Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries in 2016

NMFS Consultation Number: F/WCR-2016-4675

Action Agency: Bureau of Indian Affairs (BIA)

Affected Species and NMFS' 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
Southern Resident killer whales (*Orcinus orca*)	Endangered	No	No	No
Eulachon (*Thaleichthys pacificus*)	Threatened	No	No	No
Green Sturgeon (*Acipenser medirostris*)	Threatened	No	No	No

* Please refer to section 2.11 for the analysis of species or critical habitat that are not likely to be adversely affected.

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	No	Yes

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

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

Date: ___May 9, 2016____________ (***Date expires: May 31, 2016***)

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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
DPS	Distinct Population Segment
EFH	Essential Fish Habitat
ER	Exploitation Rate
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FRAM	Fishery Regulation and Assessment Model
HCSMP	Hood Canal Salmon Management Plan
HOR	Hatchery Origin Recruit
HR	Harvest Rate
HUC	Hydrologic Unit Code
ITS	Incidental Take Statement
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
PCE	Primary Constituent Element(s)
PFMC	Pacific Fishery Management Council
PSIT	Puget Sound Indian Tribes
PSTIT	Puget Sound 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
RER	Rebuilding Exploitation Rate
RMP(s)	Resource Management Plan(s)
SAS	Smolt to Adult Survival
RPA	Reasonable and Prudent Alternative
SUS	Southern United States
USFWS	U.S. Fish and Wildlife Service
VRAP	Viable Risk Assessment Procedure
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.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts A complete record of this consultation is on file at the Seattle NMFS West Coast Regional office.

This document constitutes NMFS' biological opinion under section 7 of the ESA and MSA Essential Fish Habitat consultation for the proposed Bureau of Indian Affairs (BIA) funding of Puget Sound treaty tribes' management, enforcement, and monitoring projects associated with Puget Sound salmon fisheries implemented from May 1-31, 2016.

This opinion considers impacts of the proposed actions on the Puget Sound Chinook salmon Evolutionarily Significant Unit (ESU) and the Puget Sound Steelhead Distinct Population Segment (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 as shown in Table 1, or NMFS has determined that the proposed actions will not affect or are not likely to adversely affect the species (Section 2.11).

1.2 Consultation History

On July 10, 2000, NMFS issued the ESA 4(d) rule establishing take prohibitions for 14 threatened 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. Since 2014, NMFS has consulted under section 7 of the ESA on the effects of Puget Sound salmon fisheries on listed species based on the general management framework described in the 2010-2014 RMP as amended for stock specific management changes. NMFS issued two biological opinions for the 2014 and 2015 fishery cycles (May 1, 2014 through April 30, 2016) that considered actions based on this framework including BIA funding of tribal salmon management programs (NMFS 2014a, NMFS 2015c).

On April 27, 2016 the BIA formally requested consultation on its administration of programs that support tribal management of 2016 Puget Sound salmon fisheries occurring May 1-31, 2016 (Shaw 2016). The fisheries that are the subject of this opinion include tribal ceremonial and subsistence, test, and commercial spring Chinook fisheries in the Nooksack, Skagit, Puyallup and White Rivers and in Washington Catch Areas 8 and 8D (Shaw 2016). The request included a detailed description of the fisheries, and expected impacts to Puget Sound Chinook and steelhead (Shaw 2016).

This opinion is based on information provided in the letter from the BIA requesting consultation to NMFS (Shaw 2016), the Final Environmental Impact Statement on the 2004 Puget Sound Comprehensive Chinook Harvest Management Plan (NMFS 2004c), documents provided by the Northwest Indian Fisheries Commission and WDFW to the Pacific Fisheries Management Council regarding salmon management objectives for the 2016 season, discussions with Puget Sound tribal and Northwest Indian Fisheries Commission 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.

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 salmonid species, other than Puget Sound Chinook salmon and steelhead, which are affected by the Puget Sound salmon fisheries considered in this opinion. In each determination 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 determinations take into account the anticipated effects 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 were accounted for and within the scope of the associated Table 1 determinations, those species are not discussed further in this opinion.

Table 1. NMFS ESA determinations regarding listed species that may be 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
December 2008 (BO) (affirmed March 1996 (BO))*	until reinitiated	(NMFS 1996)	Snake River spring/summer and fall Chinook and sockeye
April 1999 (BO) *	until reinitiated	(NMFS 1999)	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 2001b)	Hood Canal summer-run Chum
April 2001 (BO) *	until withdrawn	(NMFS 2001a)	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 2005d)	California Coastal Chinook
April 9, 2015 (BO) *	until reinitiated	(NMFS 2015a)	Lower Columbia River coho
April 2012 (BO)*	until reinitiated	(NMFS 2012e)	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 (50 CFR 402.2). Interrelated actions are those that are part of a larger action and depend on the larger action for their justification. Interdependent actions are those that have no independent utility apart from the action under consideration (50 CFR 402.02). This action requires consultation with NMFS because a Federal agency (i.e., BIA) is funding or authorizing actions that may adversely affect listed species (section 7(a)(2) of the ESA).

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 May 1-31, 2016 (Shaw 2016). The PSSMP, which establishes guidelines for management of all marine and freshwater salmon fisheries from the Strait of Juan de Fuca eastward, 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)). The fisheries under this action include tribal ceremonial and subsistence, test, and commercial spring Chinook fisheries in the Nooksack, Skagit, Puyallup and White Rivers and in Washington Catch Areas 8 and 8D (Shaw 2016).

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 includes areas where fisheries are expected to occur to from May 1-31, 2016 including tribal ceremonial and subsistence, test, and commercial spring Chinook fisheries in the Nooksack, Skagit, Puyallup and White Rivers and in Washington Catch Areas 8 and 8D (Shaw 2016). Area 8[1] is part of the marine areas adjacent to the Skagit River and Area 8D[2] is the marine waters adjacent to the Snohomish River.

1 Washington Administrative Code (WAC) 220-20-030 defines Washington Catch Area 8 to include those waters of Puget Sound easterly of a line projected from West Point on Whidbey Island to Reservation Head on Fidalgo Island, westerly of a line projected from the light on East Point 340 degrees true to the light on Camano Island (Saratoga Pass light #2, Fl Red 4 Sec), southerly of the Burlington Northern railroad bridges at the north entrances to Swinomish Channel, and northerly of the state Highway 532 bridges between Camano Island and the mainland.

2 WAC 220-20-030 defines 8D to include those waters of Puget Sound inside and easterly of a line projected 225 degrees from the pilings at old Bower's Resort to a point 2,000 feet offshore, thence northwesterly to a point 2,000 feet off Mission Point, thence across the mouth of Tulalip Bay to a point 2,000 feet off Hermosa Point, thence northwesterly following a line 2,000 feet offshore to the intersection with a line projected 233 degrees from the fishing boundary marker on the shore at the slide north of Tulalip Bay.

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

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must 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. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agencies' actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures to minimize such impacts.

This opinion considers impacts of the proposed actions under the ESA on the Puget Sound Chinook salmon ESU and the Puget Sound Steelhead DPS. NMFS has determined that the proposed action is not likely to adversely affect southern green sturgeon, southern eulachon, or Southern Resident killer whales or their critical habitat. The analysis is found in the "Not Likely to Adversely Affect" Determinations, Section 2.11.

2.1 Analytical Approach

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

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

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

- *Identify the rangewide status of the species and critical habitat 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 (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 in the action area. 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 using an "exposure-response-risk" approach.* 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.

2.2 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 determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, listing decisions, and other relevant information. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 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.

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

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

One factor affecting the status of salmonids 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.

Climate change and other ecosystem effects

Variation in fish populations in Puget Sound may reflect broad-scale shifts in natural limiting conditions, such as predator abundances and food resources in ocean rearing areas. 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 (Myers et al. 1998; Jeffries et al. 2003; Pitcher et al. 2007; DFO 2010; Jeffries 2011). 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.

One factor affecting the rangewide status of listed Puget Sound salmon and steelhead, and aquatic habitat at large is climate change. 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 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 0.1-0.6°C 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 salmonid eggs (Battin et al. 2007, Mantua et al. 2009).

Higher water temperatures and lower spawning flows, together with increased magnitude of winter peak flows are all likely to increase salmonid mortality. Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmonids 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 vulnerable 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 up-river tributary habitat.

In marine habitat, scientists are not certain of all the factors impacting steelhead survival but several ocean-climate events are linked with fluctuations in steelhead health and abundance such as El Niño/La Niña, the Aleutian Low, and coastal upwelling (Pearcy and Mantua 1999). Steelhead, along with Chinook and coho salmon, have experienced tenfold declines in survival during the marine phase of their lifecycle, and their total abundance remains well below what it was 30 years ago (LLTK 2015). The marine survival of coastal steelhead, as well as Columbia River Chinook and coho, do not exhibit the same declining trend as the Salish Sea populations. Specifically, marine survival rates for steelhead in Washington State have declined in the last 25 years with the Puget Sound steelhead populations declining to a greater extent than other regions (i.e., Washington Coast and Lower Columbia River) and are at near historic lows (Moore et al. 2014). Climate changes have included increasing water temperatures, increasing acidity, more harmful algae, the loss of forage fish and some marine commercial fishes, changes in marine plants, increased populations of seals and porpoises, etc. (LLTK 2015). Climate change plays a part in steelhead mortality but more studies are being conducted to determine the specific causes of this marine survival decline in Puget Sound.

NWFSC (2016) recently reported that climate conditions affecting Puget Sound salmonids were not optimistic; recent and unfavorable environmental trends are expected to continue. A positive pattern in the Pacific Decadal Oscillation[3] is anticipated to continue and current El Niño conditions are likely to persist. These and other similar environmental indicators suggest the continuation of warming ocean temperatures; fragmented or degraded freshwater spawning and rearing habitat; reduced snowpack; altered hydrographs producing reduced summer river flows and warmer water; and low marine survival for salmonids in the Salish Sea (NWFSC 2016). Specifically, the exceptionally warm marine water conditions in 2014 and 2015 combined with warm stream temperatures lowered steelhead marine and freshwater survival (NWFSC 2016). Any rebound in VSP parameters for Puget Sound steelhead are likely to be constrained under these conditions (NWFSC 2016).

2.2.1.1 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. On February 2,

[3] A positive pattern in the PDC has been in place since 2014.

2015, NMFS announced the initiation of five-year status reviews for 32 listed species of salmon, steelhead, rockfish, and eulachon (80 FR 6695). In December 2015, NOAA's Northwest Fisheries Science Center evaluated the viability of the listed species undergoing 5-year reviews and issued a status review update providing updated information and analysis of the biological status of the listed species (NWFSC 2015). The NWFSC's report will be used by NMFS to inform the new five-year reviews, which will be completed in 2016. In the interim, the draft status review documents generally represent the most recent data on West Coast salmon ESUs.

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 PSTRT also determined that there were 16 additional spawning aggregations or populations in the Puget Sound Chinook Salmon ESU that are now putatively extinct[4] (Ruckelhaus et al. 2006). This ESU includes all naturally spawned Chinook salmon originating from rivers flowing into Puget Sound from the Elwha River (inclusive) eastward, including rivers in Hood Canal, South Sound, North Sound and the Strait of Georgia. Also, Chinook salmon from 26 artificial propagation programs: the Kendall Creek Hatchery Program; Marblemount Hatchery Program (spring subyearlings and summer-run); Harvey Creek Hatchery Program (summer-run and fall-run); Whitehorse Springs Pond Program;

[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.

Wallace River Hatchery Program (yearlings and subyearlings); Tulalip Bay Program; Issaquah Hatchery Program; Soos Creek Hatchery Program; Icy Creek Hatchery Program; Keta Creek Hatchery Program; White River Hatchery Program; White Acclimation Pond Program; Hupp Springs Hatchery Program; Voights Creek Hatchery Program; Diru Creek Program; Clear Creek Program; Kalama Creek Program; George Adams Hatchery Program; Rick's Pond Hatchery Program; Hamma Hamma Hatchery Program; Dungeness/Hurd Creek Hatchery Program; Elwha Channel Hatchery Program; and the Skookum Creek Hatchery Spring-run Program (79 FR 20802).

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. The Whidbey Basin Region is the only region with consistently high fraction natural-origin spawner abundance, in six of the 10 populations within the Region. All other regions have either variable or declining spawning populations that have high proportions of hatchery-origin spawners (NWFSC 2016).

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

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

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

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 2006c). Under the Puget Sound Salmon Recovery Plan, the Suiattle and one each of the early, moderately early, and late run-timing populations in the Whidbey Basin Region, as well as the White and Nisqually (or other late-timed) populations in the Central/South Sound Region must also achieve viability (NMFS 2006c). 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 the listed species by the proposed actions across all populations within the Puget Sound Chinook ESU. In doing so it is important to take into account whether the genetic legacy of the population is intact or if it is no longer distinct. Populations are defined by their relative isolation from each other, and by the unique genetic characteristics that evolve as a result of that isolation to adapt to their specific habitats. If these are populations that still retain their 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 1). This framework, termed the *Population Recovery Approach*, carries forward the biological viability and delisting criteria described in the Supplement to the Puget Sound Salmon Recovery Plan (Ruckelshaus et al. 2002; NMFS 2006c). 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 ESA section 4(d) determinations and opinions on Puget Sound salmon fisheries and regional recovery planning (NMFS 2005c; 2008a; 2008e; 2010a; 2011b; 2013b, 2015c).

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 natural abundance and/or declining growth rates of the populations in these regions. In addition, spatial structure, or geographic distribution, of the White, Skagit, Elwha and Skokomish 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. 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 2005a; 2006a; 2008b; 2008c; SSPS 2007). It is likely that genetic diversity has also been reduced by this habitat loss.

