contribute to escapement are expected in 2015 or 2016 (A. Chapman, pers. comm. 2013).

Productivity (recruits/parent spawners) is 0.7 for the North Fork and 1.0 for the South Fork (Table 3). Productivity analyses indicate a relative lack of response in terms of natural-origin production given the much higher total natural escapements described in the above paragraph (NF=1.04 growth rate of recruitment, SF=1.01 growth rate of recruitment; Table 4). The trend for natural escapement is unclear for the South Fork population (Table 4). The growth rate for natural-origin escapement is higher than the growth rate for natural-origin recruitment (Table 4). This indicates that sufficient fish are escaping the fisheries to maintain or increase the number of spawners relative to the parent generation, providing some stabilizing influence for abundance and reducing demographic risks. However, the number of recruits produced per spawner remains low indicating that habitat conditions are limiting the populations' ability to grow. The combination of these factors suggests that natural-origin productivity and abundance will not increase much beyond existing levels unless constraints limiting marine, freshwater, and estuary survival for the Nooksack early populations are alleviated (NMFS 2005c and 2008b, PSIT and

WDFW 2010a). Exploitation rates during 2008-2010 averaged 23% (total) and 4% (southern U.S.(SUS))(Table 9), consistent with the RER and below the SUS exploitation rate ceiling of 7% in place during that time. Eighty-three percent of the harvest occurred in Alaska and Canadian fisheries (Table 9).

The anticipated total exploitation rate in 2014 is well above the RER for the management unit, although the exploitation rate for 2014 Puget Sound salmon fisheries is expected to be very low, i.e., 5.3% (Table 13). The exploitation rate in all southern U.S. fisheries is expected to be 6.3%. Under the proposed actions, both populations are anticipated to be below their critical thresholds (Table 13), which is cause for concern, but total natural escapements are anticipated to remain higher in 2014 given recent year hatchery-origin contribution rates. Net, troll, and recreational fisheries in Puget Sound are regulated to minimize incidental Chinook mortality while maintaining fishing opportunity on other species such as sockeye and summer/fall Chinook. Conservation measures aimed at reducing spring Chinook harvest in the Strait of Juan de Fuca, northern Puget Sound and the Nooksack River have been in place since the late 1980‘s. There have been no directed commercial fisheries on Nooksack spring Chinook in Bellingham Bay or the Nooksack River since the late 1970s. Incidental harvest in fisheries directed at fall Chinook in Bellingham Bay and the lower Nooksack River was reduced in the late 1980's by severely reducing July fisheries. Commercial fisheries in Bellingham Bay that target fall Chinook have been delayed until August for tribal fishers, and mid-August for non-treaty fishers. Since 1997, there have been very limited ceremonial and subsistence fisheries in the lower river in May and early July. Beginning in 2008, the July fishery was discontinued entirely, and a portion of the ceremonial and subsistence fishery was shifted to the lower North Fork as additional conservation measures to further limit the potential harvest of the South Fork early Chinook population (PSIT and WDFW 2010a). These protective measures are proposed to continue in 2014 as part of the Proposed Actions (Grayum and Anderson 2014, Speaks 2014, WDFW and NWIFC 2014). The proposed extension of the in-river ceremonial and subsistence (C&S) fishery in 2014 to June 15 would rely on inseason monitoring and an assessment of impact to the population (Grayum and Anderson 2014, Speaks 2014a, WDFW and NWIFC 2014). Eighty-five percent of the harvest in Puget Sound fisheries occurs in tribal treaty fisheries (FRAM 2814). If Puget Sound salmon fisheries closed in 2014, we estimate that an additional 12 and 6 natural-origin spawners would return to the North and South Fork Nooksack early Chinook escapements, respectively (NMFS 2014c). Therefore, further constraints on 2014 Puget Sound fisheries would not provide substantive benefits to either population by providing sufficient additional spawners to significantly change its status or trends than what would occur without the fisheries.

In summary, the status of the populations given their role in recovery of the ESU is cause for concern; particularly for the South Fork Nooksack population. However, information suggests that past harvest constraints have had limited effect on increasing escapement of returning natural-origin fish, when compared with the return of hatchery-origin fish, and further harvest reductions in 2014 Puget Sound fisheries would not accrue meaningful benefits for either

Nooksack population. Total natural escapements are anticipated to remain higher in 2014 given recent year hatchery-origin contribution rates. The Kendall Creek hatchery program retains the native profile of the North Fork Nooksack early Chinook. The South Fork Nooksack Chinook captive broodstock program is also essential to preservation of the population. The first substantial adult returns that will contribute to escapement are expected in 2015 or 2016. Both programs are key components in recovery of the Nooksack early Chinook populations and should buffer demographic and genetic risks while improvements in habitat occur. In 2014, 85 percent of the harvest of Nooksack early Chinook in Puget Sound fisheries is expected to occur in tribal fisheries; primarily in C&S fisheries. The co-managers propose actions to minimize impacts to Nooksack early Chinook, particularly the South Fork population, and past patterns indicate exploitation rates under the proposed action are likely to be lower than anticipated.

Whidbey/Main Basin: The ten Chinook salmon populations in Whidbey/Main Basin region are genetically unique and indigenous to Puget Sound. These areas are managed primarily for natural-origin production. The six Skagit populations are in PRA Tier 1, the Stillaguamish and Skykomish populations are in PRA Tier 2 and the Snoqualmie population is in PRA Tier 3 (Figure 2, Table 12). NMFS has determined that the Suiattle and one each of the early (Upper Sauk, North Fork Stillaguamish), moderately early (Upper Skagit, Lower Sauk, Upper Cascade, South Fork Stillaguamish), and late (Lower Skagit, Skykomish, Snoqualmie) life history types will need to be viable for the Puget Sound Chinook ESU to recover (NMFS 2006a). The ten populations comprise four management units: Skagit Spring (Suiattle, Upper Cascade and Upper Sauk), Skagit Summer/Fall (Upper Skagit, Lower Skagit and Lower Sauk), Snohomish (Skykomish and Snoqualmie) and Stillaguamish (North Fork Stillaguamish and South Fork Stillaguamish). Hatchery contribution to natural escapement is extremely low in the Skagit system and moderate in the Snohomish and Stillaguamish systems (Table 3).

Natural-origin average escapement is above rebuilding thresholds for four populations (Upper Skagit summer, Upper Sauk, North Fork Stillaguamish and Snoqualmie), below the critical threshold for the South Fork Stillaguamish and in between for the remaining populations (Table 3). Productivity is 1.0 or more for seven of the 10 populations (Table 3) although longer term trends indicate declining trends in recruitment for all but the Snoqualmie population (Table 4). Trends in natural escapement are generally stable or increasing and growth rates for natural-origin escapements are higher than the growth rate for recruitment (Table 4). This indicates that sufficient fish are escaping the fisheries to maintain or increase the number of spawners from the parent generation; providing some stabilizing influence for abundance and reducing demographic risks. The critical abundance status, low productivity, and declining escapement and growth trends for the South Fork Stillaguamish population indicate additional concern for this population. Average observed exploitation rates during 2008-2010 ranged between 17 and 50% (total) and 7 to 21% (SUS)(Table 9), generally consistent with the RERs and below the SUS exploitation rate ceilings in place during that time (Table 9). About 50 percent of the harvest occurred in Alaska and Canadian fisheries.

Under the proposed actions, nine of the 10 populations in the region are expected to exceed their critical thresholds and five to exceed their rebuilding thresholds (Table 13) in 2014. The South Fork Stillaguamish population is expected to remain below its critical threshold. Including the effects of the proposed actions, total exploitation rates for two of the four management units (Skagit spring, Skagit summer/fall; representing six populations) and the North Fork Stillaguamish population are below the RERs for the populations in those watersheds (Tables 12 and 13). Therefore, NMFS considers the proposed actions to present a low risk to those populations. The South Fork Stillaguamish population is within 0.3% in meeting its RER and the Snohomish Management Unit is 2.3% points above the RER for the populations in that unit. The exploitation rates in 2014 Puget Sound fisheries are expected to be low to moderately low across the four management units (5-18.1%)(Table 13).

In summary, the effects of the proposed actions in 2014 will meet the recovery plan guidance for two to four populations representing the range of life histories displayed in the region at low risk, including those specifically identified as needed for recovery of the Puget Sound Chinook ESU. The Whidbey/Main Basin Region is a stronghold of Chinook production in the ESU. Most populations in the region are doing well relative to abundance criteria and RERs, representing a diversity of healthy populations in the region as a whole. The stable escapement trends and, in particular, the relatively robust status of the populations compared with their thresholds should mitigate any increased risk as a result of exceeding the RER in one year for the Snohomish Management Unit. In addition, the late life history type exhibited by the Snohomish populations is also represented by the Lower Skagit River which is expected to be well below its RER. The continued critical status and trends for the South Fork Stillaguamish is a cause for concern. However, the moderately early life history type exhibited by the South Fork Stillaguamish population is represented by three other healthier populations in the region which are expected to be below their RERs.

Central/South Sound: There are six populations within the Central/South Sound Region (Figure 2). Most are genetically similar, likely reflecting the extensive influence of transplanted hatchery releases, primarily from the Duwamish-Green River population. Except for the White River, Chinook populations in this region exhibit a fall type life history and were historically managed primarily to achieve hatchery production objectives. The White River spring and Nisqually Chinook salmon population are in PRA Tier 1. The Duwamish-Green population is in PRA Tier 2, and the Cedar, Sammamish and Puyallup populations are in Tier 3. The six populations comprise five management units: Lake Washington (Cedar and Sammamish), Duwamish-Green, White, Puyallup, and Nisqually. Hatchery contribution to spawning escapement is moderate to high for the populations within this region (Table 3). NMFS determined the Nisqually and White River populations must be at low extinction risk to recover the ESU (NMFS 2006a). The Nisqually population will need to transition to natural-origin management over time, as it is considered essential to recovery of the ESU.

The basins in the Central/South Sound region are the most urbanized and some of the most degraded in the ESU. The lower reaches of all these system flow through lowland areas that have been developed for agricultural, residential, urban, or industrial use. Much of the watersheds or migration corridors for five of the six populations in the region are within the cities of Tacoma or Seattle or their metropolitan environments (Sammamish, Cedar, Duwamish-Green, Puyallup and White). Natural production is limited by stream flows, physical barriers, poor water quality, elimination of intertidal and other estuarine nursery areas, and limited spawning and rearing habitat related to timber harvest and residential, industrial, and commercial development. The indigenous population in all but the Duwamish-Green River and White Rivers have been extirpated and the objective 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 readapt to the existing conditions.

Except for the Sammamish population, current average natural-origin escapements are well above their critical thresholds, and escapements in the White and Puyallup Rivers exceed their rebuilding thresholds (Table 3). When hatchery-origin spawners are taken into account, current average escapement for the Nisqually also exceeds its rebuilding threshold. Productivity is 1.0 or more for four of the six populations (Table 3) and longer term growth rates are also positive for three of those four populations (three of the six populations in the region)(Table 4). Growth rates for recruitment and escapement are declining for the Sammamish, Nisqually, and Puyallup populations (Table 4). The White River population has the strongest escapement trend and growth rates within the ESU (Table 4). As with populations in other Puget Sound regions, the growth rates for escapement are generally higher than growth rates for recruitment. The fact that growth rates for escapement (i.e., fish through the fishery) are greater than growth rates for return (i.e., abundance before fishing) indicates some stabilizing influence on escapement from past reductions in fishing-related mortality. These reductions have led to higher escapements than would otherwise have occurred. The combination of declining growth rates, low productivity, and, for the Sammamish, low natural-origin escapement suggest that the Puyallup and Sammamish populations are at higher risk for survival and recovery than other populations in the region. However, total spawning escapement remains strong when compared to their rebuilding thresholds (Table 3). Average observed exploitation rates during 2008-2010 ranged between 18 and 78% (total) and 16 to 62% (SUS)(Table 9), generally above the RERs (Table 13). Overall, a larger proportion of the harvest of these populations occurs in SUS fisheries than for populations in other regions of Puget Sound; about 12 to 53 percent of the harvest occurred in Alaska and Canadian fisheries depending on the population.

Natural-origin spawning escapements in 2014 are expected to be between the critical and rebuilding thresholds for the Nisqually, Duwamish-Green and Cedar River populations, below critical for the Sammamish, and above the rebuilding threshold for the Puyallup and White River populations (Table 13). The additional contribution of hatchery spawners to natural escapement for most of these populations (Table 13) will mitigate demographic risk. The genetic risks related to the hatchery contributions are less clear, but except for the Duwamish-Green and White Rivers, the indigenous populations were extirpated and are being rebuilt using extant stock of Green River origin. Escapement trends are stable or increasing for all populations within the region except for the Green River, which is declining. In response to recent declines in escapements due to poor freshwater survival and unanticipated changes in spawning distribution, the co-managers have chosen to manage 2014 fisheries that impact the Green River population very conservatively as they investigate potential causes of the declines and consider whether changes in harvest strategy are appropriate (Grayum and Anderson 2014, Speaks 2014a). Although spawning escapement is anticipated to be above the level that would initiate the minimum fishing regime, the co-managers are proposing fisheries that are as restrictive as the minimum fishing regime for the Green River Chinook population i.e., no Chinook directed fisheries, limiting pre-terminal fisheries, later start dates for fisheries directed on other species (WDFW and NWIFC 2014). As a result, the total exploitation rate in 2014 is expected to be below its RER and the rate in Puget Sound fisheries is low (8.2%)(Table 13) indicating the risk to the population from the proposed action is low.

Exploitation rates in 2014 for three of the five management units are expected to exceed their RERs or RER surrogates for the populations in those units by moderate amounts (Lake Washington representing the Sammamish and Cedar populations, Puyallup, and Nisqually)(Table 13). The Cedar, Samammish and Puyallup populations are in PRA Tier 3 and the life histories of these populations is represented by other populations in the region that are in healthier condition. The observed stable growth trends and, in particular, the relatively robust current and anticipated status of the Cedar River population compared with its thresholds should mitigate increased risk possible as a result of exceeding the RER in one year. Exceeding the surrogate RERs for the Sammamish and Puyallup populations may result in some increased risk for the pace of adaptation of the local population. However, it is important to remember when assessing the risks to populations like these that there is no increased risk to the indigenous populations in these watersheds because they are extirpated and the Puyallup population is expected to remain above its rebuilding threshold under the 2014 fisheries. If the Puget Sound salmon fisheries closed in 2014 we estimate that an additional 18 natural-origin spawners would return to the Sammamish population. The number of recruits produced per spawner remains low indicating that habitat conditions are limiting the populations' ability to grow (Sammamish = 0.4, Puyallup = 0.9, Table 3). The low productivity of the watersheds given the much higher level of overall escapement (Tables 3 and 13) suggests natural-origin recruitment will not increase much beyond existing levels unless constraints limiting marine, freshwater, and estuary survival for these populations are alleviated.

For the Nisqually population, the anticipated exploitation rate in Puget Sound salmon fisheries is 28.2% for a total exploitation rate of 52% for the 2014 fishing season (Table 12). This rate exceeds its RER range of 33-46%. Exceeding the RER infers an increased risk to the survival and recovery of the Nisqually population which is experiencing declining growth rates in natural recruitment and escapement and low abundance of natural-origin escapement and is essential to the recovery of the ESU. However, it is important to consider the degree to which other factors and circumstances mitigate the risk. The 2014 total exploitation rate ceiling represents the latest step in a longer term commitment to reduced exploitation rates as part of a transitional strategy designed to reduce rates over time in concert with improvements in habitat and adjustments in hatchery operations (PSIT and WDFW 2010a, Nisqually Watershed Council 2011, Redhorse 2014, SSPS 2007). The indigenous population is extirpated and the objective 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 readapt to the existing conditions. The escapement trend of natural spawners is increasing and, in particular, growth rates for natural-origin escapement are slightly higher than growth rates for recruitment. This indicates that current fisheries management is providing some stabilizing influence to abundance and productivity; reducing demographic risks. In 2010, the co-managers implemented a stepped reduction regime in exploitation rates beginning with 65% that was to culminate in a 47% exploitation rate for the 2014 fishing season. However, analyses in 2013 concluded that exploitation rates predicted by FRAM during pre-season modeling result in lower rates when estimated using actual CWT recoveries; a more direct measure of exploitation rate (McHugh et al. 2013). Application of the results of this analysis indicated that the actual exploitation rate under the 56 percent exploitation rate objective implemented at the time (in 2013) was in fact already likely less than or equal to 47 percent. Implementation of the stepped reduction regime was proving more disruptive to the fisheries than originally anticipated so the co-managers proposed an additional intermediate step of 52% for 2014. Based on the analytical results, NMFS agreed to consider the FRAM-based objective of 52% for 2014 as part of the Proposed Action. The analysis discussed above related to bias in the FRAM estimates indicates that the actual exploitation rate will be less than 47% and thus is consistent with stepping down the harvest from 65% to 47%. This stepped-down harvest rate approach was included as part of the 2010 Puget Sound Chinook Harvest RMP that NMFS concluded would not jeopardize the ESU (NMFS 2011b). Work is currently ongoing to update the FRAM base period data which should ensure that fishery exploitation rates as estimated by FRAM are comparable to CWT-based estimates and to biologically based exploitation rate ceilings. The ceiling of 47% will be re-instated as the management objective when the FRAM upgrade is complete (Redhorse 2014). The FRAM base period upgrade should be completed for the 2015 or 2016 pre-season planning process. The co-managers have also committed to review the exploitation rate ceiling objective in collaboration with NMFS prior to completion of the FRAM upgrade process (Redhorse 2014).

Significant work is occurring in the Nisqually and its environs to improve and restore estuarine habitat through land acquisition, estuary improvement and similar projects. The timing and magnitude of changes in harvest that occur in the Nisqually watershed as part of a longer-term transitional strategy must be coordinated with corresponding habitat and hatchery actions and take into account the current status of the population. The transition will occur over years and perhaps decades as the habitat improves to support better production and the current population becomes locally adapted and less reliant on hatchery production to sustain it. Over the last 15 years, the co-managers have taken significant steps to transition from hatchery goal management to an exploitation rate ceiling approach for the Nisqually population based on impacts to unmarked Chinook. Concurrently, the co-managers installed a floating weir in an attempt to control the contribution of hatchery fish in the natural escapement as the population rebuilds. Unfortunately environmental conditions and operational challenges have thus far impeded success of the weir in limiting hatchery spawners. As part of the Proposed Action, in 2014, the co-managers are undertaking a critical evaluation of the weir program to determine: (1) how well the weir is working; (2) if it is not working as intended what additional actions can be taken to fix it; (3) what benchmarks should be used to measure effectiveness; (4) the long term prospects for successful operation of the weir (Redhorse 2014).

Given that the proposed actions are consistent with the longer term transitional strategy for recovery of the population described in the previous paragraphs, the trend in overall escapements, the escapement anticipated in 2014, and the additional actions being taken by the co-managers (Nisqually Watershed Council 2011, Redhorse 2014), the additional risks associated with exceeding the RER in the 2014 fishing year should not significantly effect the long-term persistence of the Nisqually Chinook population. Such a strategy is also consistent with NMFS' responsibility to balance its tribal trust responsibility and conservation mandates by achieving conservation benefits while reducing disruption of treaty fishing opportunity. Tribal fisheries are estimated to account for 78 percent of the harvest of Nisqually Chinook in 2014 Puget Sound salmon fisheries.