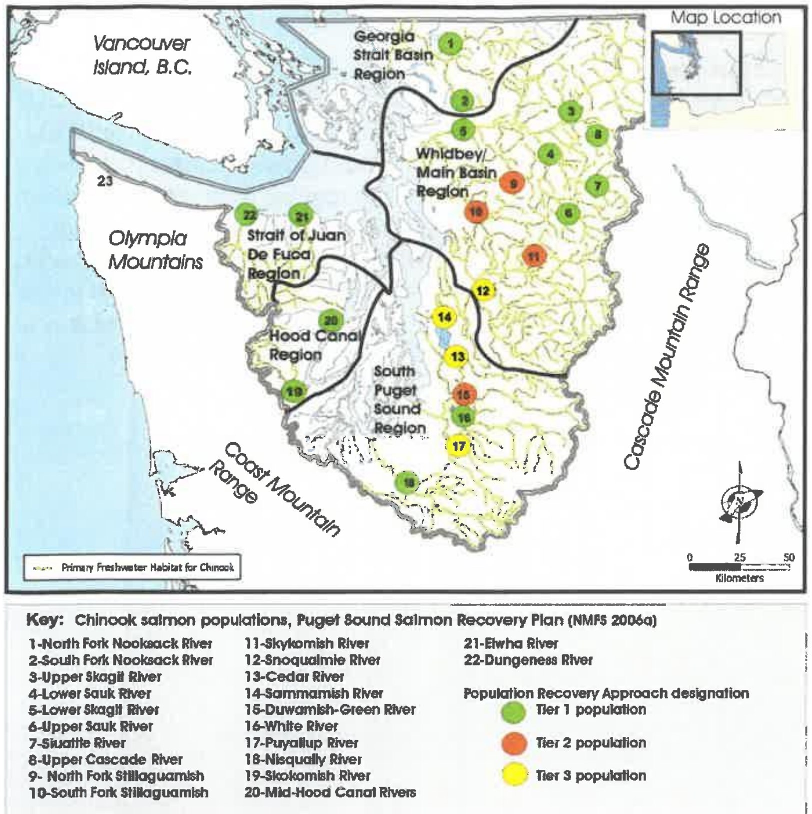

Figure 1. Populations of the Puget Sound Chinook salmon ESU.

Abundance and Productivity

Most Puget Sound Chinook populations are well below escapement levels identified as required for recovery to low extinction risk (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 exhibit a stable or increasing trend in natural escapement (Table 4). However, natural-origin abundance across the Puget Sound ESU has generally decreased since the last status review, with only 6 of 22 populations (Cascade, Suiattle and Upper Sauk, Cedar, Mid-Hood Canal, Nisqually) showing a positive change in the 5-year geometric mean natural-origin spawner abundances since the prior status review (NWFSC 2016). There is a general decline in natural-origin spawner abundance across all regions in the recent fifteen years. While the previous status review in 2010 (Ford 2011) concluded there was no obvious trend for the total ESU, addition of the data to 2014 now does show widespread negative trends in natural-origin Chinook salmon spawner population abundances. (NWFSC 2016).

Seven populations are below their critical thresholds including both populations in the Hood Canal and Strait of Juan de Fuca regions (Table 3). The North Fork Nooksack population is close to its critical threshold.

Trends in growth rate of natural-origin escapement are generally higher than growth rate of natural-origin recruitment (i.e., abundance prior to fishing) indicating some stabilizing influence on escapement possibly from past reductions in fishing-related mortality (Table 4). Since 1990, nine populations show productivity above replacement for natural-origin escapement including populations in all regions. Only six populations in three of the five regions demonstrate positive growth rates in natural-origin recruitment (Table 4). Survival and recovery of the Puget Sound Chinook Salmon ESU will depend, over the long term, on remedial actions related to all harvest, hatchery, and habitat related activities. Many of the habitat and hatchery actions identified in the Puget Sound Salmon Recovery Plan are likely to take years or decades to be implemented and to produce significant improvements in natural population attributes, and current trends are consistent with these expectations (NWFSC 2016).

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

Region	Population	1999 to 2014 Geometric mean Escapement (Spawners)		NMFS Escapement Thresholds		Recovery Planning Abundance Target in Spawners (productivity)[2]	Average % hatchery fish in escapement 1999-2014 (min-max)[5]
		Natural [1]	Natural-Origin (Productivity[2])	Critical[3]	Rebuilding[4]		
Georgia Basin	Nooksack MU	1,810	268	400	500		
	NF Nooksack	1,841	207[8] (0.6)	*200*[6]	-	3,800 (3.4)	85 (63-94)
	SF Nooksack	396	**51**[8] (1.6)	*200*[6]	-	2,000 (3.6)	84 (62-96)
Whidbey/Main Basin	Skagit Summer/Fall MU						
	Upper Skagit River	9,257	8,869[8] (2.0)	967	7,454	5,380 (3.8)	3 (1-8)
	Lower Sauk River	534	538[8] (1.8)	*200*[6]	681	1,400 (3.0)	1 (0-10)
	Lower Skagit River	1,992	1,917[8] (1.8)	251	2,182	3,900 (3.0)	4 (2-8)
	Skagit Spring MU						
	Upper Sauk River	539	520[8] (1.5)	130	330	750 (3.0)	2 (0-5)
	Suiattle River	338	325[8] (1.2)	170	400	160 (3.2)	2 (0-5)
	Upper Cascade River	300	286[8] (1.1)	170	*1,250*[6]	290 (3.0)	7 (0-25)
	Stillaguamish MU						
	NF Stillaguamish R.	901	554 (0.8)	300	552	4,000 (3.4)	37 (8-62)
	SF Stillaguamish R.	108	**101** (0.7)	*200*[6]	300	3,600 (3.3)	NA
	Snohomish MU						
	Skykomish River	3,338	1,944[8] (1.3)	1,650	3,500	8,700 (3.4)	34 (15-62)
	Snoqualmie River	1,524	1,088[8] (1.3)	400	*1,250*[6]	5,500 (3.6)	19 (8-35)
Central/South Sound	Cedar River	882	816[8] (1.9)	*200*[6]	*1,250*[6]	2,000 (3.1)	23 (10-36)
	Sammamish River	1,159	**184**[8] (0.7)	*200*[6]	*1,250*[6]	1,000 (3.0)	83 (66-95)
	Duwamish-Green R.	3,591	1,235[8] (1.0)	835	5,523	-	53 (20-79)
	White River[9]	1,644	724[8] (0.8)	*200*[6]	1,100[7]	-	44 (27-70)
	Puyallup River[10]	1,596	747[8] (1.1)	*200*[6]	522[7]	5,300 (2.3)	47 (18-76)
	Nisqually River	1,721	591[8] (1.6)	*200*[6]	1,200[7]	3,400 (3.0)	70 (53-85)
Hood Canal	Skokomish River	1,223	**334** (0.9)	452	1,160	-	67 (7-95)
	Mid-Hood Canal Rivers[11]	**179**		*200*[6]	*1,250*[6]	1,300 (3.0)	38 (5-63)

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Strait of Juan de Fuca	Dungeness River Elwha River[12]	350 1,521	**106**[8] (0.6) **108**[8]	*200*[6] *200*[6]	925[7] *1,250*[6]	1,200 (3.0) 6,900 (4.6)	68 (39-96) 89 (82-87)

[1] Includes naturally spawning hatchery fish. Nooksack spring Chinook 2014-15 escapements not available.
[2] Source productivity is Abundance and Productivity Tables from NWFSC database; measured as the mean of observed recruits/observed spawners. Sammamish productivity estimate has not been revised to include Issaquah Creek. Source for Recovery Planning productivity target is the final supplement to the Puget Sound Salmon Recovery Plan (NMFS 2006a); measured as recruits/spawner associated with the number of spawners at Maximum Sustained Yield under recovered conditions.
[3] Critical natural-origin escapement thresholds under current habitat and environmental conditions (McElhaney et al. 2000; NMFS 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, 2011, 2012, 2014) and the 2010-2014 Puget Sound Chinook Harvest Management Plan (PSIT and WDFW 2010a). North Fork and South Fork Nooksack estimates include years through 2013.
[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 available only for 1999-2013, Skagit springs, Skagit falls and Skokomish available only for 1999-2014; Snohomish for 1999-2001 and 2005-2014; Lake Washington for 2003-2014; White River 2005-2014; Puyallup for 2002-2014; Nisqually for 2005-2014; Dungeness for 2001-2014; Elwha for 2010-2014.
[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] (1990-2014)		Growth Rate[2] (1990-2013)	
			NMFS	Recruitment (Recruits)	Escapement (Spawners)
Georgia Basin	NF Nooksack (early)	1.14	increasing	1.04	1.00
	SF Nooksack (early)	1.05	increasing	1.04	1.01
Whidbey/Main Basin	Upper Skagit River (moderately early)	1.02	stable	0.98	1.01
	Lower Sauk River (moderately early)	1.00	stable	0.97	0.98
	Lower Skagit River (late)	1.01	stable	0.97	0.99
	Upper Sauk River (early)	1.04	increasing	0.99	1.03
	Suiattle River (very early)	0.99	stable	0.97	1.00
	Upper Cascade River (moderately early)	1.03	increasing	0.99	1.03
	NF Stillaguamish R. (early)	1.00	stable	0.97	1.00
	SF Stillaguamish R[3] (moderately early)	0.95	**declining**	0.94	0.97
	Skykomish River (late)	1.00	stable	0.93	1.00
	Snoqualmie River (late)	1.01	stable	0.97	0.99
Central/South Sound	Cedar River (late)	1.04	increasing	1.02	1.04
	Sammamish River[4] (late)	1.01	stable	1.04	1.07
	Duwamish-Green R. (late)	0.95	**declining**	0.95	0.98
	White River[5] (early)	1.10	increasing	1.02	1.05
	Puyallup River (late)	0.97	**declining**	0.93	0.95
	Nisqually River (late)	1.06	increasing	0.93	1.00
Hood Canal	Skokomish River (late)	1.01	stable	0.90	0.96
	Mid-Hood Canal Rivers[3] (late)	1.03	stable	0.95	1.03
Strait of Juan de Fuca	Dungeness River (early)	1.05	stable	1.04	1.08
	Elwha River[3] (late)	1.01	stable	0.91	0.94

[1] Escapement Trend is calculated based on all spawners (i.e., including both natural origin spawners and hatchery-origin fish spawning naturally) to assess the total number of spawners passed through the fishery to the spawning ground. Directions of trends defined by statistical tests.

[2] Median growth rate (λ) is calculated based on natural-origin production. It is calculated assuming the reproductive success of naturally spawning hatchery fish is equivalent to that of natural-origin fish (for those populations where information on the fraction of hatchery fish in natural spawning abundance is available). Source: Abundance and Productivity Tables from NWFSC database.

[3] Estimate of the fraction of hatchery fish in time series is not available for use in λ calculation, so trend represents that in hatchery-origin + natural-origin spawners.

[4] Median growth rate estimates for Sammamish has not been revised to include escapement in Issaquah Creek.

[5] Natural spawning escapement includes an unknown fraction of naturally spawning hatchery-origin fish from late- and early run hatchery programs in the White and Puyallup River basin.

Limiting factors

Limiting factors described in SSPS (2007) and reiterated in Ford (2011) and NWFSC (2016) 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 = -18 to -58%), but weak natural-origin Chinook salmon populations in Puget Sound still require enhanced protective measures to reduce the risk of overharvest.

2.2.1.2 Status of Puget Sound Steelhead

The Puget Sound steelhead Distinct Population Segment (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). The Puget Sound steelhead populations are aggregated into three extant Major Population Groups (MPGs) containing a total of 32 Demographically Independent Populations (DIPs) based on genetic, environmental, and life history characteristics (PSSTRT 2013a). 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). Figure 2 contains the Puget Sound Steelhead DPS, MPGs, and DIPs for Puget Sound steelhead. On February 2, 2015, NMFS announced the initiation of five-year status reviews for 32 listed species of salmon, steelhead, rockfish, and eulachon. NMFS anticipates that the new five-year reviews will be completed in 2016. In the interim, the draft status review documents generally represent the most recent data on West Coast salmon ESUs.

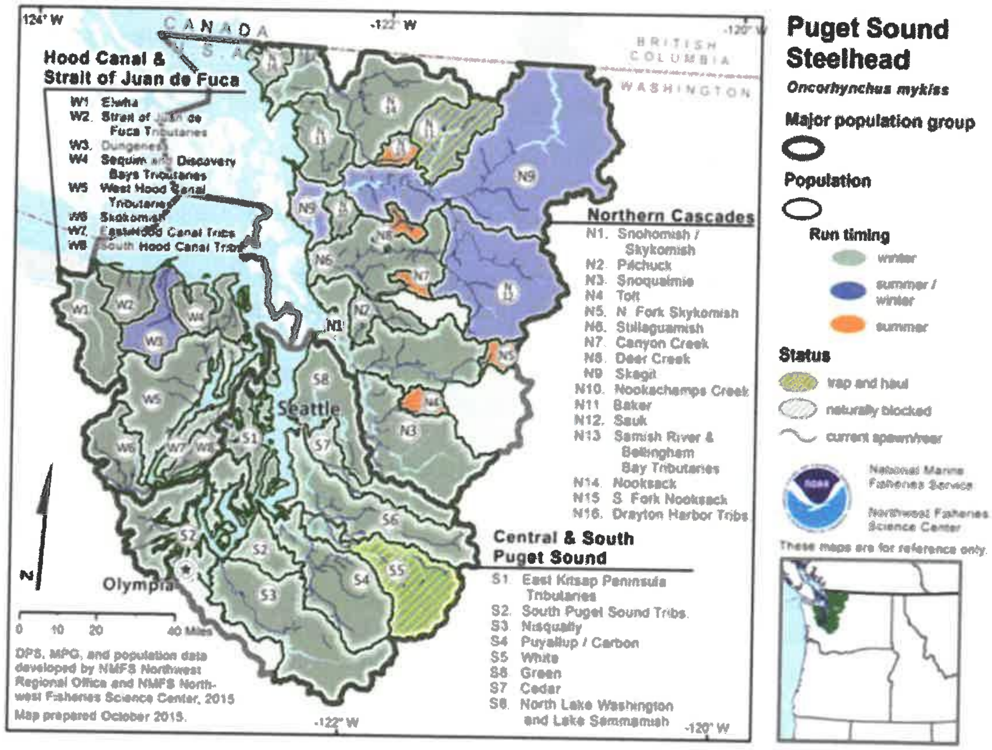

Figure 2. The Puget Sound Steelhead DPS showing MPGs and DIPs. The steelhead MPGs include the Northern Cascades, Central & Sound Puget Sound, and the Hood Canal & Strait of Juan de Fuca.

As part of the early recovery planning process, NMFS convened a technical recovery team to identify historic populations and develop viability criteria for the recovery plan. The Puget Sound Steelhead Technical Recovery Team (PSSTRT) delineated populations (DIPs) and completed a set of population viability analyses (PVAs) for these DIPs and MPGs within the DPS that are summarized in the 5-year status review and the final draft viability criteria report (PSSTRT 2013a; 2013b). These documents present the biological viability criteria recommended by the PSSTRT. The framework and the analysis it supports do not set targets for delisting or recovery, nor do they explicitly identify specific populations or groups of populations for recovery priority. Rather, the framework and associated analysis are meant to provide a technical foundation for those charged with recovery of listed steelhead in Puget Sound from which they can develop effective recovery plans at the watershed scale, and higher, that are based on biologically meaningful criteria (PSSTRT 2013a).

NMFS is in the process of developing a long-term recovery plan with our Federal, state, tribal, local, and private partners. NMFS is planning to have a draft Puget Sound steelhead recovery plan available for public review in winter 2018 with a final plan completed in 2019. More information on the Puget Sound steelhead recovery planning process can be found online at: *http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/puget_sound/overview_puget_sound_steelhead_recovery_2.html.*

Spatial Structure, and Diversity

The Puget Sound Steelhead DPS includes all naturally spawned anadromous steelhead all naturally spawned anadromous *O. mykiss* (steelhead) populations, from 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 hatcherystocks., bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive) (72 Fed. Reg. 26722, May 11, 2007). Steelhead included in the listing are the anadromous form of *O. mykiss* that occur in rivers, below natural barriers to migration, in northwestern Washington State. 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). Steelhead from six artificial propagation programs are also included in the listing: (1) Green River natural program; (2) White River winter steelhead supplementation program; (3-5) Hood Canal steelhead supplementation off-station projects in the Dewatto, Skokomish, and Duckabush Rivers; and (6) Elwha Fish Hatchery wild steelhead recovery program.

The Biological Review Team (BRT) considered the major risk factors associated with spatial structure and diversity of Puget Sound steelhead 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). 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.

In 2013, the PSSTRT completed its evaluation of factors that influence the diversity and spatial structure VSP criteria for steelhead in the DPS. For spatial structure, this included the fraction of intrinsic potential rearing and occupied spawning habitat.[5] For diversity, these factors included hatchery fish production, contribution of resident fish to anadromous fish production, and run timing of adult steelhead. Quantitative information on spatial structure and connectivity was not available for most Puget Sound steelhead populations, so a Bayesian Network framework was used to assess the influence of these factors on steelhead viability at the population, MPG, and DPS scales (PSSTRT 2013a). The Puget Sound Steelhead Technical Recovery Team concluded

[5] Where intrinsic potential is the area of habitat suitable for steelhead rearing and spawning, at least under historical conditions (PSSTRT 2013 or 2015b).

that low population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity (PSSTRT 2013a). Specifically, population viability associated with spatial structure and diversity was highest in the Northern Cascades MPG and lowest in the Central and South Puget Sound MPG (Figure 3). Diversity was generally higher for populations within the Northern Cascades MPG, where more variability in viability was expressed and diversity generally higher, compared to populations in both the Central and South Puget Sound and Hood Canal and Strait of Juan de Fuca MPG, where diversity was depressed and viabilities generally lower (NWFSC 2016). Most Puget Sound steelhead populations were given intermediate scores for spatial structure and low scores for diversity because of extensive hatchery influence, low breeding population sizes, and freshwater habitat fragmentation or loss (NWFSC 2016).

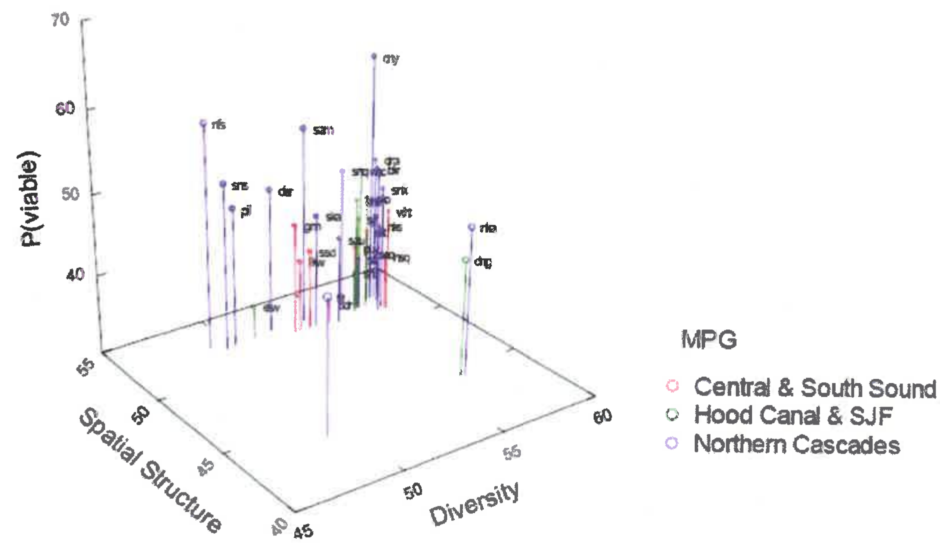

Figure 3. Scatter plot of the probabilities of viability for each of the 32 steelhead populations in the Puget Sound DPS as a function of VSP parameter estimates of influence of diversity and spatial structure on viability (PSSTRT 2013a).

Since the Technical Recovery Team completed its review of Puget Sound steelhead, the only spatial structure and diversity data that have become available have been estimates of the fraction of hatchery fish on the spawning grounds (NWFSC 2016). Hatchery production and release of hatchery smolts of both summer-run and winter-run steelhead have declined in recent years for most geographic areas within the DPS (NWFSC 2016). In addition, the fraction of hatchery steelhead spawning naturally are low for many rivers (NWFSC 2016). In recent years, production and release of hatchery steelhead for winter and summer run types has also declined for most areas of Puget Sound (NWFSC 2016). Steelhead DIPs with the highest estimated proportions of hatchery spawners are the Elwha River, Nisqually River, Puyallup River/Carbon

River, and Stillaguamish River winter-run populations. For 17 DIPs across the DPS, the five-year average for the fraction of natural-origin steelhead spawners exceeded 0.75 from 2005 to 2009; this average was near 1.0 for 8 populations, where data were available, from 2010 to 2014 (NWFSC 2016). In some river systems, these estimates are higher than some guidelines recommend (e.g., no more than 5% hatchery-origin spawners on spawning grounds for isolated hatchery programs (HSRG 2009). Overall, the fraction of natural-origin steelhead spawners is 0.9 or greater for the most recent two time periods (i.e., 2005-2009 and 2010-2014) but this fraction could also not be estimated for a substantial number of DIPs especially during the 2010 to 2014 period (Table 5) (NWFSC 2016).

Table 5. Puget Sound steelhead 5-year mean fraction of natural-origin spawners[1] (NWFSC 2015)

Run Type	DIP	Year				
		1990-1994	1995-1999	2000-2004	2005-2009	2010-2014
Winter	Cedar River					
	Green River	0.91	0.95	0.96		
	Nisqually River	0.99	1.00	0.96	0.75	
	N. Lake WA/Lake Sammamish	1.00	1.00	1.00	1.00	
	Puyallup River/Carbon River	0.93	0.89	0.82	0.86	
	White River	1.00	1.00	1.00	1.00	1.00
	Dungeness River	1.00	1.00	0.98	0.99	
	East Hood Canal Tributaries	1.00	1.00	1.00	1.00	1.00
	Elwha River	0.60	0.25			
	Sequim/Discovery Bays Tributaries					
	Skokomish River	1.00	1.00	1.00	1.00	
	South Hood Canal Tributaries	1.00	1.00	1.00	1.00	1.00
	Strait of Juan de Fuca Tributaries	1.00	1.00	1.00	1.00	1.00
	West Hood Canal Tributaries		1.00	1.00	1.00	
	Nooksack River					0.97
	Pilchuck River	1.00	1.00	1.00	1.00	1.00
	Samish River/Bellingham Bay Tributaries	1.00	1.00	1.00	1.00	1.00
	Skagit River	0.94	0.95	0.96	0.95	
	Snohomish/Skykomish Rivers	0.90	0.89	0.82	0.85	
	Snoqualmie River	1.00	1.00	1.00	1.00	1.00
	Stillaguamish River	1.00	0.88	0.75	0.81	
Summer	Tolt River	1.00	1.00	1.00	1.00	1.00

[1] Sum of all estimates divided by the number of estimates; blank cells indicate that no estimate is available for that 5-year range.

Early winter-run fish produced in isolated hatchery programs are derived from Chambers Creek stock in southern Puget Sound, which has been selected for early spawn timing, a trait known to be inheritable in salmonids.[6] Summer-run fish produced in isolated hatchery programs are derived from the Skamania River summer stock in the lower Columbia River Basin (i.e., from outside the DPS). Thus, the production of hatchery fish of both run types (winter and summer) continue to pose risk to diversity in natural-origin steelhead in the DPS.

[6] The natural Chambers Creek steelhead stock is now extinct.

More information on Puget Sound steelhead spatial structure and diversity can be found in NOAA's Puget Sound steelhead Technical recovery Team viability report (PSSTRT 2013a) and NOAA's status review update on salmon and steelhead (NWFSC 2015).

Abundance and Productivity

The 2007 BRT considered the major risk factors associated with abundance and productivity 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).

Abundance and productivity estimates have been made available in the NWFSC status review update (NWFSC 2016). Steelhead abundance estimates are available for 8 of the 16 winter-run DIPs in the Northern Cascades MPG,[7] 6 of the 8 winter-run DIPs in the Central and South Puget Sound MPG,[8] and 8 of the 8 winter-run DIPs in the Hood Canal and Strait of Juan de Fuca MPG.[9] 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. Data were available for only one summer-run DIP, the Tolt River steelhead population in the Northern Cascades MPG. Total abundance of steelhead in these populations (Figure 4) has shown a generally declining trend over much of the DPS.

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[7] Nooksack River, Samish River/Bellingham Bay Tributaries, Skagit River, Pilchuck River, Snohomish/Skykomish River, Snoqualimie River, and Stillaguamish River winter-run DIPs as well as the Tolt River summer-run DIP.

[8] Cedar River, Green River, Nisqually River, North Lake Washington/Lake Sammamish, Puyallup River/Carbon River, and White River winter-run DIPs.

[9] Dungeness River, East Hood Canal Tributaries, Elwha River, Sequim/Discovery Bays Tributaries, Skokomish River, South Hood Canal Tributaries, Strait of Juan de Fuca Tributaries, and West Hood Canal Tributaries winter-run DIPs.

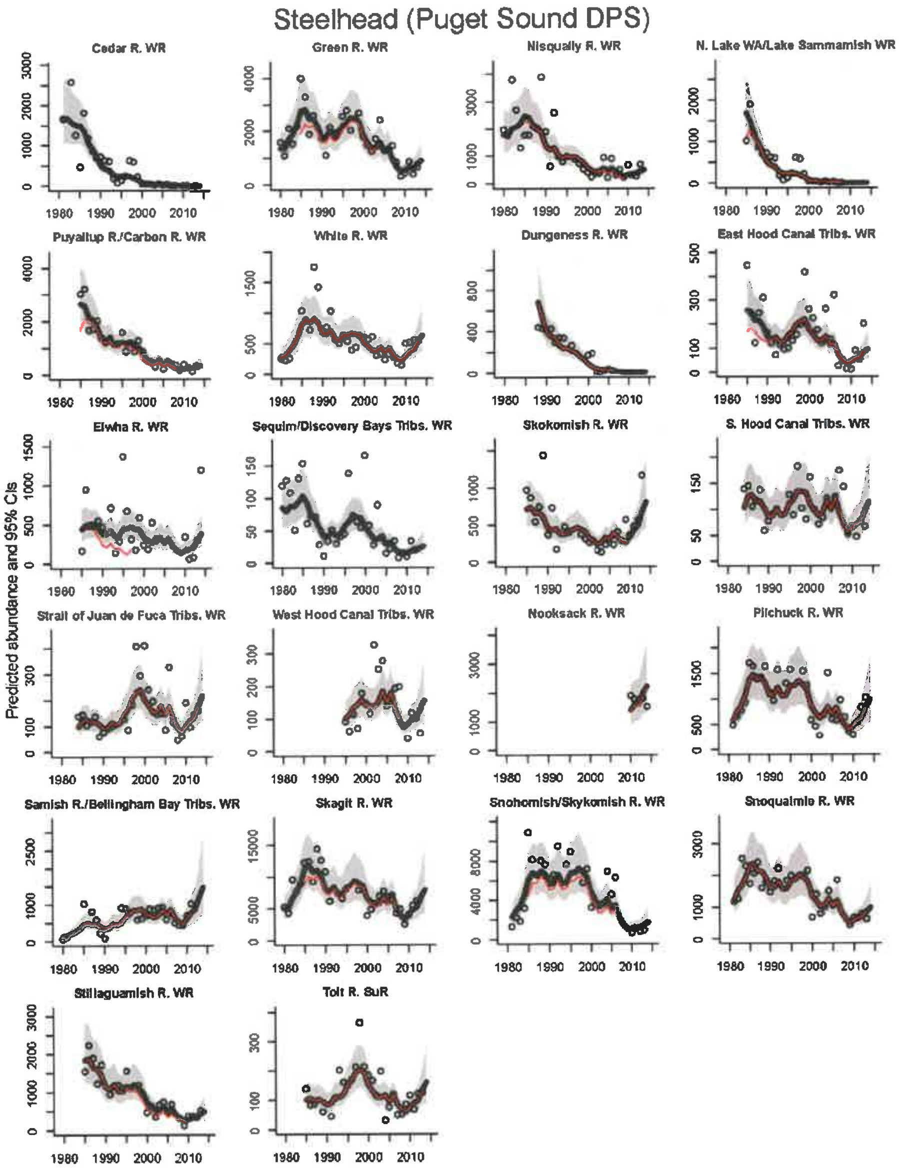

Figure 4. Trends in estimated total (black line) and natural (red line) population spawning abundance of Puget Sound steelhead.

In Figure 4, the circles represent annual raw spawning abundance data and the gray bands represent the 95% confidence intervals around the estimates.

Since 2009, 7 of the 22 populations indicate modest increases in abundance.[10] Most steelhead populations remain small. From 2010 to 2014, 8 of the 17 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 17 steelhead populations had fewer than 500 natural spawners (Table 6).

Table 6. 5-Year Geometric mean of raw natural spawner counts for Puget Sound steelhead (NWFSC 2016).