In summary, given the information and context presented above, the fishing regime represented by the proposed actions should adequately protect five (White, Cedar, Duwamish-Green, Puyallup and Nisqually) of the six populations in the Region. Therefore, implementation of the proposed 2014 fisheries will meet the recovery plan guidance of two to four populations representing the range of life histories displayed by the populations in that region at low risk including those specifically identified as needed for recovery of the Puget Sound Chinook ESU (White River and Nisqually). The Sammamish River may experience some increased risks to the pace of adaptation of the existing local stock given the current status of the natural-origin population. However, the native population has been extirpated and potential improvement in natural-origin production is limited by the existing habitat. The population is not essential for recovery of the Puget Sound Chinook ESU (PRA Tier 3) and both the life history and Green River genetic legacy of the population are represented by other healthier populations in the Central/South Sound Region.

Hood Canal: There are two populations within the Hood Canal Region: the Skokomish River and the Mid-Hood Canal Rivers populations (Figure 2). Each population forms a separate management unit. Both the Skokomish and Mid-Hood Canal Rivers populations are considered PRA Tier 1 populations. The original indigenous populations have been extirpated and hatchery contribution to natural escapement is significant for both populations, although available data for the Mid-Hood Canal population is limited (Table 3, Ruckelshaus et al. 2006). NMFS determined that both populations must be at low extinction risk to recover the ESU, so both populations will need to transition to natural-origin management over time.

The historical structure of the Hood Canal Chinook salmon population is unknown (Ruckelshaus et al. 2006). The largest uncertainty within the Hood Canal populations, as identified by the TRT, is the degree to which Chinook salmon spawning aggregations are demographically linked in the Hamma Hamma, Duckabush, and the Dosewallips rivers. The TRT identified two possible alternative scenarios to the one adopted for the Mid Hood Canal Rivers population. One is that the Chinook salmon in the Hamma Hamma, Duckabush, and Dosewallips were each independent populations (Ruckelshaus et al. 2006). Habitat differences do exist among these Mid-Hood Canal rivers. For example, the Dosewallips River is the only system in the snowmelt-transition hydroregion. The other scenario is that Chinook salmon spawning in the Hamma Hamma, Duckabush, and Dosewallips rivers were subpopulations of a single, large Hood Canal Chinook salmon population with a primary spawning aggregation in the Skokomish River. Only a few historical reports document Chinook salmon spawning in the mid-Hood Canal streams, which is consistent with one theory that they were not abundant in any one stream before hatchery supplementation began in the early 1900s. In addition the overall size of each watershed and the area accessible to anadromous fish are small relative to other independent populations (Ruckelshaus et al. 2006). Although the TRT ultimately identified two independent populations within Hood Canal Region (the Skokomish and Mid-Hood Canal rivers populations), the TRT noted that important components of the historical diversity may have been lost, potentially due, in part, to the use of transplanted Green River origin fish for hatchery production in the region (Ruckelshaus et al. 2006).

The two extant populations reflect the extensive influence of inter-basin hatchery stock transfers and releases in the region, mostly from the Green River (Ruckelshaus et al. 2006). Genetic analysis indicates no difference between fish originating from the hatchery and those spawning naturally in the river (Marshall 1999, Marshall 2000). Historically, low flows resulting from operation of the Cushman dams and habitat degradation of freshwater and estuarine habitat have adversely affected the Skokomish population. A settlement agreement in 2008 between the Skokomish Tribe and the dam operator resulted in a plan to restore normative flows to the river, improve habitat, and restore an early Chinook life history in the river using supplementation. Elements of the settlement agreement are complemented by additional actions proposed by the co-managers in 2014 as part of the Proposed Action (Redhorse 2014) to develop a late-timed fall Chinook stock that is better suited to the historic flow regime, reduced hatchery production and fishery adjustments. In addition, significant work is occurring to stabilize river channels, restore riparian forests, improve adult access to the South Fork Skokomish, and improve and restore estuarine habitat through land acquisition, levee breaching and similar projects (Skokomish and WDFW 2010, Redhorse 2014). The timing and magnitude of changes in harvest that occur in the Skokomish watershed as part of the longer-term transitional strategy must be coordinated with corresponding habitat and hatchery actions and take into account the current status of the population. The transition will occur over years and perhaps decades as the habitat improves to support better production and the current population becomes locally adapted and less reliant on hatchery production to sustain it. Over the last decade, the co-managers have transitioned from hatchery goal management to management for natural escapement, including an exploitation rate for unmarked (primarily natural origin) Skokomish Chinook of 50% beginning in 2010. This rate represents a 19% decrease in the total exploitation rate compared to the 2008-2010 average of 62%. Available information indicates fisheries have exceeded the ceiling in some recent years with rates likely in the low to mid 50 percents (L. LaVoy pers. comm. 2014). However, preliminary data indicate actions by the co-managers may have been successful in bringing the 2013 rate below the ceiling (L. LaVoy pers. comm. 2014).

Average natural-origin escapements for both populations are below their critical thresholds (Table 3). When hatchery-origin spawners are taken into account, average escapement for the Skokomish exceeds its rebuilding threshold (Table 3). Productivity is less than 1.0 (Table 3) and growth rates are declining, although the trend in natural escapement for the Skokomish is at least stable (Table 4). As with populations in other Puget Sound regions, the growth rates for escapement are generally higher than growth rates for recruitment (Table 4) indicating fisheries management seems to have had a stabilizing influence. Total average observed exploitation rates during 2008-2010 were 25 and 62 percent for the Mid-Hood Canal and Skokomish populations, respectively, both well above their RERs (Table 13). Southern U.S. exploitation rates during the same period averaged 11 and 48 percent for the Mid-Hood Canal and Skokomish River populations, respectively (Table 9). Alaska and Canadian fisheries accounted for 56 and 23 percent of the harvest of the Mid Hood Canal and Skokomish rivers populations (Table 9).

Escapement trends in the individual rivers comprising the Mid-Hood Canal rivers population have not varied uniformly. Since 1998, the spawning aggregation in the Hamma Hamma River has generally comprised the majority of the Mid-Hood Canal rivers population. In comparison, the other two rivers in the population have seen decreases in escapements during this same time period. Spawning levels have been below 10 and 20 fish since 2010 in the Duckabush and Dosewallips rivers, respectively.

Genetic analysis indicates the Hamma Hamma population is not distinct from spawners returning to the Skokomish Rivers or George Adams or Hoodsport hatcheries (Marshall 1999; Marshall 2000). The degree to which this is influenced by straying of Skokomish River Chinook in addition to the use of George Adams broodstock in the supplementation program is uncertain. Exchange among the Duckabush and Dosewallips stocks, and other Hood Canal natural and hatchery populations is probable although information is limited due to the very low escapements (PSIT and WDFW 2010a). Beginning in 2005, the co-managers increased mark rates of hatchery fish to distinguish them from natural-origin spawners in catch and escapement. The resulting information may provide better estimates of stray rates between the Mid-Hood Canal rivers and the Skokomish River system. Uncertainty about the historical presence of a natural population notwithstanding, current habitat conditions may not be suitable to sustain natural Chinook production. There is evidence to suggest that the changes in abundance were in part related to concurrent changes in marine net pen yearling Chinook hatchery production in the area, and therefore not indicative of changes in the status or productivity of the population per se. (Adicks 2010).

The TRT suggests that most of the historical Chinook salmon spawning in the Mid-Hood Canal rivers was "likely to [have] occurred in the Dosewallips River because of its larger size and greater area accessible to anadromous fish" (Ruckelshaus et al. 2006). However, production from the Hamma Hamma Fall Chinook Restoration Program, a hatchery-based supplementation program, contributes substantially to the Mid-Hood Canal rivers population. The goal of the restoration program is to restore a healthy, natural-origin, self-sustaining population of Chinook salmon to the Hamma Hamma River. This hatchery production is at least partially responsible for the recent increase in escapement observed in the Hamma Hamma River. From 2008 to 2012, on average 60% of the Chinook salmon spawning in the Hamma Hamma River were of hatchery origin (WDFW and PSTIT 2009; WDFW and PSTIT 2010, WDFW and PSTIT 2011a, WDFW and PSTIT, 2012a). The program may also buffer demographic risks to the Mid-Hood Canal Rivers population, particularly to the natural-origin spawning aggregate returning to the Hamma Hamma River (Jones 2006, NMFS 2004e).

Under the proposed actions, escapement for both populations are expected to exceed their critical thresholds (Table 13). However, hatchery spawners contribute substantially to escapement for both populations (Table 13). Total exploitation rates for both populations are expected to exceed their RER or RER surrogate (Table 13). In 2014 Puget Sound fisheries, 75 and 31 percent of the harvest is expected to occur in tribal treaty fisheries for the Skokomish and Mid-Hood Canal populations, respectively. For the Mid-Hood Canal population the exploitation rate in 2014 Puget Sound salmon fisheries is expected to be low (6.5%;Table 13). If Puget Sound salmon fisheries closed in 2014 we estimate only an additional 5 spawners would return to the Mid-Hood Canal population distributed among the three rivers and few of those would be natural-origin fish.

For the Skokomish population, the anticipated exploitation rate in 2014 under the Proposed Action from Puget Sound salmon fisheries is 30% with a total exploitation rate in 2014 of 50%. Exceeding the RER infers an increased risk to the survival and recovery of the Skokomish population which is experiencing declining growth rates in natural recruitment and escapement, low abundance of natural-origin escapement and is essential to the recovery of the ESU. Modelling suggests that a 50 percent exploitation rate if implemented over a 25 year period would represent a 50 percentage point decrease in the probability of a rebuilt Skokomish population compared with achieving the RER and a very small change (1 percentage point) in the probability that the population will fall below the critical level (NMFS 2011b). However, as discussed earlier, it is important to consider the degree to which other factors and circumstances mitigate the risk. The indigenous population is extirpated and the strategy for populations like the Skokomish as described in section 2.3.11 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 readapt to the existing conditions. The reductions in harvest that have occurred so far are a part of the longer-term transitional strategy that is being coordinated with corresponding habitat and hatchery actions (Skokomish and WDFW 2010, Redhorse 2014). As part of the proposed actions and in response to commitments in the 2010 Puget Sound Chinook Harvest RMP (PSIT and WDFW 2010a), the co-managers also developed a plan for late-timed Skokomish fall Chinook (Redhorse 2014). It includes initiation of a late-fall Chinook program to re-establish the historical run-timing that may be better suited to the in-river flow regime and watershed precipitation pattern while allowing for more robust fisheries on the extant earlier-timed population; reductions in George Adams hatchery production, fishery shaping to increase harvest of hatchery returns, and development of an adaptive management plan to assess performance of these actions. The plan is intended as an addendum to the draft Skokomish Recovery Plan (Skokomish and WDFW 2010) to complement the measures described there and for the 2008 settlement agreement as described previously. The escapement trend of natural spawners is at least stable and, in particular, growth rates for natural-origin escapement are slightly higher than growth rates for recruitment. This indicates that current fisheries management is providing some stabilizing influence to abundance and productivity; reducing demographic risks.

In summary, the status of the populations in the Hood Canal Region given their role in recovery of the ESU is cause for concern. The combination of declining growth rates, low productivity, and critical levels of natural-origin escapement suggest these populations are at high risk for survival and recovery. However, the indigenous populations no longer exist. The available information indicates further constraints on 2014 Puget Sound fisheries would have no substantive effect on the persistence of the spawning aggregations within the Mid-Hood Canal population by providing sufficient additional spawners to significantly change its status or trends than what would occur without the fisheries.. The general characteristics of the Mid-Hood Canal Rivers population, including genetic lineage, life history, and run timing, are also found in the Skokomish River population. The proposed actions are consistent with the longer term transitional strategy for recovery of the Skokomish population described in the preceding paragraphs, the trend in natural escapements is stable, the natural escapement anticipated in 2014 is consistent with that trend, and the co-managers have proposed additional actions to bolster recovery of the population. The fact that growth rates in natural-origin escapement exceed those for recruitment indicates that fisheries may provide some stabilizing influence to abundance and productivity; reducing demographic risks. When weighed against these factors, additional risks associated with exceeding the RER in 2014 should not significantly affect the long-term persistence of the Skokomish Chinook population. Such a strategy is also consistent with NMFS' responsibility to balance its tribal trust responsibility and conservation mandates by achieving conservation benefits while reducing disruption of treaty fishing opportunity. Tribal fisheries are estimated to account for 75 percent of the harvest of Skokomish Chinook in 2014 Puget Sound salmon fisheries. Nonetheless, progress in these areas should be closely watched given potential long-term effects on survival and recovery suggested by modelling and the recent year pattern of exceeding the exploitation rate ceiling.

Strait of Juan de Fuca: The Strait of Juan de Fuca Region has two watershed PRA Tier 1 populations including an early-timed population in the Dungeness, and a fall-timed population on the Elwha (Figure 2). Each population is managed as a separate management unit. NMFS determined that both populations must be at low extinction risk to recover the ESU. The status of both populations is constrained by significant habitat-related limiting factors that are in the process of being addressed. Survival and productivity of the Dungeness population are adversely affected by low flows from agricultural water withdrawals and by other land use practices (PSIT and WDFW 2010a, SSPS 2005a). Historically all but the lower 5 miles of the Elwha River was blocked to anadromous fish migration by two dams and the remaining habitat in the lower river was severely degraded. Ambitious plans to remove the dams and restore natural habitat in the watershed began in 2011. Dam removal is expected to be completed by fall 2014. Given the condition of salmon habitat in the watersheds and the significant disruption to the Elwha system as a result of dam removal, the conservation hatchery programs currently operating in the Dungeness and Elwha will be key to protecting for the near-term, and ultimately restoring the Chinook populations in the Strait of Juan de Fuca Region (Table 3). Productivity analyses have demonstrated a relative lack of response in terms of natural-origin production (Dungeness=1.08 growth rate of return, Elwha=0.95 growth rate of return, Table 4) which is consistent with other analysis that habitat and environmental factors within the watershed and in marine waters are limiting natural-origin recruitment (Ward et al. 2013).

The average natural-origin escapement for the both populations is estimated to be below their critical thresholds and productivity is likely less than 1.0 although direct estimates are not currently available for the Elwha population (Table 3). When hatchery-origin spawners are taken into account, average escapement exceeds the critical threshold for the Dungeness and the rebuilding threshold for the Elwha. The trend for natural escapement is stable or increasing for both populations (Table 4). The trends in growth rate are positive for the Dungeness and negative for the Elwha (Table 4). The conservation hatchery programs operating in the Dungeness and Elwha Rivers buffer demographic risks and preserve the genetic legacies of the populations as degraded habitat is recovered. Average observed exploitation rates during 2008-2010 were 41 and 42 percent (total) and 7 and 6 percent (SUS) for the Dungeness and Elwha River populations, respectively (Table 9), both well above the RERs (Table 13). However, over eighty percent of the harvest of both populations occurred in Alaska and Canadian fisheries (Table 9).

Under the proposed actions, escapement for the Elwha population is expected to be low but to exceed its critical threshold, and escapement for the Dungeness is expected to be below its critical threshold (Table 13). However, hatchery spawners contribute substantially to escapement for both populations (Tables 3 and 13). Total exploitation rates for both populations are expected to substantially exceed their RER surrogates and this is a concern given the challenges to the populations from other sectors. However, almost all of the harvest occurs outside the jurisdiction of the co-managers (Tables 9 and 13) and exploitation rates in 2014 Puget Sound salmon fisheries are expected to be very low, i.e., 2-3% (Table 13). If Puget Sound salmon fisheries closed in 2014 we estimate that only an additional 4 and 6 natural-origin spawners would return to the Dungeness and Elwha escapements, respectively. Therefore, further constraints on 2014 Puget Sound fisheries would not substantively effect the persistence of either population by providing sufficient additional spawners to significantly change its status or trends than what would occur without the fisheries.

2.5.1.3 Effects on Critical Habitat

Critical habitat is located in many of the areas where Puget Sound recreational and commercial salmon fisheries occur. However, fishing activities will take place over relatively short time periods in any particular area. The PCEs most likely to be affected by the Proposed Actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity that supports juvenile growth and mobility.

Most of the harvest related activities in Puget Sound occur from boats or along river banks, with most of the fishing activity in the marine and nearshore areas. The gear fishermen use include hook-and-line, drift and set gillnets, beach seines, and to a limited extent, purse seines. These types of fishing gear in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear and so would have a negligible effect on the PCEs. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area (NMFS 2004b). Also these activities would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries, i.e., recreational boating and marine species fisheries.

By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for the ESU. The proposed actions incorporate management for maximum sustainable spawner escapement and implementation of management measures to prevent over-fishing. Both of these actions have been recommended as ways to address the potential adverse effects of removing marine derived nutrients represented by salmon carcasses.

Trampling of redds during fishing has the potential to cause mortality of juvenile salmonids and to affect the structure and rugosity of juvenile habitat. Boat operation can result in stranding and mortality related to pressure changes in juveniles (PFMC 1999). Salmon fisheries are closed or fishing activities do not occur in freshwater areas in Hood Canal, North Puget Sound and the Strait of Juan de Fuca during peak spawning, rearing, and out-migration periods (Thom Johnson, pers. comm., WDFW, Fisheries Biologist, April 26, 2010). Notices are posted near fishing access areas by WDFW and the Washington State Parks, and news releases are distributed regularly by WDFW explaining responsible fishing behavior, including avoidance of spawning areas and damage to riparian areas (Thom Johnson, pers. comm., WDFW, Fisheries Biologist, April 26, 2010). The Puyallup and White River in South Puget Sound are closed to salmon fishing through much of Chinook salmon migration and spawning. These management measures should minimize redd or juvenile fish disturbance or change to habitat associated with the Proposed Actions. Therefore, there will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, water quantity and water quality from the Proposed Action. The Proposed Action will not affect the ability of critical habitat to remain functional or to retain the current ability for the PCEs to become functionally established and to serve the intended conservation role for the species.

2.5.2 Puget Sound Steelhead

2.5.2.1 Assessment Approach

As discussed in the Environmental Baseline (Section 2.3.1), available data on escapement of steelhead populations in Puget Sound are limited. Complete long-term time series of escapement and catch are available for zero out of the five Puget Sound summer run populations, four out of the twenty-five winter run populations, and one out of the five summer/winter run populations. Data are currently insufficient to provide a full run reconstruction of natural origin steelhead populations in order to assess exploitation and/or harvest rates on summer run steelhead populations as well as most summer/winter and winter run populations.

In its listing determination for Puget Sound steelhead, NMFS determined that the current harvest management strategy that eliminated the direct harvest of natural origin steelhead has largely addressed the threat of decline to the listed DPS posed by harvest (72 Fed. Reg.26722, May 11, 2007). The annual terminal (in-river) harvest rate on listed steelhead under the management strategy referenced in the listing determination averaged 4.2 percent for five winter run steelhead populations, and included an additional 325 adult steelhead taken in pre-terminal (marine) fisheries (NMFS unpubl. data 2010). NMFS previously concluded that the harvest regime in place at the time of the listing determination and the resulting impacts were not likely to jeopardize the continued existence of Puget Sound steelhead (NMFS 2010a, NMFS 2010b, NMFS 2011). Steelhead populations and associated harvest rates in the Puget Sound Steelhead DPS are similar and comparable to Columbia River steelhead populations and their associated harvest rates. In several biological opinions evaluating harvest rates for comparable Columbia River steelhead DPSs, NMFS also determined harvest would not jeopardize the DPSs and was not a risk factor (NMFS 2008f, NMFS 2008g, ODFW 2007). NMFS considers here new information related to the status, environmental baseline, cumulative effectives, and effects associated with the proposed actions. However, the available information continues to be quite limited. Since the status of Puget Sound steelhead has not changed significantly since the time of listing (Ford et al. 2011) and associated harvest rates are within those observed at the time of listing (Table 10), NMFS continues to use the conclusion of the listing determination and harvest impacts at that time as a benchmark for evaluating the effects of the proposed action.

2.5.2.2 Effects on Species

As discussed in the Environmental Baseline (Section 2.3.1), Puget Sound steelhead are caught in treaty and non-treaty fisheries in the marine and freshwater areas of the Sound. In marine areas, the majority of fisheries target salmon species other than steelhead. In freshwater areas, Puget Sound steelhead are caught in fisheries targeting both salmon and steelhead. Data are insufficient to determine the stock composition or run timing (i.e., summer, winter, or summer/winter run) of steelhead caught in pre-terminal marine fisheries, so while we are able to assess overall numbers of fish caught, we are not able to determine the impacts (e.g., harvest rates) on individual populations in marine areas. Although data in terminal areas are also very limited, steelhead caught in freshwater fisheries are assumed to be returning to their rivers of origin, so we are able to estimate impacts of these fisheries at the population level. Therefore, effects on steelhead are assessed separately for the two catagories of fisheries: (1) marine fisheries (i.e., pre-terminal); and (2) freshwater fisheries (i.e., terminal).

Marine Fisheries

The Proposed Action includes Puget Sound marine fisheries directed at Chinook, chum, coho, pink, and sockeye salmon which encounter listed summer, winter, and summer/winter steelhead populations. Encounters of steelhead in treaty marine commercial and ceremonial and subsistence (C&S) fisheries targeting other salmon species in the marine areas of Puget Sound are low. As summarized in the Environmental Baseline (Section 2.3.1), an annual average of 126 (hatchery and natural combined; range n = 7 – 266) summer, winter, and summer/winter run steelhead were landed incidentally in treaty marine fisheries from all Puget Sound marine areas combined during the 2001/2002 to 2006/2007 time period (NMFS unpubl. data 2010). An annual average of 53 (hatchery and natural combined; range n = 15 – 109) summer and winter steelhead were landed incidentally in treaty marine fisheries from all Puget Sound marine areas combined during the 2008/2009 to 2012/2013 time period (NMFS unpubl. data 2014a; W. Beattie pers. comm. 2014). Not all tribal catch is sampled for marks so these estimates represent catch of both ESA-listed natural steelhead, and unlisted and listed hatchery steelhead. Other sources of non-landed fishing mortality, such as net drop-out in gill nets, are not included in the estimate. Since the numbers of listed and unlisted steelhead encountered in marine fisheries is low, the net drop-out mortality rate is low (2%)(PSTIT and WDFW 2010b) and only a portion of those are caught in gill nets, the additional mortality from net drop-out would be very small.The total catch of steelhead (hatchery and natural combined) in treaty marine areas fisheries is anticipated to be similar to that observed during the more recent time period (i.e., 2008/09 to 2012/13) for the duration of the Proposed Action because the range of bycatch in recent years under various fishing regimes has been narrow (n=15-109) and the fishing regime under the Proposed Action will be similar to those that occurred in the more recent time period.

Encounters of steelhead in non-treaty commercial fisheries targeting other salmon species in marine areas of Puget Sound are rare. Regulations for non-treaty commercial net fisheries prohibit the retention and sale of steelhead (RCW 77.12.760, 1993). In an observer study by WDFW to estimate the incidental catch rate of steelhead in non-treaty commercial salmon fisheries, 20 steelhead were encountered in 5,058 net sets over an 18 year period (i.e., 1991 to 2008) (i.e., 1 fish annually) (J. Jording pers. comm. 2010). Over the most recent five year period from 2009 to 2013, 26 steelhead were encountered in 2,093 net sets estimated at 5 steelhead per year (K. Henry pers. comm. 2014). Incidental catch of steelhead is not sampled for marks so this estimate includes both listed natural, and listed and unlisted hatchery steelhead. Over the 23 year observer time period from 1991 to 2013, 92 steelhead were encountered in 14,302 net sets averaging 2 steelhead encounters annually; indicating that encounters of steelhead in non-treaty commercial fisheries remain rare (K. Henry pers. comm. 2014).

Encounters of steelhead in non-treaty marine recreational fisheries primarily directed at Chinook, coho, and pink salmon are low. Retention of marked, hatchery steelhead is allowed, but the total average annual landed catch is low. An annual average of 198 hatchery (range n = 102 – 352) summer, winter, and summer/winter steelhead were landed incidentally in non-treaty marine recreational fisheries from all Puget Sound marine areas combined during the 2003/04 to 2007/08 time period (R. Leland, pers. comm, 2010). An annual average of 132 hatchery (range n = 62 – 202) summer, winter, and summer/winter run steelhead were landed incidentally in non-treaty marine recreational fisheries from all Puget Sound marine areas combined during the 2008/2009 to 2012/2013 time period (E. Kraig, pers. comm. 2014). Three, unmarked, winter run steelhead were landed in 2010/2011 (WDFW and PSTIT 2011) as a result of illegal retentions. Encounters and incidental release mortality of natural steelhead are not quantified at this time (PSTIT and WDFW 2010b). In the pre-terminal (marine) catch areas, it is impossible to determine what proportion of steelhead come from individual listed natural, listed hatchery or unlisted hatchery steelhead populations. However, using a ten percent hooking mortality for marine recreational fisheries (PSTIT and WDFW 2010b), an average estimated 14 steelhead mortalities have occurred annually from 2003/2004 to 2010/2013.

In summary, under the Proposed Action an annual average of 190 steelhead will likely be taken in treaty and non-treaty marine fisheries (i.e., 53 non-treaty marine; 5 non-treaty commercial ; 132 non-treaty marine recreational). This annual estimate includes a mix of natural origin, and listed and unlisted hatchery fish and Canadian fish and compares to an estimate of 325 steelhead from the 2003/04 to 2007/08 time period. Since not all fish in marine area fisheries are sampled for marks, this annual estimate includes both encounters (fish that will be caught and released) and incidental mortality of listed natural and hatchery origin steelhead.

It would be useful to compare this catch estimate to the overall abundance of Puget Sound steelhead to provide perspective regarding the impact of the marine fisheries. Due to limited or insufficient data for nearly all Puget Sound steelhead populations, it is not possible to determine the total abundance of steelhead within the DPS. However, it is possible to provide a qualitative minimum estimate that includes numbers for those components of the DPS that are available. The resulting annual minimum average abundance of 22,361 steelhead includes listed and unlisted hatchery fish, and listed natural-origin fish based on fisheries data provided by co-managers (W. Beattie pers. comm. 2014, R. Leland pers. comm. 2014; A. Marshall pers. comm. 2014). The estimate includes total run size information for 5 out of the 32 steelhead populations (i.e., Skagit River summer/winter run; Snohomish winter run; Green winter run; Puyallup winter run; and Nisqually winter run). It also includes escapement estimates for 15 additional steelhead populations, although it does not include the associated catch data. The estimate does not include anything for 12 of the 32 listed populations or all fish that return to the hatchery racks for either the listed or unlisted hatchery programs. It also does not include anything related to Canadian steelhead populations that are also part of the mix of fish affected by marine area fisheries. Therefore, the estimate of 22,361is a partial and minimum estimate of the overall abundance of Puget Sound steelhead that are affected by marine area fisheries. Nonetheless, it provides some useful perspective about the likely impact of marine area fisheries. As discussed above, the recent year average catch in the combined marine area fisheries is 190 listed natural and listed and unlisted hatchery-origin steelhead. The catch in marine area fisheries in recent years is roughly half what it was at the time of listing, and is low compared to the estimate of overall abundance.

Freshwater Fisheries
The majority of harvest associated with the Proposed Action occurs in the terminal (i.e., freshwater) areas of Puget Sound and the Strait of Juan de Fuca. Terminal area treaty commercial fisheries targeting sockeye and spring Chinook in the Skagit River may catch natural origin winter steelhead kelts (i.e., repeat spawners) and summer steelhead. A small number of natural origin summer steelhead are also encountered in Nooksack River spring Chinook salmon fisheries. Treaty and non-treaty freshwater salmon fisheries directed at Chinook, coho and pink salmon are expected to have limited impacts to natural origin steelhead because they begin well after the peak of the winter and summer steelhead spawning period, and occur primarily in the lower to mid-mainstem river locations where listed summer steelhead are believed not to hold for an extended period (if present in the system), and fisheries conclude before significant numbers of winter steelhead arrive (PSTIT and WDFW 2010b).

NMFS used a subset of Puget Sound winter steelhead populations to calculate terminal harvest rates on natural steelhead. These are the only populations where necessary data is available to do harvest rate calculations. Nonetheless, we believe these populations are representative in the sense that terminal fisheries affecting other Puget Sound population are managed using similar regulations (i.e., gear, timing, etc). The subset of populations included: (1) Skagit River summer/winter run; (2) Snohomish River winter run; (3) Green River winter run; (4) Puyallup River winter run; and (5) Nisqually winter run (Table 13). Using the limited information available, NMFS calculated that the harvest rate on a subset of watersheds for natural-origin steelhead averaged 4.2 percent annually in Puget Sound fisheries during the 2001/2002 to 2006/2007 time period at the time of listing (NMFS unpubl. data, 2010). Harvest rates on the same subset of populations averaged 1.9 percent annually in Puget Sound fisheries during the 2007/2008 to 2012/2013 time period. These estimates include sources of non-landed release mortality such as hooking mortality and net dropout, 10 percent and 2 percent of total catch, respectively. Given the similarity of recent freshwater fisheries and the predominance of hatchery fish in Puget Sound anticipated for the 2014-15 fishery season, the anticipated catch of natural-origin Puget Sound steelhead in freshwater treaty and non-treaty fisheries is likely to reflect the 2007/2008 to 2012/2013 average incidental mortality for the five representative populations (i.e., approximately 1.9 percent), which is below the harvest rate estimate of 4.2 percent during the time of listing when NMFS determined that the current harvest management strategy that has eliminated direct harvest of natural-origin steelhead in Puget Sound has largely addressed the threat of decline to the listed DPS posed by harvest (72 Fed. Reg. 26722, May 11, 2007).

Table 13. Annual terminal harvest rate (HR) percentages (%) of natural origin steelhead take for a subset of Puget Sound winter steelhead populations for which catch and run size information are available (NMFS unpubl. Data 2014; WDFW and PSTIT 2011b; WDFW and PSTIT 2013; WDFW and PSTIT 2014, W. Beattie pers. comm. 2014).

Year	Steelhead Population				
	Skagit	**Snohomish**	**Green**	**Puyallup**	**Nisqually**
2001-02	4.2	8.0	19.1	15.7	N/C[a]
2002-03	0.8	0.5	3.5	5.2	N/C[a]
2003-04	2.8	1.0	0.8	2.2	1.1
2004-05	3.8	1.0	5.8	0.2	3.5
2005-06	4.2	2.3	3.7	0.8	2.7
2006-07	10.0	N/A[b]	5.5	1.7	5.9
Average HRs 01-07	**4.3%**	**2.6%**	**6.4%**	**4.3%**	**3.3%**
Total Average HR	**4.2%** total average harvest rate across populations from 2001-02 to 2006-07				
2007-08	5.9	0.4	3.5	1.0	3.7
2008-09	4.9	1.1	0.3	0.0	3.7
2009-10	3.3	2.1	0.4	0.0	1.2
2010-11	3.4	1.5	1.6	0.6	1.8
2011-12	2.9	0.9	2.0	0.4[c]	2.5[c]
2012-13	2.3	1.1[c]	2.4	0.7[c]	1.1[c]
Average HRs 08-13	**3.8%**	**1.2%**	**1.7%**	**0.5%**	**2.3%**
Total Average HR	**1.9%** total average harvest rate across populations from 2007-08 to 2012-13				

[a] Escapement methodology for the Nisqually River was changed in 2004; previous estimates are not comparable.
[b] Catch estimate not available in 2006-07 for Snohomish River.
[c] Preliminary catch estimates; subject to change.

Washington prohibits the retention of natural origin steelhead (those without a clipped adipose fin) in non-treaty recreational fisheries (PSTIT and WDFW 2010b). However, some fish die as a result of encounters with the gear or subsequent handling. Creel survey information indicates few encounters with steelhead occur annually in freshwater salmon recreational fisheries. Creel surveys conducted during salmon recreational fisheries from 2003 through 2012 show an estimated average fishing-related mortality[15] of 28 natural-origin summer, winter, and

[15] Hooking mortality associated with recreational fisheries is 10 percent of the marked steelhead encountered (listed and unlisted fish) (PSTIT and WDFW 2010).

summer/winter steelhead combined[16] annually (K. Ryding pers. comm. 2014). This estimate includes a 10 percent hooking mortality (PSTIT and WDFW 2010b). A comparable level of mortality is anticipated for the 2014/2015 fishery season based on the similarity of anticipated salmon fisheries under the proposed action and past creel survey results. The harvest rates shown in Table 10 for treaty and non-treaty freshwater salmon and steelhead fisheries include release mortality estimates associated with the freshwater recreational salmon fisheries.

Steelhead are also encountered during research, monitoring, and evaluation activities in terminal areas. The Pacific Salmon Commission (PSC) established the Sentinel Stocks Committee, and directed the committee to solicit research to improve escapement estimation methods for Chinook indicator stocks in British Columbia, Washington, and Oregon. The research activities conducted in Washington are operated under the Sentinel Stock program and other PSC-related research funding. Scientific research activities will catch an additional 52 natural origin steelhead annually during the proposed 2014/2015 fishery season. The incidental mortality associated with this research activity is not expected to exceed five natural steelhead annually.

Summary of Effects

Given the similarity of recent marine fisheries as compared to the proposed marine fisheries and the predominance of non-listed hatchery steelhead in Puget Sound anticipated for the 2014-15 fishery season, the anticipated catch of hatchery and natural-origin Puget Sound steelhead in marine treaty and non-treaty fisheries is 190. This is a little over half the number of fish caught in marine fisheries at the time of listing (325) and compares to the minimum estimate of Puget Sound steelhead abundance of 22,361.

Given the similarity of recent freshwater fisheries and the predominance of hatchery fish in Puget Sound anticipated for the 2014-15 fishery season, the anticipated catch of natural-origin Puget Sound steelhead in freshwater treaty and non-treaty fisheries is likely to reflect the 2007/2008 to 2012/2013 average incidental mortality for the five representative populations (i.e., approximately 1.9 percent), which is below the harvest rate estimate of 4.2 percent during the time of listing when NMFS determined that the current harvest management strategy that has eliminated direct harvest of natural-origin steelhead in Puget Sound has largely addressed the threat of decline to the listed DPS posed by harvest (72 Fed. Reg. 26722, May 11, 2007).[17]

In addition, no more than 52 natural origin Puget Sound steelhead will be encountered and no more than five natural steelhead are anticipated to be killed associated with implementation of the Pacific Salmon Treaty Sentinel Stock Program research activities.

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[16] Creel surveys provide a partial estimate of fishing mortality for a subset of Puget Sound salmon fisheries occurring in the Nooksack/Samish, Skagit, Snohomish/Stillaguamish, Green, Puyallup/White, Skokomish, and Dungeness Rivers.

[17] NMFS has not established the 4.2 percent associated with the management strategy referenced in the listing strategy as a jeopardy standard. Rather NMFS has concluded that it would not pose jeopardy, but has not defined what level of harvest above 4.2 percent would be jeopardy at this time. In addition, standards are expected to change over time consistent with changes in stock status and other information related to the DPS

As described in the Environmental Baseline (Section 2.3.1), data are insufficient to assess harvest rates among all other steelhead populations in freshwater fisheries (i.e., terminal areas) within Puget Sound. Based on the consistency in catch patterns in terminal areas from 2001/2002 to present, NMFS anticipates steelhead harvest in the remaining terminal areas for summer, winter, and summer/winter steelhead populations for which data are insufficient to assess harvest rates, also to be within the impacts to natural origin steelhead observed during the 2001/02 to 2006/07 time period during the 2014/15 fishery season. Co-managers will continue to strive to collect and improve catch accounting for these listed steelhead populations as funding and resources become available.

2.5.2.3 Effects on Proposed Critical Habitat

Critical habitat is located in many of the areas where Puget Sound recreational and commercial salmon fisheries occur. However, fishing activities will take place over relatively short time periods in any particular area. The PCEs most likely to be affected by the Proposed Actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity that supports juvenile growth and mobility.

Most of the harvest related activities in Puget Sound occur from boats or along river banks with the majority of the fishing activity occurring in the marine and nearshore areas. The gear that would be used includes hook-and-line, drift and set gillnets, beach seines, and to a limited extent, purse seines. If hooks, lines, or nets come in contact with the substrate or other habitat features, their capture efficiency is dramatically reduced. As a result, fishermen endeavor to keep gear from being in contact or entangled with substrate and habitat features because of the resultant interference with fishing and potential loss of gear and so would have a negligible effect on the PCEs. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area (NMFS 2004b). Also, these activities would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries (i.e., recreational boating and marine species fisheries).

Construction activities directly related to salmon fisheries are limited to maintenance and repair of existing facilities (such as boat launches), and are not expected to result in any additional impacts on riparian habitats. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for the DPS. The proposed actions incorporate management for maximum sustainable spawner escapement and implementation of management measures to prevent over-fishing. Both of these actions have been recommended as ways to address the potential adverse effects of removing marine derived nutrients represented by steelhead carcasses. Therefore, there will be minimal disturbance to vegetation, and negligible harm to spawning or rearing habitat, water quantity and water quality from the proposed actions. The proposed actions will not affect the ability of critical habitat to remain functional or to retain the current ability for the

PCEs to become functionally established and to serve the intended conservation role for the species.

2.5.3 Puget Sound/Georgia Basin Rockfish

We first assess the general effects of proposed fisheries on individual yelloweye rockfish, canary rockfish, and bocaccio. Next we assess the population-level effects. We analyze direct effects on listed rockfish in two steps. First, we estimate the number of listed rockfish likely to be caught in the salmon fishery 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. Throughout, we identify data gaps and uncertainties, and explain how we base assumptions in our analysis on the best available science.

Recreational and commercial salmon fishers use diverse equipment, with each gear type having a potentially different risk of incidentally catching (bycatch) yelloweye rockfish, canary rockfish, and bocaccio. Many recreational salmon anglers use downriggers that consist of cables and weights that deliver fishing gear to specific depths, mostly while trolling artificial lures. A smaller fraction of recreational salmon fishers, often referred to as 'moochers,' use one to six ounces of weight with herring as bait, and free-drift or slowly troll. Some anglers also use weighted artificial lures and free drift while jigging. Salmon and rockfish both consume some similar or identical prey items that include herring, sand lance, and smelt, making them vulnerable to the use of herring as bait and fishing lures imitating these prey items. As a result, anglers targeting salmon occasionally unintentionally hook yelloweye rockfish, canary rockfish or bocaccio. Between 2004 and 2008, recreational salmon anglers averaged nearly 350,000 trips annually (WDFW 2010). Though the frequency of Listed-rockfish bycatch by recreational salmon anglers is extremely low, the large numbers of angler trips nonetheless results in measurable incidental catches (described below).