MPG	Run	Population	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	% Char
Northern Cascades	Winter	Nooksack River					1693 (1745)	
		Pilchuck River	1225 (1225)	1465 (1465)	604 (604)	597 (597)	614 (614)	(3
		Samish River/Bellingham Bay	316 (316)	717 (717)	852 (852)	534 (534)	846 (846)	(58
		Skagit River	7189 (7650)	7656 (8059)	5424 (5675)	5547 (4767)	(5123)	(7
		Snohomish/Skykomish River	6654 (7394)	6382 (7200)	5424 (5675)	5547 (4767)	(5123)	(7
		Snoqualmie River	1831 (1831)	2056 (2056)	1020 (1020)	944 (944)	680 (680)	(-28
	Summer	Tolt River	112 (112)	212 (212)	119 (119)	73 (73)	105 (105)	(44
Central/ South PS	Winter	Cedar River	(321)	(298)	(37)	(12)	(4)	(-6
		Green River	1566 (1730)	2379 (2505)	1618 (1693)	(716)	(552)	(-2
		Nisqually River	1201 (1208)	759 (759)	394 (413)	278 (375)	(442)	(18
		N. Lk WA/Lk Sammamish	321 (321)	298 (298)	37 (37)	12 (12)		
		Puyallup River/Carbon River	1156 (1249)	1003 (1134)	428 (527)	315 (322)	(227)	(-1
		White River	696 (696)	519 (519)	466 (466)	225 (225)	531 (531)	(13
Hood Canal/ SJF	Winter	Dungeness River	356 (356)		38 (38)	24 (25)		
		East Hood Canal Tribs.	110 (110)	176 (176)	202 (202)	62 (62)	60 (60)	(-3
		Elwha River	206 (358)	127 (508)	(303)		(237)	
		Sequim/Discovery Bays	(30)	(69)	(63)	(17)	(19)	(12
		Skokomish River	503 (385)	359 (359)	259 (205)	351 (351)	(580)	(65
		South Hood Canal Tribs.	89 (89)	111 (111)	103 (103)	113 (113)	64 (64)	(-43
		Strait of Juan de Fuca Tribs.	89 (89)	191 (191)	212 (212)	101 (101)	147 (147)	(46
		West Hood Canal Tribs.		97 (97)	210 (210)	174 (149)	(74)	(-50

Steelhead productivity has been variable for most populations since the mid-1980s. In the NWFSC status review update, natural productivity was measured as the intrinsic rate of natural increase (r), which has been well below replacement for at least six of the steelhead DIPs (5). These six steelhead populations include, the Stillaguamish River winter-run in the Northern and Nisqually winter-run in the Central and South Puget Sound MPG, and the Dungeness and Elwha winter-run in the Hood Canal and Strait of Juan de Fuca MPG. Productivity has fluctuated around replacement for the remainder of Puget Sound steelhead populations, but the majority have predominately been below replacement since around 2000 (NWFSC 2016). Some steelhead populations are also showing signs of productivity that has been above replacement in the last two or three years (Figure 5). Steelhead populations with productivity estimates above replacement include the Tolt River summer-run, Pilchuck River winter-run, and Nooksack River winter-run in the Northern Cascades MPG, the White River winter-run in the Central and South Puget Sound MPG, and the East Hood Canal Tributaries and Strait of Juan de Fuca Tributaries winter-run steelhead populations in the Hood Canal and Strait of Juan de Fuca MPG.

[10] Samish River/Bellingham Bays Tributaries, White River, Skokomish River, East Hood Canal Tributaries, and Strait of Juan de Fuca Tributaries winter-run populations with Skagit River and Green River also showing early signs of upward trends.

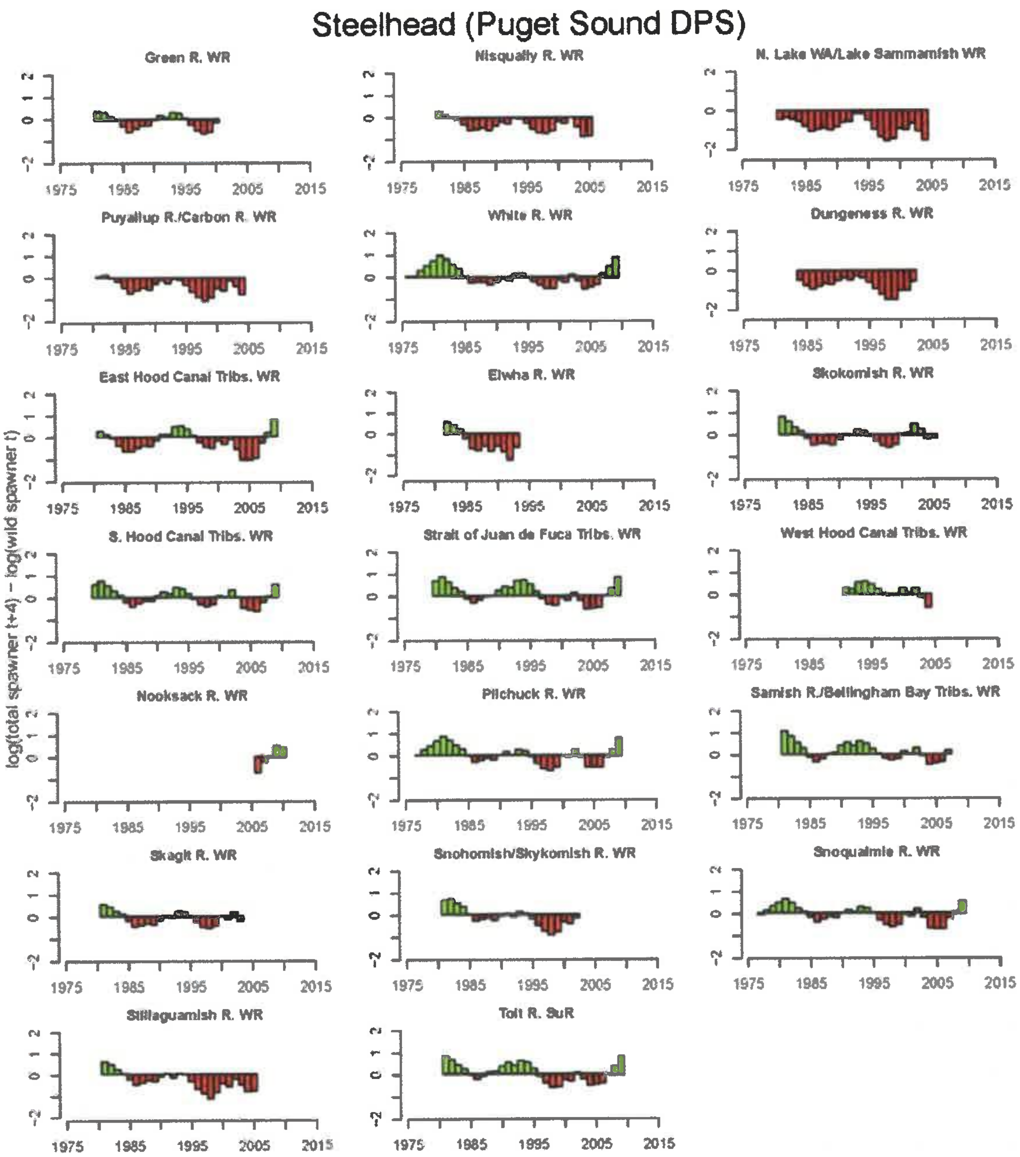

Figure 5. Trends in population productivity of Puget Sound steelhead (NWFSC 2016).

Harvest can also affect the abundance and overall productivity of Puget Sound steelhead. Since the 1970s and 1980s, harvest rates have differed greatly among various watersheds, but all harvest rates on Puget Sound steelhead have declined overall in the DPS (NWFSC 2016). From the late 1970s to early 1990s, harvest rates on natural-origin steelhead averaged between 10%

and 40%, with some populations in central and south Puget Sound[11] at over 60% (Figure 6). Harvest rates on natural-origin steelhead have dropped considerably over the last decade and have been stable and generally less than 5% (NWFSC 2016). Current harvest rates are low enough that they are unlikely to substantially reduce spawner abundance for most steelhead populations in Puget Sound (NWFSC 2016).

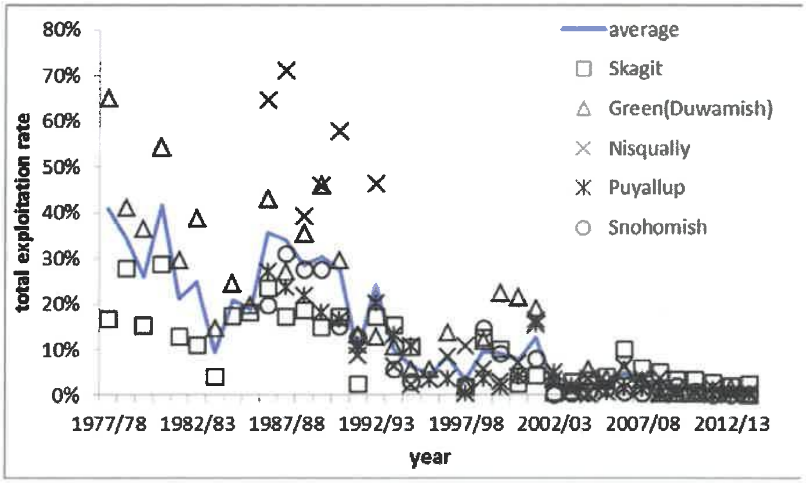

Figure 6. Total harvest rates on natural steelhead in Puget Sound rivers (WDFW 2010 in NWFSC 2016).

Overall, the status of steelhead based on the best available data on spatial structure, diversity, abundance, and productivity has not changed since the last status review (NWFSC 2016). Recent increases in abundance observed for a few steelhead DIPs have been modest and within the range of variability observed in the past several years and trends in abundance remain predominately negative or flat over the time series examined in the recent status review update (NWFSC 2016). The production of hatchery fish of both run types (winter and summer) continue to pose risk to diversity in natural-origin steelhead in the DPS. Recent increasing estimates of productivity for a few steelhead populations are encouraging but currently span only one to a few years, thus, the patterns of improvement in productivity are not widespread or considered sustainable at this time. Total harvest rates are low and unlikely to substantially reduce spawner abundance or general productivity for most Puget Sound steelhead populations. Although the new 5-year review report has yet to be published, no change in the status or composition of the Puget Sound Steelhead DPS is anticipated.

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:

[11] Green River and Nisqually River populations.

- 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 over the last 25 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 likely 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.

2.2.2 Status of Critical Habitat

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

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[12]; 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 2005a) 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

[12] 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).

distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

2.2.2.1 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 (70 FR 52630). 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 2005a). 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 while the remaining 745 miles were excluded because they are lands controlled by the military, overlap with Indian lands, or the benefits of exclusion outweighed the benefits of designation (70 FR 52630).

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 2008b), the National Flood Plain Insurance Program (NMFS 2008c), the Washington State Department of Transportation Preservation, Improvement and Maintenance Activities (NMFS 2013a), and the Elwha River Fish Restoration Plan (Ward et al. 2008). These documents provide a more detailed overview of the status of critical habitat in Puget Sound and are incorporated by reference here. Effects on habitat, including primarily critical habitat, is also addressed in Section 2.3.1.

2.2.2.2 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 2012a; Appendix B). On February 12, 2016, NMFS announced the final critical habitat designation for Puget Sound steelhead along with the critical habitat designation for Lower Columbia River coho salmon (81 FR 9252, February 24, 2016). The specific areas designated for Puget Sound steelhead include approximately 2,031 miles of freshwater and estuarine habitat in Puget Sound, Washington. NMFS excluded areas where the conservation benefit to the species was relatively low compared to the economic impacts of inclusion. Approximately 138 stream miles were excluded from the designation based on this criterion. Approximately 1,361 stream miles covered by four habitat conservation plans and approximately 70 stream miles on tribal lands were also excluded because the benefits of exclusion outweighed the benefits of designation.

There are 72 HUC5 watersheds occupied by Puget Sound steelhead within the range of this DPS. The total number of miles designated for the DPS in the final rule differ slightly from those identified in the proposed rule. Numerous minor edits were made to maps and distribution data to better reflect the areas occupied by Puget Sound steelhead. NMFS also designated approximately 90 stream miles of critical habitat on the Kitsap Peninsula that were originally proposed for exclusion, but, after considering public comments, determined that the benefits exclusion did not outweigh the benefits of designation. The final designation also includes areas in the upper Elwha River where the recent removal of two dams now provides access to areas that were previously unoccupied by Puget Sound steelhead at the time of listing but are essential to the conservation of the DPS.

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 2012a). As described further in the Section 4(b)(2) report (NMFS 2012b), 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. More information on Puget Sound steelhead critical habitat designation can be found online at: 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.

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 complexity 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 2008b), the National Flood Plain Insurance Program (NMFS 2008c), the Washington State Department of Transportation Preservation, Improvement and Maintenance Activities (NMFS 2013a), and the Elwha River Fish Restoration Plan (Ward et al.2008). In 2012, the Puget Sound Action Plan was also developed to protect and restore habitat throughout Puget Sound and can be found online at: http://www.westcoast.fisheries.noaa.gov/habitat/conservation/puget_sound _action_plan.html. Several federal agencies (e.g., EPA, NOAA Fisheries, the Corps of Engineers, NRCS, USGS, FEMA, and USFWS) are collaborating on an enhanced approach to implement the Puget Sound Action Plan. These documents provide a more detailed overview of the status of critical habitat in Puget Sound and are incorporated by reference here. Effects on habitat, including primarily critical habitat, is also addressed in Section 2.3.1.

2.3 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 and steelhead. 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 2006c) http://www.nwr.noaa.gov/Salmon-Recovery-Planning/Recovery-Domains/Puget-Sound/upload/PS-Supplement.pdf). In 2014, a Puget Sound Steelhead Recovery Team was established and recovery planning for Puget Sound steelhead is underway. NMFS is planning to have a draft Puget Sound steelhead recovery plan available for public review in 2018 with a final plan completed in 2019. More information on the recovery planning process and draft documents for public comment are available at: *http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/puget_sound/overview_puget_sound_steelhead_recovery_2.html*. Future consultations will incorporate information from the final 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.

2.3.1 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. 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 2008e) and the Pacific Coast Salmon Plan effects on Lower Columbia River Chinook (NMFS 2012e). The University of Washington Climate Impacts Group recently summarized the current state of knowledge of climate change and anticipated trends on Puget Sound and its environs including those that would affect salmon (Mauger et al. 2015)

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 several decades, the co-managers implemented strategies to manage fisheries to reduce harvest impacts and to implement harvest objectives that are consistent with the underlying productivity of the natural populations. Time and area closures, and selective gear types are implemented to reduce catches of weak stocks and to reduce Chinook salmon and steelhead 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 compared to years prior to listing (average = -35%, range = -18 to -58%). 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 fisheries to meet the conservation and allocation objectives described in the jointly-developed 2010-2014 Puget Sound Chinook Harvest RMP (PSIT and WDFW 2010a), and as amended in 2014 (Grayum and Anderson 2014, Redhorse 2014) and 2015 (Grayum and Unsworth 2015, Shaw 2015). 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 2011a). Recent year exploitation rates are summarized in Table 7.