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). There is also evidence that bycatch mortality reduction measures implemented across a variety of users do not perform as well as the experimental bycatch mortality reduction measures implemented by managers and scientists (Cox et al. 2007). A recent study of boat-based anglers in Puget Sound revealed that few anglers who incidentally captured rockfish released them at depth (approximately 3 percent), while a small number of anglers attempted to puncture the swim bladder (Sawchuk 2012), which could cause bacterial infections or mortality.

In our consultation on the WDFW Incidental Take Permit for the recreational bottom fish fishery in Puget Sound we were able to estimate the proportion of listed rockfish killed as a result of the state regulation limiting gear above 120 feet deep (consultation number F/NWR/2012/1984). This allowed us to use similar methods as the PFMC (2009) to estimate the mortality rate for yelloweye rockfish, canary rockfish, and bocaccio by fishermen targeting bottom fish. The recreational salmon fishery does not have a 120 foot rule, and thus we are not able to reliably estimate the proportion of fish caught at various depths, and therefore establish a proportional mortality rate for listed rockfish. In addition, there are large uncertainties with regard to survival of rockfish released at depth (Schroeder and Love 2002; Jarvis and Lowe 2008; Pribyl et al. 2009; Pribyl et al. 2011) and very few anglers in Puget Sound currently employ the practice. For these reasons we count all listed rockfish bycatch in the salmon fishery as mortalities, though it is likely that some fish will be caught in relatively shallow depths and survive.

Most commercial salmon fishers in the Puget Sound use purse seines and gill nets (WDFW 2010). A relatively small amount of salmon is harvested within the DPS by reef nets and beach seines. Gill nets and purse seines rarely catch rockfish of any species. From 1990 to 2008, no rockfish were recorded caught in the purse seine fishery (WDFW 2010). In 1991, one rockfish (of unknown species) was recorded in the gill net fishery, and no other fish were caught through 2008 (WDFW 2010). Low encounter rates may be attributed to a variety of factors. For each net type, the mesh size restrictions that target salmon based on size tend to allow juvenile rockfish to pass through. Gill net and purse seine operators also tend to avoid fishing over rockfish habitat, as rocky reef structures can damage their gear. In addition, nets are deployed in the upper portion of the water column away from the deeper water rockfish habitat, thus avoiding interactions with most adult rockfish. In the mid 1990's commercial salmon net closure zones were established in much of Puget Sound for seabird protection. Some of these closed areas overlap with rockfish habitat, reducing the potential for encountering rockfish. Specific areas are: (1) a closure of the waters inside the San Juan Islands, (2) a closure extending 1,500 feet along the northern shore of Orcas Island, and (3) a closure of waters three miles from the shore inside the Strait of Juan de Fuca (WDFW 2010).

The greatest risk to rockfish posed by gill nets and purse seines comes from the nets' inadvertent loss. Derelict nets generally catch on bottom structure such as rocky reefs and large boulders that are also attractive to rockfish (NRC 2007). Dead rockfish have been found in derelict nets because the net can continue to 'fish' when a portion of it remains suspended near the bottom and is swept by the current. Aside from killing fish, derelict nets alter habitat suitability by trapping fine sediments out of the water column, making a layer of soft sediment over rocky areas that changes habitat quality and suitability for benthic organisms (NRC 2007). This gear covers habitats used by rockfish for shelter and pursuit of food, and may thereby deplete food sources. For example, a study of several derelict nets in the San Juan Islands reported an estimated 107 invertebrates and 16 fish (of various species) entangled per day (NRC 2008). One net had been in place for 15 years, entangling an estimated 16,500 invertebrates and 2,340 fish (NRC 2008). Though these estimates are coarse, they illustrate the potential impacts of derelict gear on the DPS. In 2012 the state of Washington passed a law (Senate Bill 5661) requiring fishermen to report lost fishing nets within 24 hours of its loss, and has established a no-fault reporting system for lost gear. There are no devices installed on nets to track their location after they are lost, which complicates the recovery effort. In 2013 a NOAA-funded report was issued that assessed the reasons for gill net loss, best practices to prevent loss, and potential gear changes that may aid in the prevention of derelict nets (Gibson 2013).

Reef nets are deployed near rockfish habitat in the San Juan Islands, and are subject to the same area closures as gill nets and purse seines. Beach seines are used next to sandy or gravely beaches, and in each fishery all non-targeted fish are released. Because most adult yelloweye rockfish, canary rockfish, and bocaccio occupy waters much deeper than surface waters fished by reef nets and beach seines, the bycatch of adults is likely minimal to non-existent. Similarly, such nets are not likely to catch juvenile rockfish because they are small enough to pass through the mesh. Moreover, juvenile yelloweye rockfish, canary rockfish and bocaccio are unlikely to be caught in beach seines because the seines are generally not used along kelp areas where juvenile canary rockfish, and bocaccio tend to be found (WDFW 2010). If adult or juvenile yelloweye rockfish, canary rockfish and bocaccio were to be caught, the released fish would have a large chance of survival because they would not be brought to the surface from extreme depths thus avoiding barotrauma.

2.5.3.1 Bycatch Estimates and Effects on Abundance

Given the nature of the commercial salmon fisheries described above, we do not anticipate that any adult or juvenile yelloweye rockfish, canary rockfish, or bocaccio will be incidentally caught by actively fished nets. However, it is likely that some gill nets would become derelict gear near rockfish habitat and kill some listed rockfish, though we are unable to quantify the number of fish killed from new derelict nets.

All methods of recreational salmon fishing have the potential to encounter listed-rockfish. The WDFW estimates the annual bycatch of rockfish from anglers targeting salmon, halibut, bottom fish and ‘other’ marine fishes. There are a number of uncertainties regarding the WDFW recreational fishing bycatch estimates because: 1) they are based on dockside (boat launch) interviews of 10 to 20 percent of fishers, and anglers whose trips originated from a marina are generally not surveyed; 2) since rockfish can no longer be retained by fishermen, the surveys rely upon fishermen being able to recognize and remember rockfish released by species. Recent research has found the identification of rockfish to species is poor; only 5 percent of anglers could identify bocaccio, 12 percent canary, and 31 percent yelloweye in a study based throughout the Puget Sound (Sawchuck 2012), and; 3) anglers may under- report the numbers of released fish. A study in Canadian waters compared creel survey reports to actual observer-generated information on recreational fishing boats in the Southern Georgia Strait. Substantial differences were documented, with the number of released rockfish observed significantly higher than the number reported by recreational anglers during creel surveys (Deiwert et al. 2005). These factors could make the actual bycatch of yelloweye rockfish, canary rockfish, or bocaccio higher or lower than WDFW's estimates. There is additional uncertainty regarding these estimates because the WDFW continues to change the methodology to calculate them. As a result there are large differences between past and more current bycatch estimates. In our previous consultation on the salmon fisheries, we used WDFW bycatch estimates from the 2003 through 2009 time period (WDFW 2011). Since then, WDFW provided us catch estimates for the 2003 through 2011 time period (WDFW 2014). The previous estimates are much larger than the new estimates even though they span the same time period from 2003 through 2009 (the new estimates include the years 2010 and 2011). Since the WDFW continues to change the methods to derive bycatch estimates, we show data from each method to represent a potential range of bycatch for yelloweye rockfish, canary rockfish and bocaccio, but use the higher estimates to form a precautionary analysis. We consider using bycatch estimates from 2003 to 2011 valid because we anticipate that recreational salmon fisheries proposed for 2014 will result in similar fishing techniques, locations, and anticipated numbers of angler-trips as in the past decade.

2.5.3.1.1 Yelloweye Rockfish

The average annual estimated bycatch of yelloweye rockfish from salmon anglers ranges from 4 (WDFW 2014) to 111 (WDFW 2011) fish (Table 17). Though these fish will be released as mandated by state law, most will likely perish from barotrauma injuries or predation.

Table 17. Yelloweye rockfish bycatch estimates.

Species	**Low Estimate**	**High Estimate**	**Abundance Scenario**	**Percent of DPS killed (low estimate)**	**Percent of DPS killed (high estimate)**
Yelloweye Rockfish	4	111	40,000	0.01	0.3
			47,407	0.008	0.2

2.5.3.1.2 Canary rockfish

The average annual estimated bycatch of canary rockfish from salmon anglers ranges from 20 (WDFW 2014) to 312 (WDFW 2011) fish (Table 18). Though these fish will be released as mandated by state law, most will likely perish from barotrauma injuries or predation.

Table 18. Canary rockfish bycatch estimates.

Species	**Low Estimate**	**High Estimate**	**Abundance Scenario**	**Percent of DPS killed (low estimate)**	**Percent of DPS killed (high estimate)**
Canary Rockfish	20	312	15,000	0.13	2.0
			20,548	0.10	1.5

2.5.3.1.3 Bocaccio

The average annual estimated bycatch of canary rockfish from salmon anglers ranges from 2 (WDFW 2014) to 26 (WDFW 2011) fish (Table 19). Though these fish will be released as mandated by state law, most will likely perish from barotrauma injuries or predation.

Table 19. Bocaccio bycatch estimates.

Species	Low Estimate	High Estimate	Abundance Scenario	Percent of DPS killed (low estimate)	Percent of DPS killed (high estimate)
Bocaccio	2	26	3,000	0.07	0.9
			4,606	0.4	0.6

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, canary rockfish and bocaccio killed by pre-existing derelict gear or new gear that would occur as part of commercial fisheries over the next several years. As elaborated in Section 2.4.3.4, due to recent changes in state law, additional outreach and assessment efforts (i.e. Gibson 2013), and recent lost net inventories (Beattie and Adicks 2012, Beattie 2013) it is likely that fewer nets will become derelict in the upcoming 2014/15 fishing season compared to several years ago. Because of the low number of anticipated derelict gill nets, it is likely that few (if any) yelloweye rockfish, canary rockfish and bocaccio mortalities will occur from new derelict gill nets, and that any additional mortality would not induce additional risk to each population.

2.5.3.2 Effects on Spatial Structure and Connectivity

Bycatch (or death of fish in new derelict gear) of listed-rockfish could alter spatial structure. If anglers incidentally catch a greater proportion of the total population of yelloweye rockfish, canary rockfish, or bocaccio in one or more of the regions of the DPSs, the spatial structure and connectivity of each DPS could be degraded. The lack of reliable population abundance estimates from the regions of Puget Sound proper complicates this type of assessment. Yelloweye rockfish are the most susceptible to spatial structure impacts because of their sedentary nature. Localized losses of yelloweye rockfish are less likely to be replaced, compared to canary rockfish and bocaccio, which are better able to recolonize habitats due to the propensity of some individuals to travel long distances.

2.5.3.3 Diversity and Productivity

Bycatch of listed rockfish can alter diversity primarily by the removal of larger fish. Larger fish of each species are able to target baits and lures more so than juveniles, and typically enter fisheries at or near 12 inches long (30 centimeters) as they also they approach sexual maturity - thus bycatch disproportionately kills larger yelloweye rockfish, canary rockfish, and bocaccio. The loss of fish that are reproductively mature, or nearly so, would hinder the demographic diversity (and productivity) of each species. The impacts on fish within Puget Sound proper could be greater than the San Juan Island and Straits of Juan de Fuca region if anglers incidentally catch a greater proportion of the total population of each species.

2.5.3.4 Effects on Proposed Critical Habitat for Listed Rockfish

Proposed critical habitat is located in some of the areas fished by recreational and commercial fishers targeting salmon within the Puget Sound/Georgia Basin. We do not have spatial information at a fine enough scale to determine the proportion of the recreational or commercial fishery occurring inside or outside of proposed critical habitat. We proposed critical habitat in some waters shallower than 98 feet (30 m) for canary rockfish and bocaccio and proposed critical habitat in some waters deeper than 98 feet (30 m) for each listed rockfish. For all three listed rockfish we proposed deep water habitats for sites deeper than 98 feet (30 m) that possess or are adjacent to areas of complex bathymetry consisting of rock and/or highly rugose habitat (Section 2.2.2.3). Several attributes of these habitats are essential to the conservation of listed rockfish. 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) the type and amount of structure and rugosity that supports feeding opportunities and predator avoidance.

Recreational Fishing. Jigs, weights, and hooks used by recreational anglers and commercial fishers have the potential to alter benthic habitats by snagging structure, and some gear could be lost. Lost gear would not effect water quality or prey attributes of proposed critical habitat. Though recreational fishing gear is inevitably lost, there have been no observations of adverse effects to the sea floor from lost recreational fishing gear in WDFW habitat surveys (Pacunski et al. 2013), and those that could occur within the recreational bottom fish fishery would be on very small spatial scales. As such it is unlikely that lost recreational fishing gear could result in appreciable changes to listed rockfish habitat structure and rugosity attributes.

Motors used by recreational (and commercial fishers) as well as engines used by commercial fishers have the potential to pollute waters through the discharge of small levels of hydrocarbons. However, engines have become more efficient and less polluting in response to better technology and improved standards, which are administered by the Environmental Protection Agency (75 Fed. Reg. 179, September 16, 2010). As such, it is very unlikely that water quality and dissolved oxygen attributes of proposed rockfish critical habitat would be adversely affected by the proposed action.

Commercial fishing. Effects to proposed rockfish critical habitat come from lost commercial salmon gill nets. Nets are lost due to inclement weather, tidal and current action, catching upon the seafloor, the weight of catch causing submersion, vessels inadvertently traveling through them, or a combination of these factors (NRC 2008). Nets fished in rivers and estuaries can be lost from floods and/or as large logs are caught moving downstream, and a few of these nets can drift to the marine environment. Nets can persist within the marine environment for decades because they do not biodegrade and are resistant to chemicals, light, and abrasion (NRC 2008). In some cases, nets can drift relatively long distances before they catch on the bottom or wash up on the shore (NRC 2008). When derelict nets drift, they can entangle crab pots, thereby recruiting more derelict gear (Snohomish County MRC 2010). Most nets hang on bottom structure that is also attractive to rockfish. This structure consists of high-relief rocky substrates or boulders located on sand, mud or gravel bottoms (Good et al. 2010). The combination of complex structure and currents tend to stretch derelict nets open and suspend them within the water column, in turn making them more deadly for marine biota (Akiyama et al. 2007, Good et al. 2010)(Figure 7).

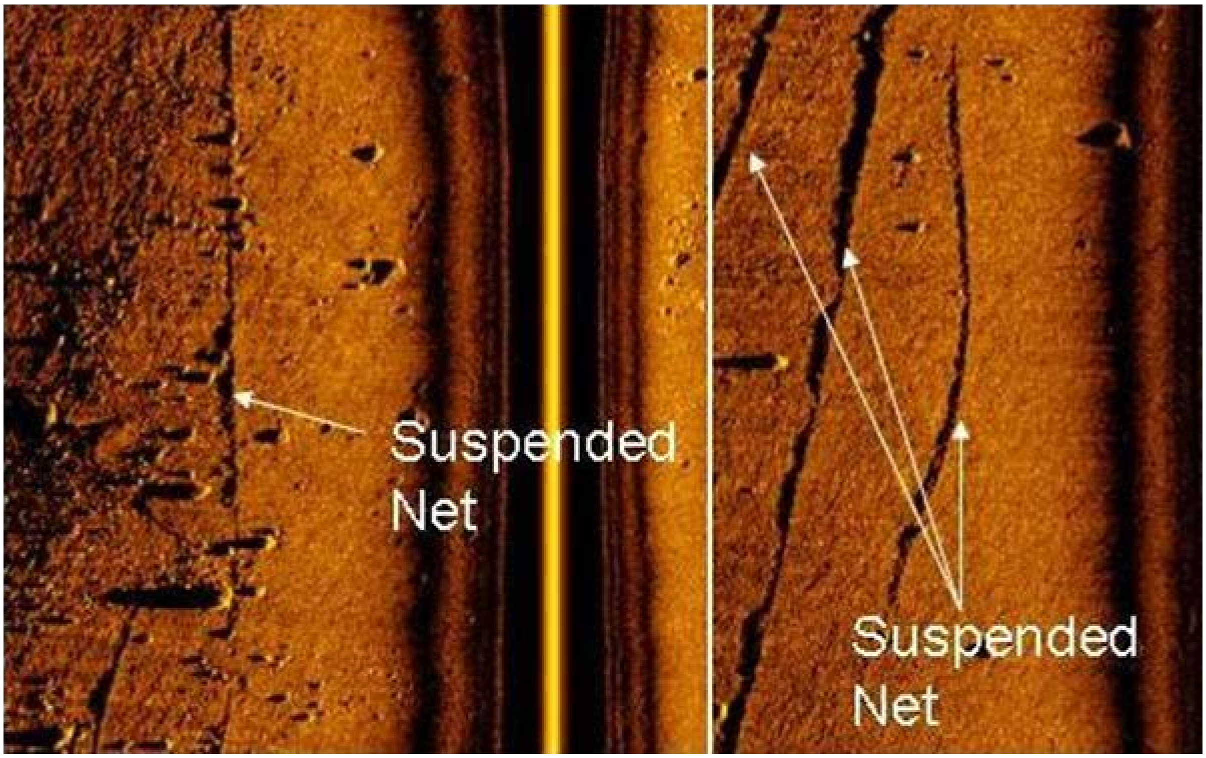

Figure 7. Sidescan sonar images of derelict nets located on Point Roberts Reef of the San Juan basin. Suspended nets have a larger acoustic shadow than nets flush with the bottom. Image used by permission of Natural Resource Consultants (NRC).

Derelict nets alter habitat suitability by trapping fine sediments out of the water column. This makes a layer of soft sediment over rocky areas, changing habitat quality and suitability for benthic organisms (Good et al. 2010). Nets can also cover habitats used by rockfish for shelter and pursuit of food, rendering the habitat unavailable. Nets can reduce the abundance and availability of rockfish prey that include invertebrates and fish (Good et al. 2010).

Based on data presented by Good et al. (2010) regarding the depth of derelict nets that are recovered, we presume that most newly lost nets would catch on bottom habitats shallower than 120 feet where they would present a limited risk to most adult listed-rockfish, yet remain a risk for some juveniles and subadults. Though we cannot estimate the number of yelloweye rockfish, canary rockfish or bocaccio killed on an annual basis from newly lost nets, we can estimate the amount of habitat altered by them. Most recovered nets are fragments of their original size; drift gill nets can be as long as 1,800 feet, and skiff gill nets can be as long as 600 feet, yet most recovered derelict nets cover an area of only about 7,000 square feet (Northwest Straits Initiative 2011), suggesting that fishers may cut nets free if they are caught on the bottom or otherwise damaged. For most derelict nets, the maximum suspension off the bottom (for a portion of the net) was less than 1.5 meters when they were recovered (Good et al. 2010), and we consider suspended and non-suspended nets to degrade benthic habitats.

Due to recent changes in state law, additional outreach and assessment efforts (i.e. Gibson 2013), and recent lost net inventories (Beattie and Adicks 2012; Beattie 2013) it is likely that fewer nets will become derelict in the upcoming 2014/15 fishing season compared to several years ago (previous estimates of derelict nets were 16 to 42 annually (NRC 2010)). In 2013 an estimated 15 nets became derelict, 12 of which were removed within days by fisheries authorities (Beattie 2013), and in 2012 eight nets were lost, and six were promptly removed (Adicks and Beattie 2012). Of note, most of these lost nets were reported by the fishermen or state or tribal fisheries authorities. Based on this new information we estimate that a range of six to 20 gill nets may be lost in the 2014/2015 fishing season, but up to 75 percent of these nets would be removed within days of their loss and have little potential to damage proposed rockfish critical habitat. In the worst case analysis assuming that 20 nets are lost and five of these become derelict they would damage up to 35,000 square feet (0.8 acre) of habitat (assuming an average of 7,000 square feet). Even presuming that all lost nets would be in proposed critical habitat (574.75 square miles for yelloweye rockfish and 1,184.75 square miles for canary rockfish and bocaccio), they would damage a fraction of the area proposed for listed rockfish and not degrade the overall condition of proposed critical habitat.

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 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Activities occurring in the Puget Sound area were considered in the discussion of cumulative effects in the biological opinion on the Puget Sound Harvest Resource Management Plan (NMFS 2011a) and in several section 7 consultations on large scale habitat projects affecting listed species in Puget Sound including Washington State Water Quality Standards (NMFS 2008c), Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013), the National Flood Plain Insurance Program (NMFS 2008d), and the Elwha River Fish Restoration Plan (Ward 2008). They remain current and we incorporate them by reference here. Those opinions discussed the types of activities taken to protect listed species through habitat restoration, hatchery and harvest reforms, and water resource management actions. The Puget Sound Salmon Recovery Plan was published in 2007 (NMFS 2006a; Shared Strategy for Puget Sound 2007).A Final Recovery Plan for Southern Resident killer whales was published January 24, 2008 (NMFS 2008e). Rules on vessel trafficto protect Southern Residents from vessel effects were adopted in 2011 (76 FR 20870). Outreach and enforcement of these regulations will reduce the vessel effects (as described in the environmental baseline) of recreational and whale watching vessels in U.S. waters of the action area. However, vessel effects in Canadian waters of the action area are likely to continue into the future at comparable levels to those seen in the present and recent past, because our regulations are specific to U.S.

waters and Canada does not have equivalent regulations.Although state, tribal and local governments have developed plans and initiatives to benefit marine fish species, ESA listed salmon, and the listed Southern Residents, they must be applied and sustained in a comprehensive way before NMFS can consider them “reasonably certain to occur” in its analysis of cumulative effects.

Cumulative effects for listed-rockfish will be influenced by several factors. 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. A 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 2.3.2

These 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. In addition, a recovery plan for listed rockfish in the Puget Sound/Georgia basin is currently under development that will assess long term research and recovery action needs.

Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on populations and PCEs, 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. Within the freshwater portion of the action area, non-Federal actions are likely to include human population growth, water withdrawals (i.e., those pursuant to senior state water rights) and land use practices. In 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 which contribute to non-point source pollution and storm water run-off. Although these factors are ongoing to some extent and likely to continue in the future, past occurrence is not a guarantee of a continuing level of activity. That will depend on whether there are economic, administrative, and legal impediments (or in the case of contaminants, safeguards). Therefore, although NMFS finds it likely that the cumulative effects of these activities will have adverse effects commensurate to those of similar past activities; it is not possible to quantify these 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 will add the effects of the action (Section 2.4) to the environmental baseline (Section 2.3) and the cumulative effects (Section 2.5) 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) reduce the value of designated or proposed critical habitat for the conservation of the species. These assessments are made in full consideration of the status of the species and critical habitat (Section 2.2).

2.7.1 Puget Sound Chinook

NMFS describes its approach to the analysis of the proposed actions in broad terms in section 2.1, and in more detail as NMFS focuses on the effects of the action in section 2.4.1. It incorporates information discussed in the Status (Section 2.3.1.1), Environmental Baseline (Section 2.4.1) and Cumulative effects (Section 2.2.6) sections. In the effects analysis, NMFS first analyzes the effects of the proposed actions on individual salmon populations within the ESU using quantitative analyses where possible and more qualitative considerations where necessary. Risk to the survival and recovery of the ESU is then determined by assessing the distribution of risk across the populations within each major geographic region and then accounting for the relative role of each population to the viability of the ESU. The derivation of the RERs, and the the status and trends include the impacts of the harvest, hatchery and habitat actions discussed in the Environmental Baseline. The derivation of the RERs also make assumptions about the effects of the actions discussed in the Cumulative Effects (i.e., variability in management error, environmental conditions, marine survival). By considering the RERs, status and trend information in the discussion of effects of the Proposed Actions, the effects of the activities in those sections of the biological opinion are integrated into our risk assessment.

The risk assessment is presented in two stages. In the first stage, a potential area of concern or risk is identified by region based on the status of the populations relative to their escapement thresholds and RERs The second stage of the analysis considers all of the populations in each region, with particular attention to those identified to be at higher risk in stage one. NMFS considers the factors and circumstances that mitigate the risks identified in the first stage leading to conclusions regarding the viability of each region and the ESU as a whole. We evaluate the likelihood of that concern or risk occurring and consider the practical influence harvest may have on the potential concern or risk.

The results of this evaluation also highlight the importance of habitat actions and hatchery conservation programs for the preservation and recovery of these populations specifically, and to the ESU in general. The status of many of these stocks is largely the result of reduced productivity in the wild from habitat loss and degradation and from other sources of human induced mortality. The analysis in this evaluation suggests that it is unrealistic to expect to achieve substantive increases in Chinook population abundance and productivity and population recovery through harvest reductions alone without also taking substantive action in other areas to improve the survival and productivity of the populations. Recovery of the Puget Sound Chinook ESU depends on implementation of a broad based program that addresses the identified major limiting factors of decline.

The analysis is unavoidably complex. It involves 22 populations spread across five geographic regions. NMFS uses a variety of quantitative metrics (e.g., RERs, critical and rebuilding thresholds, measures of growth rate and productivity) and qualitative considerations (e.g., PRA designation, whether a population is essential to a recovery scenario, the importance and status of a long-term transitional recovery plan, the magnitude of harvest in SUS fisheries, treaty fishery contribution) in its assessment of the proposed actions. These are described in section 2.4.1. The Integration and Synthesis section summarizes and explains the considerations that lead to jeopardy determination for the proposed actions. In the following, NMFS summarizes the considerations taken into account for each population in a discussion that is organized by region. The same information is displayed and summarized in Table 20 and may also help navigate the complexities of the narrative.

Both Chinook populations in the Georgia Basin Region are at or near critical status. This is cause for concern given their role in recovery of the ESU; particularly for the South Fork Nooksack population. However, impacts from the proposed actions are very low, and our analysis indicates that further harvest reductions in 2014 Puget Sound fisheries would not measurably affect the risks to survival or recovery for either Nooksack population. This result is consistent with information that indicates that past harvest constraints have had limited effect on increasing escapement of returning natural-origin fish, when compared with the much higher natural escapement including adults from the conservation hatchery programs. Escapement and growth trends are stable or positive for both populations. The conservation hatchery programs are key components in recovery of the Nooksack early Chinook populations and should buffer demographic and genetic. In 2014, 85% of the harvest of Nooksack early Chinook in Puget Sound fisheries is expected to occur in tribal fisheries; primarily in C&S fisheries. Measures to minimize impacts to Nooksack early Chinook, particularly the South Fork population, are part of the proposed actions, and past patterns indicate exploitation rates under the proposed action are likely to be lower than anticipated.

For the Whidbey/Main Basin Region, the effects of the proposed actions in 2014 will meet the recovery plan guidance of two to four populations representing the range of life histories displayed in this region at low risk including those specifically identified as needed for recovery of the Puget Sound Chinook ESU. The Whidbey/Main Basin Region is a stronghold of Chinook production in the ESU. Most populations in the region are doing well relative to abundance criteria and RERs, representing a diversity of healthy populations in the region as a whole. NMFS considers fisheries to present a low risk to populations where estimated impacts of the proposed fisheries are less than or equal to the RERs. The stable escapement trends and, in particular, the relatively robust status of the populations compared with their thresholds should mitigate any increased risk as a result of exceeding the RER in one year for the Snoqualmie and Skykomish populations. In addition, the Snoqualmie, Skykomish, and South Fork Stillaguamish populations are PRA Tier 2 and 3 watersheds and their life history types are represented by other healthier populations in the region which are expected to be below their RERs. Growth rates for natural-origin escapement are consistently higher than growth rates for natural-origin recruitment. This indicates that sufficient fish are escaping the fisheries to maintain or increase the number of spawners from the parent generation; providing some stabilizing influence for abundance and reducing demographic risks.

For the Central/South Sound Region, implementation of the proposed 2014 fisheries will meet the recovery plan guidance of two to four populations representing the range of life histories displayed by the populations in that region at low risk including those specifically identified as needed for recovery of the Puget Sound Chinook ESU (White River and Nisqually). The Green and White River populations are expected to meet their RERs under the proposed actions indicating low risk of the proposed actions to those populations. Most populations in the region are doing well relative to abundance criteria (Table 20). Given that the proposed actions are consistent with the longer term transitional strategy for recovery of the population described in Section 2.3.1.1 and Section 2.5.1.2 (Central/South Sound Region), the trend in natural escapement, the escapement anticipated in 2014, and the additional actions being taken by the co-managers as part of the Proposed Action, the additional risks associated with exceeding the RER in the 2014 fishing year should not significantly effect the survival and recovery of the Nisqually Chinook population. This approach is also consistent with NMFS' responsibility to balance its tribal trust responsibility and conservation mandates by meeting the ESA's requirements while reducing disruption of treaty fishing opportunity. Growth rates for natural-origin escapement are consistently higher than growth rates for natural-origin recruitment. This indicates that sufficient fish are escaping the fisheries to maintain or increase the number of spawners from the parent generation, providing some stabilizing influence for abundance and reducing demographic risks. The Sammamish River may experience some increased risks to the pace of adaptation of the existing local stock given the current status of the natural-origin population. However, the natural-origin population has been extirpated, and potential improvement in natural-origin production is limited by the existing habitat. The population is not essential for recovery of the Puget Sound Chinook ESU (PRA Tier 3), and both the life history and Green River genetic legacy of the population are represented by other healthier populations in the Central/South Sound Region.

The status of the populations in the Hood Canal Region, given their role in recovery of the ESU, is cause for concern. The combination of declining growth rates, low productivity, and critical levels of natural-origin escapement suggest these populations are at high risk for survival and recovery. However, the indigenous populations no longer exist. The available information indicates further constraints on 2014 Puget Sound fisheries would not measurably affect the risks to survival or recovery of the spawning aggregations within the Mid-Hood Canal population. The general characteristics of the Mid-Hood Canal Rivers population, including genetic lineage, life history, and run timing, are also found in the Skokomish River population and the Hamma Hamma conservation hatchery program should help buffer some demographic risks to the Mid-Hood Canal Rivers population. The proposed actions are consistent with the longer term transitional strategy for recovery of the Skokomish population, the trend in natural escapements is stable, the natural escapement anticipated in 2014 is consistent with that trend, and the co-managers have proposed additional actions as part of the Proposed Action to bolster recovery of the population. The fact that growth rates in natural-origin escapement exceed those for recruitment indicates that fisheries may provide some stabilizing influence to abundance and productivity; reducing demographic risks. When weighed against these factors, additional risks associated with exceeding the RER in 2014 should not significantly affect the long-term persistence of the Skokomish Chinook population. This approach is also consistent with NMFS' responsibility to balance its tribal trust responsibility and conservation mandates by achieving ESA requirements while reducing disruption of treaty fishing opportunity. Nonetheless, progress in these areas should be closely watched given potential long-term effects on survival and recovery suggested by modeling and the recent year pattern of exceeding the exploitation rate ceiling.

In the Strait of Juan de Fuca Region, both populations are in critical status and both are expected to exceed their RERs in 2014. This is cause for concern given their role in recovery of the ESU. However, impacts from the proposed actions are very low and analysis suggests further harvest reductions in 2014 Puget Sound fisheries would not measurably affect the risks to survival or recovery for either population. Under the proposed actions, escapement for the Elwha population is expected to be low but to exceed its critical threshold, and escapement for the Dungeness is expected to be below its critical threshold. When hatchery-origin spawners are taken into account, escapements exceed the critical threshold for the Dungeness and the rebuilding threshold for the Elwha. The trends in escapement and growth rate are positive for the Dungeness. The conservation hatchery programs operating in the Dungeness and Elwha Rivers are key components for recovery of these populations and buffer demographic risks and preserve the genetic legacies of the populations as degraded habitat is recovered.

In summary, under the proposed actions, the combined ocean and Puget Sound exploitation rates for the 2014 fishing year for five of the 14 management units in the ESU (9 of 22 populations) are expected to be under their RER or RER surrogates (Table 13). Three more populations are close to their RERs. NMFS considers the proposed actions to present a low risk to populations that do not exceed their RERs (NMFS 2004c). For the populations above their RERs or RER surrogates:

> (1) current and anticipated population status in 2014 and stable or positive trends in escapement and growth rate alleviated concerns about additional risk (Skykomish, Snoqualmie, Cedar, Puyallup);
>
> (2) anticipated impacts from the proposed 2014 Puget Sound fisheries are low and the effect on the population is negligible (North and South Fork Nooksack, Mid-Hood Canal Rivers, Dungeness and Elwha);
>
> (3) indigenous populations in the watershed have been extirpated and the proposed fisheries and additional actions proposed by the co-managers are consistent with long-term strategies for local adaptation and rebuilding of the remaining populations (Nisqually, Skokomish); and,
>
> (4) populations were in lower PRA tiers and life histories were represented by other healthier populations in the region (South Fork Stillaguamish, Mid-Hood Canal Rivers, Sammamish, Puyallup).

Fifteen of the 22 populations in the ESU are expected to exceed their critical thresholds and seven are expected to exceed their rebuilding thresholds (Table 20). At least four additional populations would exceed their rebuilding thresholds if the contribution of hatchery-origin fish to spawning escapement were taking into account. For populations anticipated to be below their critical thresholds, the fisheries would not meaningfully affect the persistence of the populations (North and South Fork Nooksack, South Fork Stillaguamish, Sammamish, Dungeness).

Table 20. Summary of factors considered in assessing risk by population in the Puget Sound Chinook ESU.

Region	Population	≤ RER[1]	Population Status[2] (Avg/2014)		Escapement Trend[3]	Growth Rate Return/Escapement[3]		Low impacts in PS fisheries[4]	Approach consistent with transitional strategy[4]	PRA Tier[4]
Strait of Georgia	N.F. Nooksack									1
	S.F. Nooksack									1
Whidbey/Main Basin	Upper Skagit									1
	Lower Skagit									1
	Lower Sauk									1
	Upper Sauk									1
	Suiattle									1
	Upper Cascade									1
	N.F. Stillaguamish									2
	S.F. Stillaguamish									2
	Skykomish									2
	Snoqualmie									3
South Sound	Sammamish									3
	Cedar									3
	Duwamish-Green									2
	White									1
	Puyallup									3
	Nisqually									1
Hood Canal	Mid-Hood Canal			Unk						1
	Skokomish			Unk						1
Strait of Juan de Fuca	Dungeness									1
	Elwha									1

[1]Table 13. NMFS considers fisheries to present a low risk to populations where estimated impacts of the proposed fisheries are less than or equal to the RERs,
[2] Tables 3 and 13
[3] Table 4 based on NMFS' analysis
[4] Described in text of Section 2.4.1.2 for each MPG in the ESU

NMFS noted a particular need for caution for the populations in the Hood Canal Region. There are only two populations in the region so both are essential for recovery of the ESU. Although we concluded that when weighed against the available information, additional risks associated with implementation of the proposed actions in 2014 are not likely to measurably affect the survival and recovery of the Hood Canal populations, progress in these areas should be closely watched given the status of the populations, potential long-term effects on survival and recovery suggested by modelling associated with the exploitation rate ceiling, and the recent year pattern of exceeding the exploitation rate ceiling.

As described in the previous sections, in keeping with its trust responsibility, NMFS' approach is to accept some fisheries impacts that may result in increased risk to the listed species in order to provide limited tribal fishery opportunity. This approach recognizes that the treaty tribes have a right and priority to conduct their fisheries within the limits of conservation constraints.

We also assessed the effects of the action on Puget Sound Chinook 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. The PCEs most likely to be affected by the Proposed Actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity that supports juvenile growth and mobility. Fishermen in general actively avoid contact of gear with the substrate because of the resultant interference with fishing and potential loss of gear so would not disrupt juvenile habitat. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area participating in activities un-related to the Proposed Action. Also these effects would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries. Fisheries under the Proposed Action will occur within many areas designated as critical habitat in Puget Sound. However, fishing activities will take place over relatively short time periods in any particular area.Other potential effects described in Section 2.4.1.3 are mitigated for under the Proposed Actions. As discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat, and Section 2.3, 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. For the reasons described, we would expect the Proposed Action to result in minimal additional impacts to these features although we cannot quantify those impacts because of their transitory nature.

2.7.2 Puget Sound Steelhead

ESA-listed steelhead are incidentally caught in treaty and non-treaty marine and freshwater fisheries targeting other species of salmon and hatchery origin steelhead. Incidental catch in fisheries is not a primary risk factor for steelhead. To assess if incidental take from salmon and hatchery steelhead fisheries described in the proposed action threatens the survival and recovery of ESA-listed steelhead within the DPS, NMFS incorporated information discussed in the Status

(Section 2.3.1.2), Environmental Baseline (Section 2.4.1), Effects of the Action on Species and Designated Critical Habitat (Section 2.5.2.2 and 2.5.2.3) and Cumulative Effects (Section 2.6) sections. The BRT evaluated trends in abundance of natural origin steelhead over the most recent decade (Hard et al. 2007). Data on natural origin steelhead are extremely limited or not available for the majority of summer, winter, or summer/winter run steelhead populations, particularly for summer populations. The majority of steelhead populations in the Puget Sound DPS for which data are available demonstrate declines in escapement and/or run size. In the NMFS current 5-year status review, recent steelhead abundance and trends analyses in the Puget Sound Steelhead DPS indicate relatively low abundance and declining trends, typically 3 to 10 percent annually (Ford et al. 2011). The status of Puget Sound steelhead has not changed significantly since the time of listing (Ford et al. 2011) and associated harvest rates are within those observed at the time of listing. Therefore, NMFS continues to use the harvest impacts at that time as a benchmark for evaluating the effects of the proposed action given the conclusion of the listing determination that the harvest regimes in place at the time had largely addressed harvest as a factor of decline (72 Fed. Reg. 26722, May 11, 2007).[18]

Given the similarity of recent marine fisheries as compared to the proposed marine fisheries and the predominance of non-listed hatchery steelhead in Puget Sound anticipated for the 2014-15 fishery season, the anticipated catch of hatchery and natural-origin Puget Sound steelhead in marine treaty and non-treaty fisheries is 190. This is a little over half the number of fish caught in marine fisheries at the time of listing (325) and compares to the minimum estimate of Puget Sound steelhead abundance of 22,361. The anticipated catch of natural-origin Puget Sound steelhead in freshwater treaty and non-treaty fisheries is likely to reflect the 2007/2008 to 2012/2013 average incidental mortality for the five representative populations (i.e., approximately 1.9 percent), which is below NMFS' benchmark harvest rate of 4.2 percent. Based on the consistency in catch patterns in terminal areas from 2001/2002 to present, NMFS anticipates steelhead harvest in the remaining terminal areas for summer, winter, and summer/winter steelhead populations for which data are insufficient to assess harvest rates, also to be within the impacts to natural origin steelhead observed during the 2001/02 to 2006/07 time period during the 2014/15 fishery season. Co-managers will continue to strive to collect and improve catch accounting for these listed steelhead populations as funding and resources become available. Take of ESA-listed steelhead in research activities is also low; 52 encounters and no more than 5 mortalities are anticipated.