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 7). 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; 2008e).

Table 7. Average 2008 to 2012 total and southern U.S. (SUS) exploitation rates (ER) for Puget Sound Chinook management units (see Table 3 for correspondence to populations).

Management Unit	% of total ER in AK/CAN fisheries	SUS Exploitation Rate	Total Exploitation Rate
Nooksack early	82%	5%	26%
Skagit spring	55%	12%	26%
Skagit summer/fall	58%	21%	50%
Stillaguamish	56%	8%	18%
Snohomish	44%	14%	25%
Lake Washington	56%	17%	38%
Duwamish-Green River	47%	27%	48%
White River	14%	13%	15%
Puyallup River	39%	33%	54%
Nisqually River	22%	55%	71%*
Skokomish River	24%	45%	59%*
Mid-Hood Canal rivers	57%	10%	25%
Dungeness River	85%	6%	41%
Elwha River	87%	5%	40%

*Beginning in 2010, the Skokomish Chinook Management Unit was managed for 50% and the Nisqually Chinook Management Unit was managed for a stepped harvest rate of 65% (2010-11) – 56% (2012-2013) – 52% (2014), 50% (2016).

Steelhead are caught in marine areas and in river systems throughout Puget Sound. NMFS observed that previous harvest management practices likely contributed to the historical decline of Puget Sound steelhead, but concluded in our Federal Register Notice (72 FR 26732, May 11, 2007) that the elimination of the direct harvest of wild steelhead in the mid-1990s has largely addressed this threat. The recent NWFSC status review update concluded that current harvest rates on natural-origin steelhead continue to decline and are unlikely to substantially affect the abundance and overall productivity of Puget Sound steelhead (NWFSC 2016).

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 2010c). An annual average of 102 (hatchery and wild combined) (range 9 –

252) summer and winter steelhead were landed incidentally in treaty marine fisheries from all Puget Sound marine areas combined during the 2008/2009 to 2014/2015 time period (NMFS 2015b). Tribal marine fishery catch has demonstrated a declining trend (i.e., 48% decrease in tribal pre-terminal marine steelhead harvest) from 2001 to 2015. From April 2014 to March 2015, the steelhead catch estimate for marine tribal fisheries[13] was 53 steelhead (WDFW and PSIT 2016), demonstrating perhaps the beginning of a stabilization in the declining harvest trend for tribal commercial and ceremonial and subsistence marine fisheries. 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 (Beattie 2014).

In marine non-treaty salmon commercial fisheries retention of steelhead 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 2010). Over the most recent six year period from 2009 to 2014, 28 steelhead were encountered in 2,481 net sets estimated at 5 steelhead per year (Henry 2015). Over the 24 year observer time period from 1991 to 2015, 52 steelhead were encountered in 7,781 net sets averaging 2 steelhead encounters annually (Henry 2016) indicating that encounters of steelhead in non-treaty commercial salmon fisheries remain uncommon. Incidental catch of steelhead is not sampled for marks in order to return the bycatch to the water as quickly as possible (Henry 2014). As a consequence, the catch estimates include catch of both ESA-listed steelhead and ESA-listed and unlisted hatchery steelhead.

In marine non-treaty 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 2006/2007 time period (Leland 2010). An annual average of 108 (range 22 – 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 2014/2015 time period (Kraig 2016). These catch estimates include both ESA-listed and unlisted hatchery origin steelhead. Three natural-origin steelhead were landed in 2010/2011 as a result of illegal retention (WDFW and PSIT 2011). From April 2014 to March 2015, the steelhead catch estimate for marine recreational fisheries[14] was 22 fish (WDFW and PSIT 2016). The majority of steelhead were caught in Marine Catch Area 9. All steelhead were are identified as marked hatchery fish (WDFW and PSIT 2016). Applying a catch-and-release mortality rate of 10 percent, an average estimated 11 natural-origin steelhead mortalities have occurred annually from 2008/2009 to 2014/15. This also demonstrates a declining trend (45% decrease in incidental harvest) in non-treaty recreational fisheries since 2001.

In summary, at the time of listing, during the 2001/02 to 2006/07 seasons, an average of 325 steelhead were 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-

[13] Marine Catch Areas 4B, 5, 7, 7A, 7B, 8, 8A, 8D, 9A, 10, 10A, and 10F for tribal commercial and ceremonial and subsistence fisheries.

[14] Marine Catch Areas 6, 8-1, 9 and 10 for recreational fisheries.

treaty recreational). An average of 144 steelhead have been encountered in marine treaty and non-treaty commercial, ceremonial and subsistence, and recreational fisheries (i.e., 34 treaty marine; 2 non-treaty commercial; 108 non-treaty recreational) for the most recent time period (2008/2009 to 2014/2015). 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. Overall, marine treaty and non-treaty fisheries have demonstrated a decrease in catch estimates by 55% from 2008/2009 to 2014/2015 as compared to the previous 2001/2002 to 2006/2007 time period.

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 (PSIT 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. 2013). Data are currently insufficient 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% annually in Puget Sound fisheries during the 2001/2002 to 2006/2007 time period (NMFS 2010c) (Table 8). Average harvest rates on the same subset of watersheds for natural-origin steelhead demonstrated a reduction at 1.9% in Puget Sound fisheries during the 2007/2008 to 2014/2015 time period (Table 8). These estimates include sources of non-landed mortality such as hooking mortality and net dropout, 10% and 2% respectively.

Table 8. Terminal harvest rate (HR) percentages on natural-origin steelhead for a subset of Puget Sound winter steelhead populations for which catch and run size information are available (NMFS 2015c; WDFW and PSIT 2016).

Year	Skagit	Snohomish	Green	Puyallup	Nisqually[a]
2001-02	4.2	8.0	19.1	15.7	N/A
2002-03	0.8	0.5	3.5	5.2	N/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
Avg HRs 01-07	**4.3**	**2.6**	**6.4**	**4.3**	**3.3**
Total Avg HR	**4.2%** total average harvest rate across populations from 2001-02 to 2006-07				
2007-08	5.90	0.40	3.50	1.00	3.70
2008-09	4.90	1.10	0.30	0.00	3.70
2009-10	3.30	2.10	0.40	0.00	1.20
2010-11	3.40	1.50	1.60	0.60	1.80
2011-12	2.90	0.90	2.00	0.40	2.50
2012-13	2.30	1.10	2.38	0.70	1.10
2013-14	2.60	0.89	1.09	0.56	1.33
2014-15	1.23[c]	0.99[c]	1.04[c]	0.54[c]	0.79[c]
Avg HRs 2007-15	**3.79**	**1.28**	**1.76**	**0.54**	**2.30**
Total Avg HR	**1.9%** total average harvest rate across all populations from 2007-08 to 2014-15				
Total average HR 2001-02 to 2013-14	**3.2**				

[a] Escapement methodology for the Nisqually River was adjusted 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.

As mentioned above, 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 and the NWFSC's recent status review update confirmed continued declines in natural-origin steelhead harvest rates are not likely to substantially affect steelhead abundance in the DPS (NWFSC 2016). NMFS also evaluated the 2014-15 Puget Sound Chinook Harvest plan 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 harvest plan would not jeopardize the survival and recovery of the DPS (NMFS 2014a).

As described in the Status of Puget Sound Steelhead (Section 2.2.1.2), NMFS convened a technical recovery team that identified historic populations and developed viability criteria for a steelhead recovery plan (PSSTRT 2013a; 2013b). In May 2013, NMFS convened a recovery team to lead Puget Sound Steelhead Recovery Planning. NMFS plans to publish the draft Puget Sound Steelhead Recovery Plan for public comment in 2018. NMFS expects that both Federal and State steelhead recovery and management efforts will provide new tools, data and technical analyses, further refine Puget Sound steelhead population structure and viability, if needed, and better define the role of individual populations at the watershed level and in the DPS.

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 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 steelhead have been observed in the fishery. 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 NMFS issued an incidental take permit to the WDFW for listed species caught in these two fisheries, including Puget Sound Chinook salmon (NMFS 2012d). 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. Hatchery-origin fish may also pose risk through genetic, ecological, or harvest effects. Seven factors may pose positive, negligible, or negative effects to population viability of naturally-produced salmon and steelhead. These factors are:

(1) the hatchery program does or does not remove fish from the natural population and use them for hatchery broodstock,
(2) hatchery fish and the progeny of naturally spawning hatchery fish on spawning grounds and encounters with natural-origin and hatchery fish at adult collection facilities,
(3) hatchery fish and the progeny of naturally spawning hatchery fish in juvenile rearing areas,
(4) hatchery fish and the progeny of naturally spawning hatchery fish in the migration corridor, estuary, and ocean,

(5) research, monitoring, and evaluation that exists because of the hatchery program,
(6) the operation, maintenance, and construction of hatchery facilities that exist because of the hatchery program, and
(7) fisheries that exist because of the hatchery program, including terminal fisheries intended to reduce the escapement of hatchery-origin fish to spawning grounds.

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 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[15] 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.

About one-third of the hatchery programs in Puget Sound incorporate natural-origin Chinook salmon as broodstock for supportive breeding (conservation) or harvest augmentation purposes. Use of natural-origin fish as broodstock for conservation programs is intended to impart viability benefits to the total, aggregate population by bolstering total and naturally spawning fish abundance, preserving remaining diversity, or improving population spatial structure by extending natural spawning into unused areas. Integration of natural-origin fish for harvest augmentation programs is intended to reduce genetic diversity reduction risks by producing fish that are no more than moderately diverged from the associated, donor natural population. Incorporating natural-origin fish as broodstock for harvest programs produces hatchery fish that are genetically similar to natural-origin fish, reducing risks to the natural population that may result from unintended straying and spawning by unharvested hatchery-origin adults in natural spawning areas. To allow monitoring and evaluation of the performance and effects of programs incorporating natural-origin fish as broodstock, all juvenile fish are marked prior to release with CWTs or with a clipped adipose fish so that they can be differentiated and accounted for separately from juvenile and returning adult natural-origin fish.

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

[15] 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.

implemented as conservation measures to recover early returning Chinook salmon operate in the White (Appleby and Keown 1994), Dungeness (Smith and Sele 1995), and North Fork Nooksack rivers, and for summer Chinook salmon on the North Fork Stillaguamish and Elwha Rivers (Fuss and Ashbrook 1995; Myers et al. 1998). Supplementation or re-introduction programs are in operation for early Chinook 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).

Currently hatchery supplementation programs are also in place for the North Fork and South Fork Nooksack populations as described in their respective draft Hatchery and Genetic Management Plans (WDFW 2014, Lummi Nation 2015). The North Fork Nooksack hatchery program has a goal to collect up to 520 adults annually to meet its broodstock goal and the recent 13 year average return to the hatchery is 606 adults (WDFW 2014). The South Fork Nooksack program is transitioning from broodstock kept in captivity to adults now returning to Skookum Creek Hatchery that represent the genetic legacy of the South Fork Nooksack population. Each program has met their hatchery's egg-take objectives in recent years with few exceptions, and are expected to do so again in 2016 and for the foreseeable future (WDFW 2014, Lummi Nation 2015), thus ensuring that what remains of the genetic legacy is preserved and can be used to advance recovery.

There are currently 14 hatchery programs in Puget Sound that propagate steelhead. Currently there are five steelhead supplementation programs operating for natural-origin winter run steelhead conservation purposes in Puget Sound. Fish produced through the five conservation programs are designated as part of the listed Puget Sound Steelhead DPS, and are protected with their associated natural-origin counterparts from take (79 FR 20802, April 14, 2014). In the Central/Southern Cascade MPG, two conservation programs operate to rebuild the native Green River winter-run steelhead population, and one program is implemented to recover the native White River winter-run population. The other two conservation programs are operated to conserve steelhead populations that are part of the Hood Canal and Strait of Juan de Fuca MPG. The Hood Canal Steelhead Supplementation Program functions to rebuild native stock winter-run steelhead abundances in the Dewatto, Duckabush, and South Fork Skokomish river watersheds, and the Elwha River Native Steelhead program preserves and assists in the recolonization of native Elwha River winter-run steelhead. Listed hatchery-origin steelhead from the integrated programs listed above produce fish that are similar to the natural-origin steelhead populations, are designed for conservation of the ESA-listed populations, and allow for natural spawning of hatchery-origin fish.

Five programs produce "early winter" (previously "Chambers Creek lineage") unlisted steelhead for harvest in recreational and tribal fisheries: (1) Dungeness River; (2) Nooksack River; (3) Stillaguamish River; (4) Skykomish River; and (5) Snoqualmie River. Three other harvest augmentation programs propagate unlisted summer-run fish derived from Columbia River, Skamania stock that has become localized to their Puget Sound release sites. The operational status of these Skamania summer-run programs beyond the 2016 release year remains uncertain. The early winter and Skamania summer steelhead stocks reared and released as smolts through the nine programs 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. Gene flow from hatchery steelhead poses a genetic risk to natural-origin steelhead (NMFS 2016). Of particular importance to this harvest evaluation is that early winter steelhead have been artificially selected to return in peak abundance as adults earlier in the winter than the associated natural-origin Puget Sound winter run steelhead populations in the watersheds where the hatchery fish are released. Early winter and summer steelhead hatchery programs are isolated programs, where hatchery-origin adults return before the majority of the natural-origin run to reduce the genetic risk. The earlier return timing for the hatchery-origin steelhead minimizes hatchery-origin and natural-origin stock overlap and co-occurrence during the in-river migration and spawning periods. This temporal and spatial separation in adult return and spawn timing provides protection to the later-returning natural-origin steelhead populations in harvest areas when and where fisheries directed at early winter steelhead occur (Crawford 1979).

On March 3, 2016, NOAA Fisheries announced that they were releasing a FEIS that reviewed five HGMPs for early winter steelhead hatchery programs submitted by the co-managers for review and approval under the ESA. As mentioned above, the HGMPs describe five early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. On April 15, 2016, NMFS announced the release of the FEIS (NMFS 2016) for five HGMP on early winter steelhead programs. NMFS will prepare a record of decision no sooner than 30-days after the release of the FEIS.

As described in Section 2.2.1.2, NWFSC (2016) noted that hatchery steelhead releases in Puget Sound have declined in most areas. The Puget Sound Early Winter Steelhead FEIS indicated that steelhead hatchery releases decreased from about 2,468,000 annually (NMFS 2014c) to about 1,504,750 annually (Appendix A in NMFS 2016). Hatchery programs propagating unlisted winter steelhead account for the majority of hatchery-origin steelhead smolt releases (531,600) and a total of 841,600 unlisted smolts released annually (including 310,000 summer steelhead) in the Puget Sound DPS (Appendix A in NMFS 2016).