Critical habitat is located in many of the areas where Puget Sound recreational and commercial salmon fisheries occur. However, fishing activities will take place over relatively short time periods. The PCEs most likely to be affected by the Proposed Actions are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure and rugosity that supports juvenile growth and mobility. Fishermen

[18] NMFS has not established the 4.2 percent associated with the management strategy referenced in the listing strategy as a jeopardy standard. Rather NMFS has concluded that it would not pose jeopardy, but has not defined what level of harvest above 4.2 percent would be jeopardy at this time. In addition, standards are expected to change over time consistent with changes in stock status and other information related to the DPS.

endeavor to keep gear from being in contact or entangled with substrate and habitat features because of the resultant interference with fishing and potential loss of gear and so would have a negligible effect on the PCEs. Any impact to water quality from vessels transiting critical habitat areas on their way to the fishing grounds or while fishing would be short term and transitory in nature and minimal compared to the number of other vessels in the area (NMFS 2004b). Development activities contributed and continue to contribute to the loss and degradation of steelhead habitat in Puget Sound such as barriers to fish passage, adverse effects on water quality and quantity associated with dams, loss of wetland and riparian habitats, and agricultural and urban development activities. Extensive propagation of out-of-basin stocks (e.g., Chambers Creek and Skamania hatchery stocks) throughout the Puget Sound DPS, and predation by marine mammals and birds are also sources of concern. NMFS convened a technical recovery team to identify historic populations and develop viability criteria for a steelhead recovery plan. These reports are currently being finalized. NMFS expects that both Federal and State steelhead recovery and management efforts will provide new tools, data and technical analyses, refine Puget Sound steelhead population structure and viability, and better define the role of individual populations in the DPS. The recovery plan will identify measure necessary to protect and restore degraded habitats, manage hatcheries and fisheries consistent with recovery, and prioritize research on data gaps regarding population parameters. The recovery plan is anticipated to be completed in 2017.

In summary, harvest was not identified as a primary limiting factor for decline at the time of listing. The anticipated incidental catch in the proposed action is nearly half the rate that occurred during the time of listing, in which NMFS determined the elimination of direct harvest largely addressed the decline posed by harvest (72 Fed. Reg. 26722, May 11, 2007), and incidental harvest of steelhead is considered low, even when combined with anticipated research effects. Effects to critical habitat through fishing vessels and fishermen will be minimal and transitory. The recovery plan anticipated in 2017 will identify measure necessary to protect and restore degraded habitats, manage hatcheries and fisheries consistent with recovery, and prioritize research on data gaps regarding population parameters. Thus, the proposed action is not likely to impede the survival and recovery of the Puget Sound Steelhead DPS.

2.7.3 Puget Sound/Georgia Basin Rockfish

Bycatch in fisheries is a primary limiting factor for listed-rockfish. As detailed in Section 2.3, Environmental Baseline, yelloweye rockfish, canary rockfish, and bocaccio are caught by anglers targeting halibut, bottom fish and by researchers. To assess if take from the salmon fisheries within the range of the listed rockfish DPSs threatens the viability of each species, in combination with other sources of bycatch in the environmental baseline, we review the population-level impact from all fisheries and research combined. In order to conduct this analysis, we must assess take numbers relative to 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 listed-rockfish DPSs. The best available abundance data for any basin for each species comes from the 2008 WDFW ROV surveys in the surveyed San Juan Island and Strait of Georgia regions (Pacunski et al. 2013), and we use this survey as a fundamental source to understand the total abundance of the DPSs (summarized in Table 8). WDFW may have over- or underestimated the abundance of each species when it expanded the data from the ROV, drop camera, and bottom trawl surveys to produce abundance estimates. This risk is inherent in the study design of each methodology and a common challenge to fisheries management and species conservation. To address the possibility that each survey method resulted in over-estimates of abundance, our analysis includes two population scenarios—one based on the WDFW estimates and one that is roughly 20 percent less. We incorporated these reductions in our analysis to test the sensitivities of the abundance estimate for each species. We note that there may be equal probability that the WDFW population numbers are underestimates of abundance for each species. The structure of this assessment underestimates the total abundance of each DPS, resulting in a conservative 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 Pacific Fishery Management Council (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 (DFO 2010; 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 similar life histories of yelloweye rockfish, canary rockfish, and bocaccio to 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 to yelloweye rockfish, canary rockfish, and bocaccio from the proposed salmon fisheries we calculated the range of total anticipated annual mortalities (Table 21).

Table 21. Total annual take for the salmon fisheries and percentages of the listed-rockfish.

Species	Range of Estimated Lethal Take[a]	Abundance Scenario	Range of Percent of DPS Killed
Bocaccio	2 to 26	3,000	0.07 to 0.9
		4,606	0.4 to 0.6
Canary Rockfish	20 to 313	15,000	0.13 to 2.0
		20,548	0.10 to 1.5
Yelloweye rockfish	4 to 111	40,000	0.01 to 0.3
		47,407	0.008 to 0.2

For yelloweye rockfish, canary rockfish, and bocaccio, mortalities from the proposed salmon fisheries in the range of the DPSs would be below the precautionary level as described above (0.5 (or less) of natural mortality) for each of the abundance scenarios.

Annual natural mortality rate for bocaccio is approximately 8 percent (as detailed in Section 2.2.1) (Palsson et al. 2009); thus, the precautionary level of fishing and research mortality would be 4 percent. Lethal takes from the proposed salmon fisheries would be below the precautionary level for each of the abundance scenarios.

Annual natural mortality rates for canary rockfish ranges from 6 to 9 percent (as detailed in Section 2.2.1) (Methot and Stewart 2005; Stewart 2007); thus, the precautionary level of fishing and research mortality would be 3 to 4.5 percent. Lethal takes from the proposed salmon halibut fisheries would be below the precautionary level for each of the abundance scenarios.

Annual natural mortality rates for yelloweye rockfish range from 2 to 4.6 percent (as detailed in Section 2.2.1) (Wallace 2007; Yamanaka and Kronlund 1997); thus, the precautionary range of fishing and research mortality would be 1 to 2.4 percent. Lethal takes from the salmon fisheries in the DPS would be below the precautionary level for each of the abundance scenarios.

To assess the population-level effects to yelloweye rockfish, canary rockfish, and bocaccio from activities associated with the research permits within the environmental baseline, fishery take associated with the proposed action, and fishery take within the environmental baseline, we calculated the total mortalities for all sources (Table 22).

Table 22. Total takes for the halibut fishery and percentages of the listed-rockfish covered in this Biological Opinion in addition to takes within the environmental baseline.

Species	Total Take in Baseline (plus salmon fishery)	Total Lethal Take in Baseline (plus salmon fishery)	Abundance Scenario	Percent of DPS Killed
Bocaccio	105 (+26)	66 (+26)	3,000	3.1
			4,606	2.0
Canary rockfish	263 (+312)	201 (+312)	15,000	3.4
			20,548	2.5
Yelloweye rockfish	491 (+111)	411 (+111)	40,000	1.3
			47,407	1.1

Lethal takes are most relevant for viability analysis. For yelloweye rockfish, canary rockfish, and bocaccio, the takes from the salmon fishery, in addition to previously assessed lethal scientific research and fishery bycatch (detailed in Section 2.3, Environmental Baseline), would be within or below the precautionary level for each of the abundance scenarios. Our analysis of potential bycatch for each species uses precautionary assumptions and thus would likely be lower than estimated.

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, canary rockfish and bocaccio killed by pre-existing derelict gear or new gear that would occur as part of commercial fisheries over the next several years. Despite these data limitations, it is unlikely that mortality associated with derelict gear would cause mortality levels of yelloweye rockfish, canary 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 deep (and thus avoid most adults); 3) new derelict gear would degrade a relatively small area (up to 0.8 acres of habitat per year), and thus would be unlikely to result in significant additional mortality to Listed-rockfish; and 4) the state law requiring lost nets to be reported within 24 hours of their loss, and the recent and the ongoing program to provide outreach to fishermen to prevent net loss.

Given the threatened status of yelloweye rockfish and canary rockfish, and the endangered status of bocaccio in the Puget Sound/Georgia Basin DPS, we will continue to evaluate whether it is appropriate for us to rely on acceptable mortality levels established using the methods described by Walters and Parma (1996) and the Scientific and Statistical Committee (2000).

We also assessed the effects of the action on yelloweye rockfish, canary rockfish, and bocaccio critical habitat in the context of the status of proposed critical habitat, the environmental baseline, and cumulative effects to evaluate whether the effects of the proposed fishing are likely to reduce the value of proposed critical habitat for the conservation of each species. The main potential effect of the proposed fishing on listed rockfish proposed critical habitat would be derelict fishing nets. As discussed in Section 2.2, Rangewide Status of the Species and Critical Habitat and Section 2.3, Environmental Baseline, of this opinion, proposed 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. We would expect the proposed fishing to result in minimal additional impacts by the loss of some gill nets to a subset of these features. Thus, the proposed fishing is not likely to reduce the value of proposed critical habitat for the conservation of yelloweye rockfish, canary rockfish, and bocaccio of the Puget Sound/Georgia Basin DPSs.

In spring of 2013, NMFS appointed a recovery team to assist in the development of a recovery plan for listed rockfish of the Puget Sound/Georgia Basin. The recovery plan will identify measures necessary to protect and restore degraded habitats, manage fisheries consistent with recovery, and prioritize research on data gaps regarding listed rockfish habitat usage and population parameters. A draft recovery plan is expected to be released for public review and comment in late 2014. In summary, the level of lethal take from the proposed action is within or below the precautionary range, and the duration of the action. The ongoing recovery planning process, which includes state and tribal representatives, will identify protective measures to address impacts from all sources of bycatch. The increased use of descending devices is an important component of fisheries management, as well as studying the long-term survival of released rockfish. The recovery team is assessing the need for establishing RCAs and will include a framework for these evaluations in the recovery plan.

In summary, the three listed DPSs are at risk with regard to the each of the four VSP criteria, and habitats utilized by listed-rockfish are impacted by nearshore development, derelict fishing gear, contaminants within the food-web and regions of poor water quality, among other stressors. Benefits to habitat within the DPSs have come through the removal of thousands of derelict fishing nets, though nets deeper than 100 feet remain a threat. Degraded habitat and its consequences to listed-rockfish can only be described qualitatively because the precise spatial and temporal impacts to populations of yelloweye rockfish, canary rockfish and bocaccio are poorly understood. However, there is sufficient evidence to indicate that listed-rockfish productivity may be reduced because of alterations to habitat structure and function. Because most adult yelloweye rockfish, canary rockfish and bocaccio occupy waters much deeper than surface waters fished by commercial nets, the bycatch of adults in commercial salmon fisheries is likely low to non-existent. However, derelict gear is a source of potential incidental mortality. The recreational bycatch levels from the 2014/15 salmon fishery season, in combination with anticipated bycatch from other fisheries and research, their current status, the condition of the environmental baseline, and cumulative effects would not threaten the survival and recovery of yelloweye rockfish, canary rockfish and bocaccio. The structure of our analysis provides conservative population scenarios for the total population of each DPS, and likely overestimates the total mortalities of caught and released fish. Within this analysis, all of the calculated bycatch levels were within or below the precautionary mortality rates identified for overfished rockfish of the Pacific Coast. Concerns remain about fishery-mortality effects to spatial structure, connectivity and diversity for each species. These concerns are partially alleviated because of the low bycatch rates for each species, and considering that the abundance of each species is likely higher than assessed within our analysis.

2.8 Conclusion

2.8.1 Puget Sound Chinook

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 actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon ESU.

After reviewing the current status of critical habitat designated for the Puget Sound Chinook ESU, the environmental baseline within the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to adversely modify Puget Sound Chinook designated critical habitat.

2.8.2 Puget Sound Steelhead

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 actions, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Steelhead DPS.

After reviewing the current status of critical habitat proposed to be designated for the Puget Sound Steelhead ESU, the environmental baseline within the action area, the effects of the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to adversely modify proposed designated critical habitat for the Puget Sound Steelhead DPS.

2.8.3 Puget Sound/Georgia Basin Rockfish

After reviewing the current status of yelloweye rockfish, canary rockfish and bocaccio within the Puget Sound/Georgia Basin DPSs, the environmental baseline for the action area, the effects of the proposed fisheries, and the cumulative effects, NMFS concludes that the proposed actions are not likely to jeopardize the continued existence of each species of listed-rockfish.

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 results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. For this consultation, we interpret "harass" to mean an intentional or negligent action that has the potential to injure an animal or disrupt its normal behaviors to a point where such behaviors are abandoned or significantly altered.[19] Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

This incidental take statement specifies the impact of any incidental taking of endangered or threatened species. It also provides reasonable and prudent measures that are necessary or appropriate to minimize impacts and sets forth terms and conditions in order to implement the reasonable and prudent measures.

[19] NMFS has not adopted a regulatory definition of harassment under the ESA. The World English Dictionary defines harass as "to trouble, torment, or confuse by continual persistent attacks, questions, etc." The U.S. Fish and Wildlife Service defines "harass" in its regulations as "an intentional or negligent act or omission which creates the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering (50 CFR 17.3). The interpretation we adopt in this consultation is consistent with our understanding of the dictionary definition of harass and is consistent with the Service's interpretation of the term.

2.9.1 Amount or Extent of Take

2.9.1.1 Puget Sound Chinook

NMFS anticipates incidental take of listed Puget Sound Chinook to occur in Puget Sound salmon and steelhead fisheries from May 1, 2014 through April 30, 2015 through contact with fishing gear. NMFS anticipates Puget Sound salmon fisheries occurring in 2014 together with ocean and Puget Sound fisheries approved under existing consultations will not exceed the exploitation rates summarized in Table 13 in the column titled Ocean+Puget Sound. These exploitation rates account for landed and non-landed mortality of listed Puget Sound Chinook encountered in the consultation fisheries. Test, research, update and evaluation fisheries that inform fishery management decisions are included as part of the fishery-related mortality in FRAM model run Chin2814 summarized in Table 13. Exploitation rates are used to define the extent of take for several reasons: (1) they are a direct measure of the take of the listed species; (2) they are a key parameters used to analyze the effects of the proposed actions; (3) fisheries are designed and managed based on exploitation rates; (4) they can be monitored and assessed; and, (5) they are responsive to changes in abundance.

2.9.1.2 Puget Sound Steelhead

NMFS anticipates incidental take to occur in Puget Sound treaty and non-treaty marine and freshwater commercial, ceremonial and subsistence, and recreational salmon and steelhead fisheries from May 1, 2014 through April 30, 2015 through contact with fishing gear.

Based on catch estimates from 2001/2002-2006/2007, NMFS anticipates that, , no more than 325 steelhead incidental mortalities will be caught in marine treaty and non-treaty fisheries targeting salmon and unlisted hatchery steelhead. Since not all catch is sampled for marks, this estimate includes an unknown proportion of listed natural-origin, and listed and unlisted hatchery fish as well as both encounters and incidental mortality.

Based on catch estimates from 2001/2002 – 2006/2007, NMFS anticipates that the harvest rate on natural-origin steelhead in freshwater treaty and non-treaty fisheries targeting salmon and unlisted hatchery steelhead will be no more than 4.2 percent. This was calculated as an average across the five Puget Sound winter steelhead populations for which sufficient data are available (i.e., Skagit, Snohomish, Green, Puyallup and Nisqually). That is, the 4.2 percent harvest rate represents an average across the five winter steelhead populations; it is not an anticipated population specific freshwater harvest rate.

NMFS does not have similar estimates of freshwater harvest for other Puget Sound steelhead populations. However, NMFS anticipates that the harvest rates for other populations will be within the range for the five populations discussed above based on the similarity of catch patterns and fishing regulations.

In addition, no more than 52 natural origin steelhead will be encountered and no more than 5 mortalities are anticipated during implementation of research activities.

2.9.1.3 Puget Sound/Georgia Basin Rockfish

NMFS anticipates that incidental take of ESA listed rockfish will occur by two separate pathways. (1) Bycatch of listed-rockfish by anglers targeting salmon, and (2) the indirect effects of lost (derelict) nets. NMFS anticipates that up to 114 yelloweye rockfish, 312 canary rockfish and 26 bocaccio will be killed as bycatch by anglers during the 2014/2015 Puget Sound salmon fishing season. The WDFW monitors the bycatch estimates of listed-rockfish species through dockside and phone surveys of anglers within the DPS and provides this data to NMFS on an annual basis. NMFS anticipates that some minimal take of listed-rockfish will occur as a result of the indirect effects of lost nets in the Puget Sound/Georgia Basin. NMFS estimates that up to 20 gill nets from salmon fisheries may become lost, and of those up to five nets would not be retrieved. If those five nets are lost within rockfish habitat, they would degrade benthic areas potentially used by listed-rockfish. Estimating the specific number of listed-rockfish that may be killed from a new derelict net is difficult to quantify because of several factors that include the location of its loss, the habitat which it eventually catches on, and the occurrence of fish within or near that habitat. The co-managers also track derelict nets through their reporting system and partnership with the Northwest Straits Initiative.

2.9.1.4 Southern Resident Killer Whales

In Section 1.2, we incorporated by reference NMFS' previous biological opinion and critical habitat analysis and findings regarding the Puget Sound Chinook Resource Management Plan effects on Southern Resident Killer Whales (NMFS 2011a). We incorporated the previous analysis and findings by reference (and therefore the status, environmental baseline, effects, and conclusions), because the fisheries currently proposed would only have a limited effect on Puget Sound Chinook stocks during the May 30, 2014-April 30, 2015 fishing season, and the effects during this time are not likely to be more than the effects previously considered for three-years of past fishing (NMFS 2011a). For clarity and completeness, we repeat those conclusions here. NMFS finds that the proposed fisheries are within the scope of effects considered in the previous biological opinion (NMFS 2011a), and the proposed fisheries are likely to adversely affect, but not likely to jeopardize the continued existence of Southern Resident killer whales or adversely modify their critical habitat. The allowable take estimated for killer whales in the NMFS (2011a) opinion remains in effect (i.e., Take is within the extent of effects analyzed where the abundance of large Chinook in the action area as estimated by FRAM during July-September is within the range evaluated in this biological opinion (Table 1 in Appendix A of NMFS 2011a; No Action FRAM abundance w/ 6.6% reduction in abundance from proposed fisheries: 873,766 – 1,747,166 Chinook)).

2.9.2 Effect of the Take

In Section 2.7, NMFS determined that the level 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 when the reasonable and prudent alternative is implemented.

2.9.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures to minimize the amount or extent of incidental take (50 CFR 402.02).

There are four reasonable and prudent measures included in this incidental take statement for the Puget Sound Chinook salmon ESU and Puget Sound steelhead DPS considered in this opinion:

(1) In-season management actions taken during the course of the fisheries shall be consistent with the level of incidental take established preseason that were analyzed in the biological opinion (see section 2.8.1.1).
(2) Catch and other management measures used to control fisheries shall be monitored using best available measures.
(3) The fisheries shall be sampled for stock composition and other biological information.
(4) A schedule to complete those tasks that were identified in the documents comprising the consultation package from the BIA (Grayum and Anderson 2014, Speaks 2014, Redhorse 2014) to be started or completed in 2014 will be developed no later than June 1, 2014. Progress on the tasks consistent with the schedule must occur unless otherwise agreed by the parties or consultation may need to be re-initiated.
(5) The reasonable and prudent measures developed for killer whales in the NMFS (2011a) opinion remain in effect.