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[16] river basins (NMFS 2012a; 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., 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 2012a; 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 2012a; 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 2012a). 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 2012a). 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

[16] The Elwha dams have been removed, which has significantly changed the Elwha River's hydrology and now allows for steelhead and salmon access to miles of historical habitat upstream.

upper tributaries, summer run steelhead may be at higher risk than winter run steelhead from habitat degradation in larger, more complex watersheds (NMFS 2012a; 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 2008b), Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013a), the National Flood Plain Insurance Program (NMFS 2008c), and the Elwha River Fish Restoration Plan (Ward et al.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. 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.

2.3.2 Scientific Research

The listed salmon and steelhead species in this opinion are the subject of scientific research and monitoring activities. Most biological opinions issued by NMFS have conditions requiring specific monitoring, evaluation, and research projects to gather information to aid the preservation and recovery of listed species. The impacts of these research activities pose both benefits and risks. Research on the listed species in the Action Area is currently provided coverage under Section 7 of the ESA or 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 9). 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 9 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A) for the listed Puget Sound Chinook salmon ESU and Puget Sound steelhead DPS.

Table 9. Annual take allotments for research on listed species in 2012-2016 (Dennis 2016).

Species	Life Stage	Production/Origin	Total Take	Lethal Take
Puget Sound Chinook	Juvenile	Natural	432,471	12,149
		Listed hatchery intact adipose	78,382	4,023
		Listed hatchery clipped adipose	115,921	11,891
	Adult	Natural	883	52
		Listed hatchery intact adipose	145	11
		Listed hatchery clipped adipose	2,693	87
Puget Sound steelhead	Juvenile	Natural	70,223	1,326
		Listed hatchery intact adipose	103	2

		Listed hatchery clipped adipose	9,050	175
	Adult	Natural	1,357	30
		Listed hatchery clipped adipose	40	5

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

2.4 Effects of the Action on Species and Designated Critical Habitat

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 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.

2.4.1 Puget Sound Chinook

2.4.1.1 Assessment Approach

In assessing the effects of the proposed 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 next 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 A). 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 10) for the purposes of assessing proposed harvest actions, since FRAM is the analytical tool used by NMFS to assess proposed fishery actions. Surrogate standards are identified for those populations where data are currently insufficient or NMFS has not completed population-specific analyses 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. We also consider the results of independent analysis conducted using other methods (e.g., analysis of MSY in the Nisqually Chinook Stock Management Plan (2011) for the Nisqually Chinook population).

Table 10. 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 Sauk River Suiattle River Upper Cascade	46% 50%	38% 41% 38-41%
	Skagit Summer/Fall	Upper Skagit River Lower Skagit River Lower Sauk River	54% 36% 33%	60% 51% 49%
	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] Cedar[a]		*30%* *30%*
	Green-Duwamish	Duwamish-Green	62%	46%
	White	White[b]		*23%*
	Puyallup	Puyallup[c]		*33-46%*
	Nisqually	Nisqually[d]		*33%*
Hood Canal	Mid-Hood Canal	Mid-Hood Canal[e]		*18-23%*
	Skokomish	Skokomish	36%	33%
Strait of Juan de Fuca	Dungeness	Dungeness[b]		*23%*
	Elwha	Elwha[b]		*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 the Skokomish (33%) as surrogate.

[d] Uses range including Skokomish (33%) and Green Rivers fall Chinook as surrogates

[e] 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[17] 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.[18] 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 2004b). 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 A). 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[19] when the expected escapement of that population does not meet its critical threshold or its RER. 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.

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

[18] 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.

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

The Supplement to the Puget Sound Recovery Plan 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 (Ruckelshaus et al. 2002; NMFS 2006c). 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 identified within Puget Sound, depending on the historical biological characteristics and acceptable risk levels for populations within each region (Ruckelshaus et al. 2002; NMFS 2006c). Unlike other ESUs (e.g., Lower Columbia River (NMFS 2013b)), however, the Puget Sound Recovery Plan and PSTRT 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 PSTRT, 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.[20] For a more detailed explanation of the technical approach see NMFS (2000b, 2004b, 2011a).

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, if consistent with the ESA's requirements, 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.

2.4.1.2 Effects on the Species

Effects of the proposed action on listed species occur through implementation of the proposed action as described earlier (see Sections 1.2 and 1.3). Escapements and exploitation rates expected to result from fisheries during May 1-31, 2016 are summarized in Table 11. Exploitation rates are reported by management units and escapements by populations. As Table 11 demonstrates, only those Chinook management units in the Puget Sound Chinook ESU with spring or early returning life histories are anticipated to be affected by the proposed action. Other Chinook populations in Puget Sound exhibit a summer or fall run timing, returning mid-June

[20] 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 1999; 2005b; 2008e; 2010b, NMFS 2014a, NMFS 2015c).

through September, or return to locations outside the areas where the proposed fisheries would occur (i.e., Dungeness and Elwha River Chinook). Impacts in PST and PFMC fisheries are included in actions previously consulted on by NMFS (2004a, 2008e) and are therefore part of the Environmental Baseline (see Section 2.3.1). Thus, Table 11 represents the sum of fishing-related mortality anticipated under the proposed action together with that evaluated under the existing PFMC and PST consultations. Also included in Table 11 are the RERs and critical and rebuilding thresholds discussed above that NMFS uses as benchmarks to evaluate the effects of the proposed actions on survival and recovery of populations within the ESU. For management units comprised of multiple populations, Table 11 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%).[21] All of the population specific RERs are shown in Table 11.

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 11 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 reflected in Table 11 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.

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

Table 11. FRAM adult equivalent exploitation rates and escapements for the 2016 ocean and May 1-31 Puget Sound fisheries 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	32.4%	3.9%	**36.4%**	23%
Whidbey/ Main Basin	Skagit spring	19.2%	7.9%	27.1%	38-41%
	Skagit summer/fall	30.0%	0%	30.0%	49-60%
	Stillaguamish	12.3%	0%	12.3%	18-30%
	Snohomish	16.6%	0%	16.7%	18%
Central/South Sound	Lake Washington	27.7%	0%	27.7%	*30%*
	Duwamish-Green R	27.7%	0%	27.7%	46%
	White River	5.1%	2.1%	7.2%	*23%*
	Puyallup River	27.7%	0%	27.7%	*33-46%*
	Nisqually River	23.2%	0%	23.2%	*33%*
Hood Canal	Mid-Hood Canal R.	19.4%	0%	**19.4%**	*18-23%*
	Skokomish River	19.4%	0%	19.4%	33%
Strait of Juan de Fuca	Dungeness River		0%		*23%*
	Elwha River		0%		*23%*

Region	Escapement	Natural (HOR+NOR)	NOR	Critical	Rebuilding
Georgia Basin	Nooksack Management Unit		**331**		500
	NF Nooksack (early)	NA	**91**	*200*	-
	SF Nooksack (early)	NA	**135****	*200*	-
Whidbey/ Main Basin	Upper Sauk River (early)	1,002	1,002	967	330
	Suiattle River (very early)	502	502	200	400
	Upper Cascade River (moderately early)	341	341	251	*1,250*
	Upper Skagit River (moderately early)	13,300	12,795	130	7,454
	Lower Sauk River (moderately early)	664	664	170	681
	Lower Skagit River (late)	2766	2,766	170	2,182
	NF Stillaguamish R. (early)	355	**200**	300	552
	SF Stillaguamish R. (moderately early)	121	**68**	*200*	300
	Skykomish River (late)		2,087	1,650	3,500
	Snoqualmie River (late)		785	400	*1,250*
Central/South Sound	Cedar River (late)	1,515	1,121	*200*	*1,250*
	Sammamish River (late)	828	128	*200*	*1,250*
	Duwamish-Green R. (late)	4,342	2,122	835	5,523
	White River (early)	1,681	807	*200*	1,100
	Puyallup River (late)	1,407	373	*200*	522
	Nisqually River (late)	1,949	861	*200*	1,200
Hood Canal	Mid-Hood Canal Rivers (late)	336	336*	*200*[3]	*1,250*
	Skokomish River (late)	1,975	**149**	452	1,160
Strait of Juan de Fuca	Dungeness River	332	86	*200*	925
	Elwha River	2,823	155	*200*	*1,250*

Source: Chin2716_ STTFinal_TreatyOnly_PuySkokSkagitPSZeroEverywhereexceptSpringPlanFisheries.xlsm (L. Lavoy, pers. comm., April 29, 2016). Model output escapements adjusted to reflect natural-origin (NOR) or natural (hatchery-origin (HOR)+NOR) escapement as closely as possible using FRAM 2716 inputs, preseason forecasts or postseason data from previous years; those not reported directly from FRAM are underlined.

*Information not available to assess 2016 natural origin escapement for the Mid-Hood Canal population. Previous postseason reports indicate NOR Chinook contribute approximately 62% (Mid-Hood Canal) and 28% (Skokomish) to natural escapement for these populations since 2004. Sammamish escapement based on 2011-2015 contribution to Lake Washington natural-origin escapement.

** C. James, pers. comm, May 2, 2016. Represents NOR spawners of SF Nooksack origin only. NF Nooksack spawners stray into the South Fork but the progeny of the spawners is genetically distinct from each other.

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 1). 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. Both populations are expected to be affected by the proposed action in the action area described in Section 1.4.

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. 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=207, North Fork average NOR+HOR=1,841; Table 3) and the hatchery 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=51, South Fork average NOR+HOR=396; 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. The hatchery spawners likely do not provide the same buffer against risk as in the North Fork Nooksack case. 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 2016 (C. James, pers. comm. 2016, A. Chapman, pers. comm. 2014).

Productivity (recruits/parent spawners) is 0.6 for the North Fork and 1.6 for the South Fork (Table 3). This analysis indicates a relative lack of response in terms of natural-origin production given the much higher total natural escapements described in the above paragraph as shown in Table 3. The growth rates for natural-origin escapement and natural-origin recruitment are both positive but low (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 2008-2012 averaged 26% (total) and 5% (southern U.S.(SUS))(Table 7), higher than the RER but below the SUS exploitation rate ceiling of 7% in place during that time. Eighty-two percent of the harvest occurred in Alaska and Canadian fisheries (Table 7).

The anticipated total exploitation rate resulting from the proposed action is 36.4%, above the RER for the management unit of 23%, although the exploitation rate in the proposed action area alone (Puget Sound) is expected to be very low, i.e., 3.9% (Table 11). Under the proposed action, both populations are anticipated to be below their critical thresholds (Table 11), which is cause for concern, but total natural escapements are anticipated to remain higher in 2016 given recent year hatchery-origin contribution rates. In the South Fork, escapement should be supplemented further by the first returns from the new conservation hatchery program. Spring Chinook harvest restraints in the Strait of Juan de Fuca, northern Puget Sound, and the Nooksack River have been in place since the late 1980s. There have been no directed commercial fisheries on Nooksack spring Chinook in Bellingham Bay or the Nooksack River since the late 1970s. Since 1997, there have been very limited ceremonial and subsistence fisheries in the lower river in May. These protective measures are proposed to continue in 2016 as part of the proposed action (Shaw 2016). The proposed in-river ceremonial and subsistence (C&S) fishery in 2016 would rely on inseason monitoring and an assessment of impact to the population (Shaw 2016). Under the proposed action virtually all of the harvest on Nooksack early Chinook in SUS fisheries would occur in tribal treaty fisheries. If the proposed action were not to occur in 2016, we estimate that an additional 8 and 12 natural-origin spawners would return to the North and South Fork Nooksack early Chinook escapements, respectively. Therefore, further constraints to fisheries occurring from May 1-31, 2016 would come solely at the expense of tribal fisheries and not provide substantive benefits to either population by providing sufficient additional spawners to significantly change its status or trends from 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 2016 Puget Sound fisheries would not accrue meaningful benefits for either Nooksack population. Total natural escapements are anticipated to remain higher in 2016 given recent year hatchery-origin contribution rates. The Kendall Creek hatchery program retains the native profile of the North Fork Nooksack early Chinook (WDFW 2014). 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 (Lummi 2015). 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. Each of the conservation programs has continued to meet their respective hatchery supplementation goals (WDFW 2014, Lummi 2015). Under the proposed action, virtually all of the harvest of Nooksack early Chinook in SUS fisheries is expected to occur in tribal fisheries; primarily in C&S fisheries. The proposed action indicates minimal 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 1). 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 three populations (Upper Skagit summer, Upper Sauk and North Fork Stillaguamish), below the critical threshold for the South Fork Stillaguamish, and in between for the remaining populations (Table 3). Productivity is 1.1 or more for eight of the 10 populations (Table 3) while longer term trends indicate declining trends in recruitment for all the populations (Table 4). With the exception of the South Fork Stillaguamish, trends in natural escapement are 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. However, since the remaining populations in this region exhibit a summer or fall run timing, returning mid-June through September, the proposed action is only expected to affect the populations that comprise the Skagit Spring and Snohomish Management Units as fisheries occur between May 1 and May 31, 2016.

Including the effects of the proposed action, total exploitation rates for every population in the region are expected to remain well below their associated RERs (Table 11) from May 1-31, 2016. Therefore, NMFS considers the proposed action to present a low risk to each population. In short summary, the effects of the proposed action during May 1-31, 2016 will meet the recovery plan guidance for every population affected in the region, 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 continued critical status and trends for the South Fork Stillaguamish is a cause for concern. However, there is no anticipated affect to this population from the proposed action and 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 all expected to be well below their RERs after accounting for total exploitation rates.

Central/South Sound: There are six populations within the Central/South Sound Region (Figure 1). 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 constitute 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 systems 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 Puyallup River exceeds its rebuilding threshold (Table 3). Productivity is 1.0 or more for four of the six populations (Table 3). Natural escapement trends are increasing or stable for four of the six populations (Table 4). Growth rates for recruitment and escapement are declining for the Duwamish-Green, Nisqually, and Puyallup populations (Table 4). The White River population has one of 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 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. 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 2008-2012 ranged between 15 and 71% (total) and 13 to 55% (SUS) (Table 7), above the RERs for three of the five management units (11). Overall, a larger proportion of the harvest of these populations occurs in SUS fisheries than for populations in other regions of Puget Sound; 14 to 56% of the harvest occurred in Alaska and Canadian fisheries depending on the population (Table 7).