NMFS also concludes that the following reasonable and prudent measure is necessary to minimize the impacts to ESA listed Puget Sound/Georgia Basin rockfish.

Derelict gear impacts on listed rockfish shall be reported using best available measures.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and NMFS, BIA, USFWS or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The NMFS, BIA, and USFWS or any applicant have 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 incidental take statement (50 CFR 402.14). If the following terms and conditions are not complied with, the protective coverage of section 7(o)(2) will likely lapse.

The BIA, USFWS, and NMFS must comply with the following terms and conditions, which implement the reasonable and prudent measures, described above and outline required reporting/monitoring requirements in order to be exempt from the prohibitions of section 9 of the ESA.

These terms and conditions are non-discretionary.

(1) The BIA, USFWS and NMFS, to the extent of their authority, shall work with WDFW and the Puget Sound treaty tribes to ensure that preseason plan, and in-season management actions taken during the course of the fisheries are consistent with the levels of anticipated take.

(2) The BIA, USFWS and NMFS, to the extent of their authority, shall work with WDFW and the Puget Sound treaty tribes to ensure that the catch and implementation of other management measures associated with fisheries that are the subject of this opinion are monitored at levels that are comparable to those used in recent years.
(3) The BIA, USFW and NMFS, to the extent of their authority, shall work with WDFW and the Puget Sound treaty tribes to ensure that the fisheries that are the subject of this opinion are sampled for stock composition, including the collection of coded-wire tags and other biological information (age, sex, and size) to allow for a thorough post-season analysis of fishery impacts on listed species.
(4) The NMFS will meet with the co-managers no later than June 1 to develop a schedule to complete those tasks that were identified in Section 2.8.3, item (4) to be started or completed in 2014. If continuing progress on the tasks consistent with the schedule does not occur, consultation may need to be re-initiated.
(5) The BIA, USFWS, and NMFS, in cooperation with WDFW, and Puget Sound treaty tribes as appropriate, shall ensure that commercial fishers report the loss of any fishing gear within 24 hours of its loss to appropriate authorities.[20]
(6) The terms and conditions developed for killer whales in the NMFS (2011) opinion remains in effect.

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 CFR 402.02). NMFS believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by the BIA, USFWS and NMFS in cooperation with the Puget Sound treaty tribes and WDFW.

(1) The BIA, USFWS, and NMFS in collaboration with WDFW and the Puget Sound treaty tribes should continue to evaluate improvement in gear technologies and fishing techniques in commercial and recreational fisheries to reduce impacts on listed species without compromising data quality used to manage fisheries.
(2) The BIA, USFWS, and NMFS in collaboration with WDFW and the Puget Sound treaty tribes, should continue to evaluate the potential selective effects of fishing on the size, sex composition, or age composition of salmon populations.
(3) The BIA, USFWS, and NMFS in collaboration with the WDFW and the Puget Sound treaty Tribes, should continue to collect data on steelhead populations where insufficient data exist and improve upon catch accounting for all steelhead populations as resources become available.
(4) The BIA, USFWS, and NMFS in collaboration with the WDFW, and the Puget Sound treaty tribes, should implement the recommendations for the prevention, retrieval and

[20] 1-855-542-3935 (WA Dept of Fish and Wildlife) or 360-733-1725 (Northwest Straits), http://www.derelictgeardb.org/reportgear.aspx, or a tribal fishery manager.

investigation of gear modifications of gill nets used in Puget Sound salmon fisheries reported in Gibson (2013).

(5) The BIA, USFWS, and NMFS in collaboration with the WDFW, and the Puget Sound treaty tribes, should transition to working with anglers to use descending devices to mitigate the effects of barotrauma for listed rockfish bycatch.

(6) The BIA, USFWS, and NMFS in collaboration with the WDFW, and the Puget Sound treaty tribes, should continue to assess best available and precautionary methods to estimate listed rockfish bycatch in the salmon fishery in Puget Sound.

2.11 Reinitiation of Consultation

As provided in 50 CFR 402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

2.12 "Not Likely to Adversely Affect" Informal Consultations

This section addresses two additional species (southern green sturgeon, southern eulachon) which occur in the action area and any associated critical habitat.

Green Sturgeon

Individuals of the southern DPS of green sturgeon are unlikely to be caught in Puget Sound salmon fisheries. Most marine area fisheries use hook-and-line gear to target pelagic feeding salmon near the surface and in mid-water areas. Net gear that is used in terminal and nearshore areas throughout the action area is fished at the surface. Green sturgeon are bottom oriented, benthic feeders. NMFS is not aware of any records or reports of green sturgeon being caught in Puget Sound salmon fisheries. Any contact of the gear with the bottom would be rare and inadvertent. Given their separation in space and differences in feeding habitats, and the nature and location of the salmon fisheries, NMFS would not expect green sturgeon to be caught in or otherwise affected by the proposed fisheries or there to be any effect on the primary constituent elements (PCEs) of the critical habitat, making any such effects discountable. The proposed salmon fisheries therefore are not likely to adversely affect green sturgeon or its designated critical habitat.

Eulachon

Eulachon in the listed southern DPS are primarily a marine, pelagic species that spawn in the lower reaches of coastal rivers and whose primary prey is zooplankton (Drake et al. 2010a). They are typically found "in near-benthic habitats in open marine waters" of the continental shelf between 20 and 150 m depth (Hay and McCarter 2000). In Puget Sound the species is found on occasion in several rivers including the Elwha, the Puyallup, the Nisqually, the Little Quilcene, and the Snohomish, as well as rivers in the San Juan Islands (W. Palsson, WDFW, unpubl. data). Since 1888, the states of Washington and Oregon have maintained a commercial and recreational fishery for eulachon. In the commercial fishery, eulachon were caught using small-mesh gillnets (i.e., ≤2 inches) and small mesh dipnets (although small trawl gear is legal, it is rarely used). However, in 2010, following the listing of eulachon under the ESA, the states of Washington and Oregon permanently closed the commercial and recreational eulachon fishery. In 2014 the states of Washington and Oregon adopted a limited-opportunity recreational and commercial fishery on eulachon in the Columbia River as well as the Cowlitz and Sandy Rivers. Eulachon have been taken as bycatch in pink shrimp trawl gear off of the coast of Oregon, Washington and California (Hannah and Jones 2007) and in Puget Sound (W. Palsson, pers. comm., WDFW, Fish Biologist). Salmon fisheries in the northern Puget Sound areas use nets with large mesh sizes (i.e., >4 inches) and hook and line gear designed to catch the much larger salmon species. The gear is deployed to target pelagic feeding salmon near the surface and in mid-water areas. Encounters of eulachon in salmon fisheries would be extremely unlikely given the general differences in spatial distribution and gear characteristics. NMFS is not aware of any record of eulachon caught in either commercial or recreational Puget Sound salmon fisheries. Given all of the above, NMFS would not expect eulachon to be caught or otherwise affected by the proposed fisheries, making any such effects discountable. The proposed salmon fisheries therefore are not likely to adversely affect eulachon or its designated critical habitat.

3 Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

The consultation requirement of 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 effects occur when EFH quality or quantity is reduced by a direct or indirect physical, chemical, or biological alteration of the waters or substrate, or by the loss of (or injury to) benthic organisms, prey species and their habitat, or other ecosystem components. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 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 descriptions of EFH for Pacific coast groundfish (PFMC 2005), coastal pelagic species (PFMC 1998), and Pacific coast salmon (PFMC 1999) contained in the Fishery Management Plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce. This section is NMFS' Magnuson-Stevens Fishery Conservation and Management Act (MSA) consultation on the three federal actions considered in the above sections of the opinion (see Section 1.3).

3.1 Essential Fish Habitat Affected by the Project

The action area includes habitats that have been designated as EFH for various life-history stages of Puget Sound Chinook salmon, coho salmon and Puget Sound pink salmon. The action area includes the major rivers and tributaries, and marine waters to the east of Cape Flattery in the hydrologic units identified for Chinook, coho salmon and Puget Sound pink salmon in Table A-1 of Appendix A to Amendment 14 (USGS Hydrologic Units 17110002-17110021)(PFMC 1999, 2010). In those waters, it includes the areas used by Chinook, coho and pink adults (migration, holding, spawning), eggs and alevins (rearing) and juveniles (rearing, migration). The action area includes habitats of Pacific coast groundfish used for spawning, breeding, feeding, or growth to maturity, as described in the Fishery Management Plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce (see NMFS' Final Rule, 71 FR 27408). Essential fish habitat for CPS is defined based on the temperature range where they are found, and on the geographic area where they occur at any life stage. This range varies widely according to ocean temperatures. The east-west boundary of CPS EFH includes all marine and estuary waters from the coasts of California, Oregon, and Washington to the limits of the EEZ (the 200-mile limit) and above the thermocline where sea surface temperatures range between 10° and 26° centigrade. The southern boundary is the U.S./Mexico maritime boundary. The northern boundary is more changeable and is defined as the position of the 10° C isotherm, which varies seasonally and annually. In years with cold winter sea surface temperatures, the 10° C isotherm during February is around 43° N latitude offshore, and slightly further south along the coast. In August, this northern boundary moves up to Canada or Alaska. Assessment of potential adverse effects on these species EFH from the proposed action is based, in part, on this information.

3.2 Adverse Effects on Essential Fish Habitat

3.2.1 Salmon

The PFMC assessed the effects of fishing on salmon EFH and provided recommended conservation measures in Appendix A to Amendment 14 of the Pacific Coast Salmon Plan (PFMC 1999). The PFMC identified five types of impact on EFH: 1) gear effects; 2) harvest of prey species by commercial fisheries; 3) removal of salmon carcasses; 4) redd or juvenile fish disturbance; and 5) fishing vessel operation on habitat. Of the five types of impact on EFH identified by the PFMC for fisheries, the concerns regarding gear-substrate interactions, removal of salmon carcasses, redd or juvenile fish disturbance and fishing vessel operation on habitat are also potential concerns for the salmon fisheries in Puget Sound. However, the PFMC recommendations to address these effects are already included in the proposed action.

Gear Effects & Fishing Vessel Operation

Possible fishery-related impacts on riparian vegetation and habitat would occur primarily through bank fishing, movement of boats and gear to the water, and other stream side usages. The types of salmon fishing gear that are used in Puget Sound salmon fisheries in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. The proposed fishery implementation plan includes actions that would minimize these impacts if they did occur, such as area closures. Also these effects would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries (i.e., recreational boating and marine species fisheries). Therefore, the proposed fisheries would have a negligible additional impact on the physical environment. When fishing nets are lost, salmon subsequently can become entangled in the derelict gear and die (see Removal of Salmon Carcasses).

Removal of Salmon Carcasses

Salmon carcasses provide nutrients to stream and lake ecosystems. Spawning salmon reduce the amount of fine sediment in the gravel in the process of digging redds (PFMC 1999). Salmon fishing removes a portion of the fish whose carcasses would otherwise have contributed to providing those habitat functions.

The PFMC conservation recommendation to address the concern regarding removal of salmon carcasses was to manage for spawner escapement levels associated with maximum sustained yield (MSY), implementation of management measures to prevent over-fishing and compliance with requirements of the ESA for ESA listed species. The mortality that may occur associated with derelict gear is taken into account in setting MSY spawner escapement levels as part of the natural mortality component. These conservation measures are basic principles of the harvest objectives used to manage salmon fisheries. Therefore, management measures to minimize the effects of salmon carcass removal on EFH, including mortality from derelict gear, are an integral component of the management of the proposed fisheries.

Redd or Juvenile Fish Disturbance

Trampling of redds during fishing has the potential to cause mortality of salmonids. Boat operation can result in stranding and mortality related to pressure changes in juveniles (PFMC 1999).

The PFMC report recommended angler education and the closer of key spawning areas during the time that eggs and juvenile salmon were present. Salmon fisheries are closed or fishing activities do not occur in freshwater areas in Hood Canal, North Puget Sound and the Strait of Juan de Fuca during peak spawning, rearing and out-migration periods (Thom Johnson, pers. comm., WDFW, Fisheries Biologist, April 26, 2010). Notices are posted near fishing access areas by WDFW and the Washington State Parks, and news releases are distributed regularly by WDFW explaining responsible fishing behavior, including avoidance of spawning areas and damage to riparian areas (Thom Johnson, pers. comm., WDFW, Fisheries Biologist, April 26, 2010). The Puyallup and White River in South Puget Sound are closed to salmon fishing through much of Chinook salmon migration and spawning. These management measures should minimize redd or juvenile fish disturbance due to conduct of the proposed Puget Sound salmon fisheries.

3.2.2 Groundfish

As described in Section 2.4.4 of this opinion, NMFS believes that the proposed action would have the following adverse effects on the EFH of groundfish.

Habitat Alteration

Lost commercial fishing nets would adversely affect groundfish EFH. As described in section 2.4.4, most nets hang on bottom structure that is also used by groundfish. This structure consists of high-relief rocky substrates or boulders located on sand, mud or gravel bottoms (Good et al. 2010). Derelict nets alter habitat suitability by trapping fine sediments out of the water column. This makes a layer of soft sediment over rocky areas, changing habitat quality and suitability for benthic organisms (Good et al. 2010). Nets can also cover habitats used by groundfish for shelter and pursuit of food, rendering the habitat unavailable. Using the most common derelict net size reported by Good et al. (2010), if up to 20 nets were initially lost and five were not retrieved they would degrade approximately one acre of benthic habitat.

Reduction in Groundfish Prey

Nets can reduce the abundance and availability of groundfish prey that include invertebrates and fish (Good et al. 2010).

Entanglement

Various groundfish species can be accidently entangled by inorganic debris such as derelict fishing nets that settle to and catch upon structure of benthic environments (Hanson et al. 2004).

3.2.3 Coastal Pelagic

The proposed action would not have an adverse affect on coastal pelagic EFH. Commercial and recreational fisheries targeting salmon would not appreciably alter habitats used by coastal pelagic species. Any derelict gear would occur in benthic habitats, not pelagic habitats.

3.3 Essential Fish Habitat Conservation Recommendations

NMFS expects that fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2 above, approximately one acre of designated EFH for Pacific coast groundfish species.

Pursuant to Section 305(b)(4)(A) of the MSA, NMFS is required to provide EFH conservation recommendations to Federal agencies regarding actions which may adversely affect EFH.

NMFS is not providing any EFH conservation measures for salmon EFH because the proposed action includes adequate measures to mitigate for the potential adverse effects from salmon fishing. We provide the following conservation recommendations to minimize the adverse affects to groundfish EFH; consistent with the terms and conditions described for rockfish in Section 2.8.3 of the opinion:

Derelict Gear Reporting

The BIA, USFWS and NMFS, in collaboration with the state and Puget Sound treaty tribes, should encourage commercial fishers to report derelict gear lost in marine areas within the Action Area to appropriate authorities within 24 hours of its loss.

Derelict Gear Accounting & Locations

The BIA, USFWS and NMFS, in collaboration with the state and Puget Sound treaty tribes, should track the total number and approximate locations of nets lost (and subsequently recovered) in marine areas within the Action Area and account for them on an annual basis.

Derelict Gear Prevention

The BIA, USFWS and NMFS, in collaboration with the Washington Department of Fish and Wildlife, and Puget Sound treaty tribes, should implement the recommendations for the prevention, retrieval and investigation of gear modifications of gill nets used in Puget Sound salmon fisheries reported in Gibson (2013).

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, BIA, USFWS and NMFS must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

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

The BIA, NMFS and USFWS must reinitiate EFH consultation with NMFS 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' EFH conservation recommendations (50 CFR 600.920(l)).

4 Data Quality Act Documentation and Pre-Dissemination Review

Section 515 of the Treasury and General Government Appropriations Act of 2001 (Public Law 106-554, 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 biological opinion addresses these DQA components, documents compliance with the DQA, and certifies that this biological opinion has undergone pre-dissemination review.

4.1 Utility

This ESA section 7 consultation on the issuance of the ESA section 10(a)(1)(A) research permit concluded that the actions will not jeopardize the continued existence of any species. Therefore, the funding/action agencies may carry out the research and fishery management actions and NMFS may permit them. Pursuant to the MSA, NMFS determined that no conservation recommendations were needed to conserve EFH.

The intended users of this consultation are the applicants and funding/action agencies listed on the first page. The agencies, applicants, and the American public will benefit from the consultation.

Individual copies were made available to the applicants. This consultation will be posted on the NMFS NW Region web site (http://www.nwr.noaa.gov). 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 its supporting documents are clear, concise, complete, unbiased, and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA Regulations, 50 CFR 402.01 *et seq.*, and the MSA implementing regulations regarding EFH, 50 CFR 600.920(j).153

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

Referencing
All supporting materials, information, data, and analyses are properly referenced. They follow 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.

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Appendix A

Summary of the Independent Science Panel's Findings, New Science Available Following the Science Panel's Review, and Future Research Needs to Characterize Uncertainty and Reduce Bias

INDEPENDENT SCIENCE PANEL'S FINDINGS

Through the recent NMFS- Canadian Department of Fisheries and Oceans (DFO) bilateral scientific workshop process, an independent science panel completed a rigorous and comprehensive review of the status of the science relating the potential effects of salmon fisheries on the abundance of Chinook salmon available to Southern Residents and the potential consequences of these effects to the survival and recovery of the whales.

Based on the ESA endangered listing and an endangered listing pursuant to Canada's Species at Risk Act, DFO joined with NMFS to commission an independent, multidisciplinary panel of scientists to review the available science regarding Southern Residents and salmon fisheries in an open and inclusive scientific workshop process and produced a report documenting its findings. We held three transboundary workshops bringing a multidisciplinary group of scientists together to present and critically evaluate the best available science pertinent to the following key question:

> *To what extent are salmon fisheries affecting recovery of Southern Resident killer whales by reducing the abundance of their available prey, and what are the consequences to their survival and recovery?*

The series of scientific workshops was attended by all seven members of the panel and nearly a hundred other invited scientists representing NMFS, DFO, academia, industry, conservation organizations, management agencies, tribes, First Nations and others. The first workshop occurred September 21-23, 2011 in Seattle, Washington and the second March 13-15, 2012 in Vancouver, Canada. The panel issued a draft report following the second workshop. Comments received on the panel's draft report and other analyses requested by the panel were presented and considered at the third workshop, which was held September 18-20, 2012 in Seattle. The panel issued its final report on November 30, 2012 (Hilborn et al. 2012).

The science panel was charged with evaluating the available science; it was not asked to make management recommendations or perform analyses. Applying the science to management remains the responsibility of NMFS and DFO in their respective jurisdictions, operating in accordance with applicable statutes and consultation protocols. However, the panel's findings regarding the strengths and weaknesses of the available science inform the agencies' decisions regarding actions that affect the abundance of Chinook salmon available to the whales. A key purpose of the workshop process was to critically evaluate the science relating Chinook abundance to the population demographics of the whales and to consider whether changes in fisheries would contribute to the recovery of the whales by appreciably increasing the abundance of their prey.