The White River population exhibits an early timed life history while the remaining populations in this region exhibit a fall timed life history. NMFS expects the proposed action to only affect the White River population in this region as the fisheries will occur from May 1-31, 2016 prior to the return of other populations in the region. Natural-origin spawning escapements in 2016 are expected to be between the critical and rebuilding thresholds for all of the populations except for the Sammamish, which is expected to be below the critical threshold (Table 11). The additional contribution of hatchery spawners to natural escapement for most of these populations (Table 11) 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 and Puyallup, which are declining (Table 4). However, including the effects of the proposed action, total exploitation rates for every management unit in the region are expected to remain well below their associated RERs (Table 11) from May 1-31, 2016. Therefore, NMFS considers the proposed action to present a low risk to each population.

In summary, given the information and context presented above, the fishing regime represented by the proposed action should adequately protect each of the six populations in this region. Therefore, the proposed action will meet the recovery plan guidance for populations representing the range of life histories displayed by the populations in this region at including those specifically identified as needed for recovery of the Puget Sound Chinook ESU (White River and Nisqually).

Hood Canal: There are two populations within the Hood Canal Region: the Skokomish River and the Mid-Hood Canal Rivers populations (Figure 1). 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 abundance and productivity data indicate some increased risks for these populations but the location and timing of the proposed action will not affect these populations. 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). Growth rates are declining for the Skokomish population and mixed for the Mid-Hood Canal Rivers population, although the trend in natural escapement for both populations are at least stable (Table 4). The populations in this region exhibit a fall timed life history and return to locations outside the action area described in Section 1.4. NMFS has determined the proposed action will not affect populations in this region (Table 11, Puget Sound ER = 0).

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 1). 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. 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. Analyses of the growth rate of recruitment demonstrates a relative lack of response by either population in terms of natural-origin production (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 abundance and productivity data indicate some increased risks for these populations but the location and timing of the proposed action will not affect these populations. The average natural-origin escapement for 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 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. Both populations return to locations outside the terminal areas where the proposed action will occur. Therefore, similar to the Hood Canal region, NMFS has determined the proposed action will not affect populations in this region (Table 11, Puget Sound ER = 0).

2.4.1.3 Effects on Critical Habitat

Critical habitat is located in the areas where the proposed action will 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.

The proposed harvest related activities in Puget Sound will occur from boats or along river banks, with most of the fishing activity in river 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 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).

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.

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 these areas during peak spawning, rearing, and out-migration periods. 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.

2.4.2 Puget Sound Steelhead

2.4.2.1 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 data are available for one 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. Since data are currently insufficient to provide a full run reconstruction of most 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, an alternative approach to analyzing natural-origin steelhead impacts was developed.

This alternative approach takes into account information from the listing determination for Puget Sound steelhead. NMFS determined that the harvest management strategy at the time that eliminated the direct harvest of natural origin steelhead 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% for five winter run steelhead populations, and included an additional 325 adult steelhead taken in pre-terminal (marine) fisheries (NMFS 2010c). 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). Overall, marine treaty and non-treaty fisheries have demonstrated over a 50% decline in steelhead harvest from 2008 – 2015 as compared to 2001- 2007, the time period used for determining harvest effects during listing of Puget Sound steelhead (Section 2.3.1). 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 (ODFW 2007; NMFS 2008b; NMFS 2008a). Available information continues to be quite limited. The status of Puget Sound steelhead has not changed significantly since the time of listing (NWFSC 2016) and associated harvest rates continue to be within, or most recently lower than, the range of those observed at the time of listing (Table 8).

2.4.2.2 Effects on the Species

As discussed in the Environmental Baseline (Section 2.3.1), Puget Sound steelhead are caught in tribal fisheries in the marine and freshwater areas of the Sound. In marine areas, fisheries target salmon species other than steelhead. In freshwater areas, Puget Sound steelhead are caught in fisheries targeting both salmon and steelhead. Under the proposed action, natural-origin steelhead are likely to be incidentally caught in tribal marine and freshwater fisheries for spring Chinook salmon during the month of May 2016. 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 with certainty, but given the timing of the fisheries and the proximity of the marine areas in the proposed fisheries to major river systems, we assume they are returning to the rivers in the immediate area. 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.

The proposed action includes the following Puget Sound tribal fisheries directed at spring Chinook salmon which incidentally encounter listed summer, winter, and summer/winter steelhead populations: Ceremonial and subsistence (C&S) fishery in the Nooksack River, commercial, test and C&S fisheries in Skagit Bay and the Skagit River, commercial fishery in Tulalip Bay, and C&S fisheries in the White and Puyallup Rivers for the month of May 2016 (Shaw 2016). Fisheries in the Nooksack, Skagit Bay, and Skagit River and Tulalip Bay all affect demographically distinct populations (DIPs) within the Northern Cascade MPG. We first evaluate the impacts of the individual fisheries on the DIPs and then combine the results of our analysis to evaluate the effect on the Northern Cascade MPG. The C&S fisheries in the Puyallup and White Rivers affect DIPs within the Central/South Sound MPG. Because the proposed fisheries are in the terminal areas or rivers of their MPGs, they would not affect steelhead returning to DIPs in the other MPGs.

Nooksack

The Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified two extant steelhead DIPs in the Nooksack River watershed, which are part of the Puget Sound Steelhead DPS: Nooksack River winter-run and the South Fork Nooksack River summer-run steelhead (PSSTRT 2013b). As described in section 2.2.1.2 (Figure 1), the two DIPs are in the Northern Cascades MPG. Abundance goals for natural-origin steelhead for Nooksack River steelhead DIPs and the DPS range from 114 to 44,091 and 30,449 to 613,662, respectively (Table 12).

Table 12. Puget Sound Steelhead TRT DIP and overall DPS abundance goals for natural-origin steelhead in the Nooksack River watershed (PSSTRT 2013a).

Population Basin				Quasi-extinction Threshold (QET)	Low Abundance	Viable	Capacity
Population Name	Area km^2	Mean Elevation (m)	Total Stream Length (m)		1% SAS	5% SAS	20% SAS
Nooksack winter	1,982	619	1,257,480	73	2,205	11,023	44,091

South Fork Nooksack summer	172	926	99,347	27	114	568	2,273
Puget Sound DPS Total				1,462	30,449	153,194	613,662

The PSSTRT (2013a) developed criteria for MPG and DPS viability. The Puget Sound Steelhead DPS would be considered viable only if all its MPGs maintain viable status (PSSTRT 2013a). The number of viable DIPs required for MPG viability in the Northern Cascades MPG, where Nooksack River steelhead summer and winter steelhead are identified, is 2 out of the 5 summer-run and 5 of the 11 winter-run steelhead populations (Table 13).

Table 13. Number of viable DIPs required for MPG viability in the Northern Cascades MPG (PSSTRT 2013a).

MPG	Life History Type	Number of DIPs	Number Viable
Northern Cascades	Summer-run	5	2
	Winter-run	11	5

In the NWFSC status review update for Pacific Northwest Salmon and Steelhead listed under the ESA, the NWFSC (2016) reported only one 5-year geometric mean natural spawner count (2010-2014) for the Nooksack River winter-run steelhead population in the Nooksack watershed from 1990 to 2014 (Table 14). Estimates for the South Fork Nooksack summer DIP are not available. Despite lack of data, the Nooksack River winter-run population is considered one of the largest steelhead populations in the Northern Cascades MPG.[22]

Table 14. Number of viable DIPs required for MPG viability in the Northern Cascades MPG (PSSTRT 2013a).

MPG	DIP	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	% Change
Northern Cascades	Nooksack winter	--	--	--	--	1693 (1745)	--
	South Fork Nooksack summer	--	--	--	--	--	--

The Nooksack Tribe and Lummi Nation have proposed a spring Chinook salmon C&S tribal fishery in the Nooksack River (MCAs 77B or 77C) during May 1 to May 31. Tribal C&S fisheries involve traditional gillnets (e.g., drift gillnet and set net gear) and selective tangle-nets. All steelhead encountered in the Nooksack Tribe gillnet and Lummi Nation tangle-net fisheries would be winter-run steelhead. Summer-run steelhead have been observed spawning in February and would be out of the system by the proposed Nooksack tribal spring Chinook salmon fisheries (Currence 2016). Based on 2015 tribal catch data from the 2015 Nooksack Tribe and Lummi

[22] The largest steelhead populations in the Northern Cascades MPG include Nooksack River winter, Samish River and Bellingham Bay Tributaries winter, Skagit River winter, Snohomish River/Skykomish River winter, and Snoqualmie River winter steelhead.

Nation C&S fishery, a total of 13 natural-origin winter-run steelhead were encountered with three confirmed steelhead kelts (Shaw 2016). In 2015, the Nooksack Tribe harvested 6 natural-origin steelhead; 3 of the six fish were winter-run steelhead kelts. In 2015, the Lummi Nation selective tangle-net fishery encountered 39 natural-origin steelhead with an estimated 18.5% release mortality of 7 fish. Based on the 2015 fishery, a total incidental catch of 13 steelhead is anticipated in the 2016 Nooksack River tribal C&S traditional gillnet and tangle-net fisheries in (Shaw 2016).

As described above, winter-run steelhead incidental catch in Nooksack River spring Chinook salmon fisheries was 13 fish in May 2015 (Shaw 2016). The 2010-2014 Nooksack winter-run steelhead 5-year average geometric mean count of spawners was 1,693 fish. Thirteen winter-run steelhead harvested in the Nooksack River tribal C&S fisheries in May represent a harvest rate of 0.8% on the average Nooksack winter-run natural-origin spawners. Due to only one set of data (2010-2014) for the Nooksack winter-run steelhead population since 1990, we are unable to determine at this time whether the population is decreasing, stable, or increasing. However, based on the most recent average abundance estimate (NWFSC 2016; Table 14) and that the Nooksack winter-run population is one of the largest steelhead populations in the Northern Cascade MPG (NWFSC 2016), it is likely that incidental impacts from the Nooksack River tribal C&S fisheries during the month of May on natural-origin winter steelhead would be negligible and would not impede the Nooksack winter-run steelhead DIP from reaching viability.

Skagit Bay

The Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified four extant steelhead populations in the Skagit River watershed, which are part of the Northern Cascades MPG in the Puget Sound Steelhead DPS: Mainstem Skagit River summer/winter run steelhead; Nookachamps Creek winter-run steelhead; Baker River summer/winter run steelhead; and Sauk River summer/winter run steelhead (PSSTRT 2013b). Abundance goals for natural-origin steelhead in Skagit River steelhead DIPs and the DPS range from 123 to 129,551 and 30,449 to 613,662, respectively (Table 15).

Table 15. Puget Sound Steelhead TRT DIP and overall DPS abundance goals for natural-origin steelhead in the Skagit River watershed (PSSTRT 2013a).

Population Basin				Quasi-extinction Threshold (QET)	Low Abundance	Viable	Capacity
Population Name	Area km^2	Mean Elevation (m)	Total Stream Length (m)		1% SAS	5% SAS	20% SAS
Mainstem Skagit River summer/winter	5,543	1,098	2,815,113	157	6,478	32,388	129,551
Nookachamps Creek winter	183	252	159,503	27	123	616	2,462
Baker River summer/winter	771	999	421,859	36	503	2,514	10,056
Sauk River summer/winter	1,897	1,132	1,079,263	103	2,323	11,615	46,460
Puget Sound DPS Total				1,462	30,449	153,194	613,662

In the NWFSC status review update for Pacific Northwest Salmon and Steelhead listed under the ESA, the NWFSC (2016) reported a slight (7%) increase in 5-year geometric mean natural spawner counts for the Skagit River watershed from between the most recent five year time periods, i.e., 2005-2009 compared with 2010-2014 (Table 16).

Table 16. 5-year geometric mean of raw natural spawner counts for the Skagit River watershed, where available (NWFSC 2016). Natural spawner counts are in parentheses.

MPG	DIP	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	% Change
North Cascades	Skagit River winter-run	7189 (7650)	7656 (8059)	5424 (5675)	5547 (4767)	(5123)	(7)

In Marine Catch Area (MCA) 8 (Skagit Bay), spring Chinook salmon commercial fisheries are proposed for tribal management weeks 19-21 during May 1 to May 15, two days per week. Nearly all of the C&S and commercial gillnet effort involves drift gillnet gear. Treaty purse seiners are not allowed to fish in MCA 8 (NOAA and BIA 2015). These tribal gillnet fisheries are anticipated to be comparable to those in recent years (Shaw 2016). One natural-origin steelhead of Skagit River origin is anticipated to be encountered in the Skagit Bay (MCA 8) spring Chinook salmon commercial fishery in May 2016. One steelhead represents a harvest rate of 0.02% on the total Skagit River natural spawners. Because this catch will occur in Skagit Bay where steelhead of mixed stocks co-occur, we are unable to determine which Skagit River steelhead DIP would be affected. However, due to the low number of steelhead encounters (1 fish; 0.02%) and the current status of the Skagit River winter-run population as a whole, these incidental fishery effects are considered to have negligible effects on abundance, productivity, spatial structure diversity and are unlikely to impede the four Skagit River steelhead DIPs from reaching viability.

Skagit River

The Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified four extant steelhead DIPs in the Skagit River watershed, which are part of the Northern Cascade MPG in the Puget Sound Steelhead DPS: Mainstem Skagit River summer/winter run steelhead; Nookachamps Creek winter-run steelhead; Baker River summer/winter run steelhead; and Sauk River summer/winter run steelhead (PSSTRT 2013b). Abundance goals for natural-origin steelhead in Skagit River steelhead DIPs and the DPS range from 123 to 129,551 and 30,449 to 613,662, respectively (Table 15).

The Skagit River Tribes have proposed commercial, C&S, and test gillnet fisheries for spring Chinook salmon in the Upper Skagit River (MCA 78D) and Lower Skagit River (78C) from May 1 to May 31. The Swinomish and Sauk-Suiattle Tribes' have proposed spring Chinook fisheries in the Lower Skagit River (78C) for tribal management weeks 19-21, May 1 to May 15, for two days per week (Shaw 2016). The Upper Skagit Tribe has proposed a spring Chinook fishery in the Lower Skagit River (78C) and Upper Skagit River (78D) for tribal management weeks 20-22, May 8 to May 22, for 14 hours (week 20), 16 hours (week 21), and 16 hours per week (week

22). The Skagit River spring Chinook salmon test fishery is proposed to occur in the Lower Skagit River for tribal management weeks 19-23, May 1 to May 31. Total steelhead incidental encounters in these spring Chinook salmon fisheries are anticipated to be approximately 54 kelt-adjusted[23] Skagit River natural-origin steelhead, resulting in an incidental encounter rate of approximately 6% winter-run steelhead kelts.