Conclusions and Recommendations of the Independent Science Panel

The panel found good evidence that Chinook salmon are a very important part of the Southern Residents diet and good evidence, collected since 1994, that some killer whales have been in poor condition and poor condition is associated with higher mortality rates. They further found that the mechanistic data developed to date provide some support for a cause and effect relationship between salmon abundance and killer whale survival and reproductions. They identified "reasonably strong" evidence that vital rates of Southern Residents are, to some degree, ultimately affected by broad-scale changes in their primary Chinook salmon prey. However, they suggested that the effect is not linear, because predicted improvements in killer whale survival diminish at Chinook salmon abundance levels beyond the historical average. Overall, the panel concluded that the impact of reduced Chinook salmon harvest on future availability of Chinook salmon to Southern Residents is not clear, and cautioned against overreliance on correlative studies (Hilborn et al. 2012). In the panel's words:

> "The Panel's overall view is that the predator-prey system involving Chinook salmon, SRKW, NRKW, and some pinnipeds is only partially described by correlations between Chinook salmon and SRKW. Therefore, any predictions about impacts of changing fisheries may not be robust to changes in the status of other Chinook salmon predators, or even to changes in Chinook salmon abundance (Hilborn et al. 2012)."

The panel made a number of recommendations for additional research, which we briefly summarize in Table 2. Most of the panel's recommendations are intended to provide additional information to evaluate two main issues highlighted in their report: the likelihood of a cause-and-effect relationship between variation in coastal indices of Chinook salmon abundance and Southern Residents vital rates, and the degree to which changes in fisheries would influence the abundance of Chinook salmon available to the whales.

Both the workshops themselves and the resulting report focused considerable attention on the question of whether the significant statistical relationship between various Chinook salmon abundance indices and killer whale whale vital rates indicates a cause-and-effect relationship between the two. Several of their research recommendations are designed to improve our understanding of this relationship. Recommendations in this category consist primarily of research to better understand the whales' winter coastal diet and distribution (i.e., to determine if Chinook salmon are in fact important to the whales year-round), and research to more directly evaluate whether periods of low salmon abundance also correspond with levels of poor condition or nutritional stress exhibited by the whales. Research to investigate seasonal variation in condition and metabolism also falls in this category. Many of these research topics were previously identified in the NMFS Southern Resident killer whale recovery plan (NMFS 2008) and are currently ongoing at some level.

NMFS is also concerned about the indirect effect of fishery reductions on hatchery production. Most hatcheries are designed to mitigate for habitat degradation and the associated loss of naturally produced fish. These hatcheries produce fish to provide harvest for ocean and terminal area fisheries. A large proportion of the Chinook salmon in the ocean is produced in hatcheries. In some places, the majority of fish are hatchery-origin. If ocean fisheries were reduced or closed to protect killer whales, it is unclear whether the hatcheries would continue to produce fish. The net effect of a fishery reduction could actually be a reduction in ocean abundance as hatcheries close or otherwise redirect their mitigation obligations.

Table 1 – Summary of panel's research recommendations (page numbers in parentheses)

Recommendation	In Recovery Plan?	Research in Progress?
Collect information on the SRKW coastal diet and distribution (v, xii, 18, 20, 21, 23, 38)	Yes	Yes
Collect more information on stock-specific Chinook salmon distribution during winter (35, 38)	Yes	No
Better quantify Chinook salmon consumption by other predators, particularly seals and sea lions, including updated abundance estimates of these predators (ix, 38, B-4)	No	Yes
Gain more realistic understanding of SRKW dynamics as a function of both prey abundance and abundance of other predators; better quantify abundance of Chinook salmon that would be made available to SRKW through fishery reductions fishery removals (competing risk of death models) (ix, 33, 35, 38, 51, 52)	No	No
Collect information on seasonal differences in SRKW metabolism, condition, and prey consumption. (21, 22, 24, vi)	Yes	Partial
Evaluate relationship between salmon abundance and whale condition (vi, xii, 24)	No	Partial
Better quantify the effects of alternative fishing scenarios on long-term abundance of Chinook salmon (36)	No	No
Research to characterize potential catastrophic risks faced by SRKW (52)	Yes	Yes
Better estimates of the carrying capacity of SRKW and whether they are currently experience density dependent growth	No	Yes

New Science Developed Following the Workshop Process
Additional information and analysis related to the effects of salmon abundance on Southern Residents has become available since the Panel released their final report in November of 2012. This information is briefly summarized below.

Updated abundance information for the whales – Most of the analysis reported to the independent science panel used annual Southern Resident abundance data through 2010. The NWFSC has continued to fund the Center for Whale Research (CWR) to conduct the annual census of the Southern Resident population, and census data is now available through 2013. During this three-year period, the summer census number declined from 86 animals to 82 animals as a result of 9 deaths (7 adult females, 2 adult males, 1 juvenile, and 1 calf) and 5 births. Following the July 2013 census count of 82 whales, two additional adults have disappeared (1 adult female, 1 adult male) leaving 80 whales in the population. This recent decline emphasizes the importance of updating analyses of future population projections and serves to reinforce the uncertainties about future population status.

Publication of the NWFSC technical report describing the demographic analyses reported during the workshops – The primary population modeling analyses conducted by the NWFSC to evaluate the potential effects of changes in salmon abundance on future killer whale abundance have been published as NMFS technical report (Ward et al. 2013). In addition, the NWFSC also evaluated several additional indices of Chinook salmon abundance as potential predictors of Southern Resident survival and birth rates. At the time of the 2nd workshop, the best-supported index was terminal run of fall-run Chinook salmon from the Oregon coast to Northern BC (Ward et al. 2013). Subsequent analyses after conclusion of workshop process found that a total run index consisting of all Chinook salmon stocks from California to Northern BC, combining terminal run with ocean catches, is a slightly better predictor. Both Ward et al. (2013) and the panel emphasized that most indices of Chinook salmon ocean abundance are highly correlated, so it is a mistake to put too much emphasis on minor differences in results among indices.

Distribution and diet of whales on the outer coast – As part of an effort to help understand where the Southern Residents go in the winter, and thus their winter habitat use, NWFSC staff researchers in collaboration with Cascadia Research Collective researchers tagged an adult male in December 2012 with a satellite-linked tag. The movements of this whale (and associated pod members) were monitored for 93 days. During that time the locations of the satellite tag allowed the whales to be intercepted as they traveled along the coast of Washington, Oregon, and California allowing for the collection of remains from predation events and fecal samples. In total, researchers collected 32 prey samples and 22 fecal samples. Preliminary analysis of these prey remains samples indicated that most prey samples were Chinook salmon, with smaller number of steelhead, chum, and halibut. Successful satellite tagging continues through the present, with anticipated collection of more prey samples.

Additional analysis of whale condition – In fall of 2013 the NWFSC funded researchers from the CWR and the Southwest Fisheries Science Center to collect additional photogrammetric data on the Southern Residents. Based on an initial analysis of the data, the researchers obtained measurable images from >85% of the population in 2013, many of which were of whales also analyzed in 2008 (Durban 2013). In 2014 the NOAA Fisheries Office of Science and Technology plans to fund analysis of these data as well as further analysis of the 2008 data in order to develop condition information for individual whales.

Future Research Needs to Characterize Uncertainty and Reduce Bias

A key question raised by the panel was the degree of confidence that broad reductions in salmon fisheries would in fact lead to appreciable increases in Chinook salmon available to the Southern Residents and that these increases would result in meaningful changes in whale survival or fecundity. In particular, the panel noted that fisheries reductions should not be expected to produce a 1:1 increase in Chinook salmon available to Southern Residents, because a portion of the salmon not caught in fisheries will be consumed by other predators or lost to other sources of mortality. Put another way, they suggested that the assumption of constant natural mortality is incorrect and that the true level of salmon mortality might vary greatly as a function of salmon abundance, predator abundance, and environmental conditions. In addition to failing to account for all potential sources of salmon mortality, the panel suggested that a simple two-species model would not adequately characterize the dynamics of such a complex system.

The panel made several suggestions for research related to the assertion that the model overestimated impacts, including collecting additional information on other salmon predator's abundance and diet, use of competing risk of death models and additional ecosystem models to better characterize how changes in fisheries interact with multiple predator species to affect Chinook abundance, and additional modeling of alternative "realistic" fishing scenarios. Most of these recommendations are for new research or analysis that is not explicitly addressed by the Southern Resident killer whale recovery plan.

The NWFSC has recently initiated a project to more closely examine the predator prey relationships and ecosystem functions consistent with the panel's recommendations. Another priority is to continue to develop and use methods for evaluating whale health and nutritional status and how this changes seasonally and among years. Continued photogrammetry studies are an important ongoing component of this effort, as are additional data on health status using other assays (e.g. hormones, microbial analysis, and behavioral information) will also be valuable. Combining multiple sources of information on individual whales in a common database will also allow for fuller development of individual health profiles.

As noted above, NMFS is also interested in examining the potential effects of fishery reductions on hatchery production and the net effect on salmon abundance.

Appendix B

Viable Risk Assessment Procedure

Viability Risk Assessment Procedure

NMFS analyzes the effects of harvest actions on populations using quantitative analyses where possible and more qualitative considerations where necessary. The Viable Risk Assessment Procedure (VRAP) is an example of a quantitative risk assessment method that was developed by NMFS and applied primarily for analyzing harvest impacts on Puget Sound and Lower Columbia River tule Chinook. VRAP provides estimates of population-specific exploitation rates (called Rebuilding Exploitation Rates or RERs) that are designed to be consistent with ESA-related survival and recovery requirements. Proposed fisheries are then evaluated, in part, by comparing the RERs to rates that can be anticipated as a result of the proposed harvest plan. Where impacts of the proposed plan are less than or equal to the RERs, NMFS considers the harvest plan to present a low risk to that population (the context and basis of NMFS' conclusions related to RERs is discussed in more detail below). The results of this comparison, together with more qualitative considerations for populations where RERs cannot be calculated, are then used in making the jeopardy determination for the ESU as a whole. A brief summary of VRAP and how it is used to estimate an RER is provided below. For a more detailed explanation see NMFS (2000) and NMFS (2004).

The Viable Risk Assessment Procedure:

- quantifies the risk to survival and recovery of individual populations compared with a zero harvest scenario;
- accounts for total fishing mortality throughout the migratory range of the ESU;
- explicitly incorporates management, data, and environmental uncertainty; and
- isolates the effect of harvest from mortality that occurs in the habitat and hatchery sectors.

The result of applying the VRAP to an individual population is an RER which is the highest allowable ("ceiling") exploitation rate that satisfies specified risk criteria related to survival and recovery. Calculation of RERs depend on the selection of two abundance-related reference points (referred to as critical and rebuilding escapement thresholds (CET and RET4)), and two risk criteria that define the probability that a population will fall below the CET and exceed the RET. Considerations for selecting the risk criteria and thresholds are discussed briefly here and in more detail in NMFS 2000.

The selection of risk criteria for analytical purposes is essentially a policy decision. For jeopardy determinations, the standard is to not "…reduce appreciably the likelihood of survival and recovery …" (50 CFR 402.2). In this context, NMFS used guidance from earlier biological opinions to guide the selection of risk criteria for VRAP. NMFS' 1995 biological opinion on the operation of the Columbia River hydropower system (NMFS 1995) considered the biological

4 Also referred to in previous opinions as the Upper Escapement Threshold.

requirements for Snake River spring/summer Chinook to be met if there was a high likelihood, relative to the historic likelihood, that a majority of populations were above lower threshold levels[5] and a moderate to high likelihood that a majority of populations would achieve their recovery levels in a specified amount of time. High likelihood was considered to be a 70% or greater probability, and a moderate-to-high likelihood was considered to be a 50% or greater probability (NMFS 1995). The Cumulative Risk Initiative (CRI) has used a standard of 5% probability of absolute extinction in evaluating the risks of management actions to Columbia River ESUs. The different standards of risk, i.e., 50% vs. 5%, were based primarily on the thresholds that the standard was measured against. The CRI threshold is one of absolute extinction, i.e., 1 spawning adult in a brood cycle. The Biological Requirements Work Group (BRWG 1994) threshold is based on a point of potential population destabilization, i.e., 150-300 adult spawners, but well above what would be considered extinction. In fact, several of the populations considered by the BRWG had fallen below their thresholds at some point and rebounded, or persisted at lower levels. Since the consequences to a species of the CRI threshold are much greater than the consequences of the BRWG thresholds, the CRI standard of risk should be much higher (5%). Scientists commonly define high likelihood to be ≥95%. For example, tests of significance typically set the acceptable probability of making a Type I error at 5%. The basis of the VRAP critical threshold is more similar to the BRWG lower threshold in that it represents a point of potential population destabilization. However, given the uncertainties in the data, especially when projected over a long period of time, and the different risk to populations represented by the two thresholds, we chose a conservative approach both for falling below the critical threshold, i.e., 5%, and exceeding the recovery threshold, i.e., 80%.

The risk criteria were chosen within the context of the jeopardy standard. They measure the effect of the proposed action against the baseline condition, and require that the proposed action not result in a significant negative effect on the status of the species over the conditions that already exist. We determined that the risk criteria consistent with the jeopardy standard would be that: (1) the percentage of escapements below the critical threshold differs no more than 5% from that under baseline conditions; *and* (2) the viable threshold must be met 80% of the time, *or* the percentage of escapements less than the viable threshold differs no more than 10% from that under baseline conditions. Said another way, these criteria seek to identify an exploitation rate that will not appreciably increase the number of times a population will fall below the critical threshold and also not appreciably reduce the prospects of achieving recovery. For example, if under baseline conditions, the population never fell below the critical threshold, escapements must meet or exceed the critical threshold 95% of the time under the proposed harvest regime.

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5 The Biological Requirements Work Group defined these as levels below which uncertainties about processes or population enumerations are likely to become significant, and below which qualitative changes in processes are likely to occur (BRWG 1994). They accounted for genetic risk, and some sources of demographic and environmental risk.

As described above, VRAP uses critical escapement and rebuilding escapement thresholds as benchmarks for calculating the RERs. Both thresholds represent natural-origin spawners. The CET represents a boundary below which uncertainties about population dynamics increase substantially. In cases where sufficient stock-specific information is available, we can use the population dynamics relationship to define this point. Otherwise, we use alternative population-specific data, or general literature-based guidance. NMFS has provided some guidance on the range of critical thresholds in its document, *Viable Salmonid Populations* (McElhaney et al. 2000). The VSP guidance suggests that effective population sizes of less than 500 to 5,000 per generation, or 125 to 1,250 per annual escapement, are at increased risk. For the Lower Columbia River tule analyses, we generally used CETs corresponding to the Willamette/Lower Columbia River TRT's quasi-extinction thresholds (QET): 50/year for four years for 'small' populations, 150/year for four years for medium populations, and 250/year for four years for large populations (McElhany et al. 2000).

The RET may represent a higher abundance level that would generally indicate recovery or a point beyond which ESA type protections are no longer required. The RET could also be an estimate of the spawners needed to achieve maximum sustainable yield or for maximum recruits, or some other designation. It is important to recognize, though, that the RET is not an escapement goal but rather a threshold level that is expected to be exceeded most of the time (≥ 80%). It should also be noted that, should the productivity and/or capacity conditions for the population improve, the RET should be changed to reflect the change in conditions.
There is often some confusion about the relationship between rebuilding escapement thresholds used in the VRAP analysis, and abundance related recovery goals. The RET are generally significantly less than recovery goals that are specified in recovery plans. VRAP seeks to analyze a population in its existing habitat given current conditions. As the productivity and capacity of the habitat improves, the VRAP analysis will be adjusted to reflect those changes. Thus the RET serves as a step in the progression to recovery, which will occur as the contributions from recovery action across all sectors are realized.

There are two phases to the VRAP process for determining an RER for a population. The first, or model fitting phase, involves using data from the target population itself, or a representative indicator population, to fit a spawner-recruit relationship representing the performance of the population over the time period analyzed. Population performance is modeled as:

$$R = f(S, \mathbf{e}),$$

> where S is the number of fish spawning in a single return year, R is the number of adult equivalent recruits,[6] and **e** is a vector of environmental, density-independent indicators of annual survival.

6 Equivalently, this could be termed "potential spawners" because it represents the number of fish that would return to spawn absent harvest-related mortality.

Several data sets are necessary for this: a time series of natural spawning escapement, a time series of total recruitment by cohort, and time series for the environmental correlates of survival. In addition, one must assume a functional form for f, the spawner-recruit relationship. Given the data, one can numerically estimate the parameters of the assumed spawner-recruit relationship to complete the model fitting phase.

The data are fitted using three different models for the spawner recruit relationship: the Ricker (Ricker 1975), Beverton-Holt (Ricker 1975), and Hockey stick (Barrowman and Meyers 2000). The simple forms of these models can be augmented by the inclusion of environmental variables correlated with brood year survival. The VRAP is therefore flexible in that it facilitates comparison of results depending on assumptions between production functions and any of a wide range of possible environmental co-variates. Equations for the three models are as follows:

$R = (aS\mathrm{e}^{-bS})(M^{c}\mathrm{e}^{dF})$ [Ricker]

$R = (S/[bS + a])(M^{c}\mathrm{e}^{dF})$ [Beverton-Holt]

$R = (\min[aS, b])(M^{c}\mathrm{e}^{dF})$ [hockey stick]

In the above, M is the index of marine survival and F is the freshwater correlate.

The second, or projection phase, of the analysis involves using the fitted model in a Monte Carlo simulation to project the probability distribution of the near-term future performance of the population assuming that current conditions of productivity continue. Besides the fitted values of the parameters of the spawner-recruit relationships, one needs estimates of the probability distributions of the variables driving the population dynamics, including the process error (including first order autocorrelation) of the spawner-recruit relationship itself and each of the environmental correlates.[7] Also, since fishing-related mortality is modeled in the projection phase, one must estimate the distribution of the deviation of actual fishing-related mortality from the intended ceiling. This is termed “management error” and its distribution, as well as the others, is estimated from available recent data.

For each of a stepped series of exploitation rates the population is repeatedly projected for 25 years. From the simulation results we computed the fraction of years in all runs where the escapement is less than the critical escapement threshold and the fraction of runs for which the final year’s escapement is greater than the rebuilding escapement threshold. Exploitation rates for which the first fraction is less than 5% and the second fraction is greater than 80% (or 10%

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7 Actual environmental conditions may vary from the modeled 25-year projections due to such things as climate change, restoration actions, development, etc. However, it is difficult to anticipate exactly how conditions might be different for a specific population which is the focus of the VRAP analysis. Incorporation of the observed uncertainty in each of the key parameters in the VRAP analysis, the use of high probabilities related to abundance thresholds and periodic revision of the RERs on a shorter time frame (e.g., 5-10 years) in the event that conditions have changes serve to mitigate this concern.

from baseline) satisfies the identified risk criteria are thus used to define the population specific ceiling exploitation rates for harvest management.

Finally, the population-specific RERs must be made compatible with the exploitation rates generated from the FRAM model for use in fishery management planning. The VRAP and the FRAM model were developed for different purposes and are therefore based on different data sources and use different approaches to estimate exploitation rates. The VRAP uses long-term population intensive data to derive a RER for a single population. The FRAM uses fishery intensive data to estimate the effects of southern U.S. West Coast fishing regimes across the management units (populations or groups of populations) present in those fisheries. Because the FRAM model is used for preseason planning and to manage fisheries, it is necessary to ensure that the RERs derived from VRAP are consistent with the management unit exploitation rates that we estimated by the FRAM model. To make them compatible, the RERs derived from VRAP are converted to FRAM-based RERs using linear or log-transform regressions between the exploitation rate estimates from the population specific data and post season exploitation rate estimates derived from FRAM.

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