Four extant steelhead summer/winter-run populations exist in the Skagit River watershed (Table 15). Skagit River 5-year geometric mean spawner counts are determined for the Skagit River winter-run populations as a whole representing an average estimate of 5,123 steelhead for 2010-2014 (Table 16). Fifty-four winter-run steelhead harvested in the Skagit River tribal commercial, C&S, and test fisheries in May represent a harvest rate of 1% of the recent (2010-2014) average natural-origin winter-run steelhead spawners in the Skagit River.

Skagit watershed summary

Based on the analysis above for the Skagit River winter-run DIP, it is likely that the combined impacts from the Skagit Bay and Skagit River tribal commercial, C&S, and test fisheries during the month of May on natural-origin winter steelhead would be very low. Due to the very low impact of the proposed fisheries (1.02%), the increasing abundance trend (7%) and the current status of the Skagit River winter-run steelhead as a whole, this very low impact in Skagit River tribal fisheries during May 2016 is unlikely to prevent the Skagit River winter-run steelhead DIPs from reaching viability.

Tulalip Bay

The Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified eight extant steelhead populations in the Skykomish, Snohomish, Stillaguamish, and Snoqualmie watersheds, that drain into Tulalip Bay, which are part of the Northern Cascades MPG in the Puget Sound Steelhead DPS: Stillaguamish winter-run; Deer Creek summer-run; Canyon Creek summer-run; Snohomish/Skykomish River winter-run; Pilchuck River winter-run; North Fork Skykomish River summer-run; Snoqualmie River winter-run steelhead; and Tolt River summer-run steelhead (PSSTRT 2013b). Abundance goals for natural-origin steelhead in these steelhead DIPs and the DPS range from 100 to 42,779 and 30,449 to 613,662, respectively (Table 17).

[23] For Skagit River steelhead encounters, a 8.68% encounter rate is applied to the overall catch estimate to determine the amount of kelts intercepted during Skagit River tribal spring Chinook salmon fisheries (Shaw 2016).

Table 17. Puget Sound Steelhead TRT DIP and overall DPS abundance goals for natural-origin steelhead located in the Skykomish, Snohomish, Stillaguamish, and Snoqualmie watersheds near Tulalip Bay (PSSTRT 2013a).

Population Basin				Quasi-extinction Threshold (QET)	Low Abundance	Viable	Capacity
Population Name	Area km²	Mean Elevation (m)	Total Stream Length (m)		1% SAS	5% SAS	20% SAS
Stillaguamish winter	1,230	398	927,234	67	1,912	9,559	38,236
Deer Creek summer	180	761	105,313	31	157	786	3,144
Canyon Creek summer	100	864	47,716	24	100 (12)	250 (60)	243
Snohomish/Skykomish River winter	1,595	420	1,021,690	73	2,139	10,695	42,779
Pilchuck River winter	356	253	242,383	34	519	2,597	10,386
North Fork Skykomish River summer	156	1,195	117,602	25	100 (66)	331	1,325
Snoqualmie River winter	1,615	620	1,134,038	58	1,674	8,370	33,479
Tolt River summer	182	784	117,732	25	100 (32)	250 (160)	641
Puget Sound DPS Total				1,462	30,449	153,194	613,662

In the NWFSC status review update for Pacific Northwest Salmon and Steelhead listed under the ESA, the NWFSC (2016) reported both increases (3% Pilchuck winter to 44% Tolt summer steelhead) and decreases (83% Snohomish/Skykomish winter and (28% Snoqualmie winter steelhead) in the 5-year geometric mean natural spawner counts for the Stillaguamish, Snohomish, Skykomish, and Snoqualmie watersheds between the most recent two five year periods (Table 18).

Table 18. 5-year geometric mean of raw natural spawner counts times the fraction natural estimate, if available) for steelhead populations adjacent to Tulalip Bay, where available (NWFSC 2016). Total natural spawner counts are in parentheses.

MPG	DIP	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	% Change
Northern Cascades	Stillaguamish winter	1078 (1078)	1024 (1166)	401 (550)	259 (327)	(392)	(20)
	Snohomish/ Skykomish winter	6654 (7394)	6382 (7200)	3230 (3980)	4589 (5399)	(930)	(-83)
	Pilchuck winter	1225 (1225)	1465 (1465)	604 (604)	597 (597)	614 (614)	(3)
	Snoqualmie winter	1831 (1831)	2056 (2056)	1020 (1020)	944 (944)	680 (680)	(-28)
	Tolt summer	112 (112)	212 (212)	119 (119)	73 (73)	105 (105)	(44)
Puget Sound DPS Total				1,462	30,449	153,194	613,662

In Marine Catch Area (MCA) 8D (Tulalip Bay), spring Chinook salmon commercial tribal fisheries are proposed May 1 to May 31. Tribal commercial fisheries in Tulalip Bay, MCA 8D involve drift gillnet and set net gear. There is drift gillnet effort in both areas, but fishers in MCA 8D primarily use set nets. Within Tulalip Bay, a shallow (<1 m deep) 1.5 km^2 harbor, fisheries exclusively use set net gear (NOAA and BIA 2015). Regulations for MCA 8D limit fisheries to specific time periods, which are almost entirely daylight hours and require net attendance at all times (NOAA and BIA 2015).

In MCA 8D (Tulalip Bay) spring Chinook salmon tribal commercial fisheries, an average of two steelhead per year have been harvested between tribal management weeks 19-22 during the month of May based on past catch data from 2008 to 2015 (Shaw 2016). Run-timing of adult summer steelhead from the Deer Creek, Canyon Creek, and Tolt River steelhead DIPs is generally from July through mid-October and spawn timing is generally from early to mid-April through May. No abundance estimates are available for Deer or Canyon Creeks summer-run steelhead populations. For tribal management, winter-run steelhead encountered in Area 8D (Tulalip Bay) are proportioned between winter steelhead populations from the Stillaguamish and Snohomish watersheds weighted by the estimated escapement levels in each system (Shaw 2016). Since Area 8D (Tulalip Bay) is in closer proximity to the mouth of the Snohomish River and the Snohomish winter steelhead escapement estimates are often four times (or greater) higher than Stillaguamish winter steelhead escapements, the tribes anticipate that all steelhead incidentally harvested in May 2016 will be attributed to the Snohomish/Skykomish winter-run steelhead population. For these reasons it is unlikely summer-run steelhead would be encountered in the tribal Tulalip Bay fishery, but the fishery may encounter summer-run kelts from the Stillaguamish and Tolt watersheds. Due to the increasing abundance trend of the Tolt summer-run steelhead population under similar past encounters, we anticipate negligible effects to occur to these summer-run populations if any summer-run steelhead are encountered in the tribal spring Chinook salmon fishery.

The Snohomish/Skykomish Rivers winter-run DIP has been demonstrating a decline in natural-origin abundance from an average of 5,399 fish to 930 fish from 2005-2009 to 2010-2014. This represents a steep decrease in estimated abundance of 83% over the past two five-year periods (Table 18). However, the two steelhead encounters expected in the proposed tribal fishery represent only a 0.03% harvest rate on the most recent average total abundance of natural-origin winter-run spawners in the Snohomish/Skykomish Rivers DIP. This low impact is expected to have negligible effects on the abundance, productivity, spatial structure, and diversity of Snohomish/Skykomish Rivers winter-run steelhead and are unlikely to prevent the DIP from reaching viability.

In summary, tribal fisheries implemented under the proposed action during the month of May 2016 are expected to have negligible to very low impacts to listed steelhead DIPs in the Northern Cascade MPG. All impacts are expected to be on winter-run steelhead DIPs. The anticipated combined harvest rates of the proposed fisheries on DIPs within the Northern Cascade MPG are 0.08% on Nooksack winter-run steelhead, 1.02% on Skagit winter-run steelhead, and 0.03% on

Snohomish/Skykomish winter-run steelhead. These impacts are expected to have negligible to very low impacts on the abundance, productivity, spatial structure, and diversity of these DIPs.

The PSSTRT criteria is 5 of the 11 winter steelhead DIPs must be viable for the Northern Cascade MPG to be viable. Since the impacts are not anticipated to impede any of the DIPs from reaching viability, the proposed fisheries would not then impede achieving the viability criteria for the Northern Cascade MPG.

Puyallup and White Rivers

The Puget Sound Steelhead Technical Recovery Team (PSSTRT) identified two extant steelhead populations in the Puyallup River and White River watersheds, which are part of the Puget Sound Steelhead DPS: Puyallup River/Carbon River and White River winter-run steelhead (PSSTRT 2013b). Abundance goals for natural-origin steelhead in Puyallup and White Rivers steelhead DIPs and the DPS range from 1,472 to 34,981 and 30,449 to 613,662, respectively (Table 19).

Table 19. Puget Sound Steelhead TRT DIP and overall DPS abundance goals for natural-origin steelhead in the Puyallup River and White River watersheds (PSSTRT 2013a).

Population Basin				**Quasi-extinction Threshold (QET)**	**Low Abundance**	**Viable**	**Capacity**
Population Name	Area km²	Mean Elevation (m)	Total Stream Length (m)		1% SAS	5% SAS	20% SAS
Puyallup River/Carbon River winter	1,395	672	803,817	58	1,472	7,358	29,432
White River winter	1,285	1,061	863,251	64	1,749	8,745	34,981
Puget Sound DPS Total				1,462	30,449	153,194	613,662

In the NWFSC status review update for Pacific Northwest Salmon and Steelhead listed under the ESA, the NWFSC (2016) reported a slight (14%) decrease in 5-year geometric mean natural spawner counts for the Puyallup/Carbon watershed from between the most recent two five-year periods and a significant (136%) increase in 5-year geometric mean natural spawner counts for the White River watershed (Table 20).

Table 20. 5-year geometric mean of raw natural spawner counts for Puyallup River and White River steelhead populations, where available (NWFSC 2016).

MPG	**DIP**	**1990-1994**	**1995-1999**	**2000-2004**	**2005-2009**	**2010-2014**	**% Change**
North Cascades	Puyallup/Carbon Rivers winter	1156 (1249)	1003 (1134)	428 (527)	315 (322)	(277)	(-14)
	White River winter	696 (696)	519 (519)	466 (466)	225 (225)	531 (531)	(136)

The Puyallup and Muckleshoot Tribes have proposed C&S tribal gillnet fisheries for spring Chinook salmon in the Puyallup River (MCR 81B) and the White River (MCA 81C) from May 1 to May 31. The White River spring Chinook salmon gillnet fishery is proposed during tribal management week 20 beginning May 8, seven days per week until the Muckleshoot Tribe has reached their share of 34 spring Chinook salmon. The Puyallup Tribe has proposed a First Fish Ceremonial Fishery in the Puyallup River (81B) for tribal members commencing tribal management week 21, the week of May 15, for 12 hours with a cap of 12 spring Chinook salmon. The Puyallup Tribe has also proposed a tribal spring Chinook salmon C&S gillnet fishery in the Puyallup River (81B) for tribal elders commencing tribal management week 22, beginning May 22 for 10 hours a day, two days per week until the Puyallup Tribe spring Chinook salmon catch share is met. Steelhead encounters are expected to be minimal resulting in up to two steelhead for all Puyallup River and White River steelhead tribal C&S gillnet fisheries; one steelhead encounter in each tribal C&S fishery (Shaw 2016).

Two extant steelhead winter-run populations exist in the Puyallup River and White River watersheds (Table 19). Current five-year geometric mean spawner counts represent an average estimate of 277 Puyallup River winter steelhead and 531 White River winter steelhead for 2010-2014 (Table 20). This is a slight decrease (14%) in the average steelhead spawner counts between the most recent two five-year periods for the Puyallup/Carbon winter steelhead DIP but a significant increase (136%) in the average steelhead spawner counts for the White River winter steelhead DIP. One winter-run steelhead in the Puyallup tribal spring Chinook salmon fishery represents a 0.4% impact on the Puyallup/Carbon Rivers DIP and one winter-run steelhead in the White River tribal spring Chinook salmon fishery represents a 0.2% harvest rate on the recent average natural-origin spawner abundance (2010-2014) in these watersheds. Based on the most recent average abundance estimates (NWFSC 2016; Table 20) and status information, these impacts would result in negligible effects on the abundance, productivity, spatial structure, and diversity of the Puyallup/Carbon Rivers and White River winter-run DIPs and would not impede the DIPs and therefore the Central/South Sound MPG from reaching viability

Summary

In summary, available information on steelhead viable salmonid population (VSP) criteria to evaluate natural-origin steelhead viability continues to be limited; therefore, current abundance estimates were used to determine tribal fishery incidental impacts on natural-origin steelhead. The total number of natural-origin steelhead incidentally caught in tribal commercial, C&S, and test fisheries is likely to be 72 fish (3 steelhead in marine fisheries; 69 steelhead in freshwater fisheries). As described above, this represents negligible to very low harvest rates on natural-origin steelhead spawners in the Puget Sound steelhead DIPs identified above.[24] The status of Puget Sound steelhead has not changed significantly since the time of listing (NWFSC 2016) and associated harvest rates continue to be within, and most recently lower than (average 1.9%), the range of those observed at the time of listing (4.2%; sections 2.3.1 and 2.4.2.1). Incidental effects from tribal marine and freshwater spring Chinook salmon fisheries range from negligible to very

[24] The Puget Sound steelhead DIPs affected by marine and freshwater tribal fisheries include: Mainstem Skagit River, Nookachamps Creek, Baker River, Sauk River, Snohomish/Skykomish Rivers, Puyallup/Carbon Rivers, and White River winter-run steelhead.

low and are unlikely to prevent any of these Puget Sound steelhead DIPs from reaching viability. Because the proposed fisheries would not impede the DIPs from achieving viability, they will also not impede the Northern Cascades or Central/South Sound MPG from reaching viability. No other MPGs are affected by the proposed fisheries. Since all Puget Sound steelhead MPGs must be viable for recovery of the DPS, the proposed fisheries would also not impede the Puget Sound Steelhead DPS as a whole from reaching viability. In addition, overall, the proposed tribal commercial, C&S, and test spring Chinook salmon fisheries described above represent a reduction in incidental harvest rates on Puget Sound steelhead populations.

No steelhead harvest-related specific research is included in the research, monitoring, and evaluation activities during May 2016. Any tribal test fisheries are included in the overall tribal fisheries impacts described above.

2.4.2.3 Effects on Critical Habitat

Critical habitat is located in the areas where the proposed action will 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.

The proposed harvest related activities in Puget Sound will occur from boats or along river banks, with most of the fishing activity in river 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 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).

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 these areas during peak spawning, rearing, and out-migration periods. 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.

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 effects 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 Cumulative Effects

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

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 the cumulative effects sections of several section 7 consultations on large scale habitat projects affecting listed species in Puget Sound including Washington State Water Quality Standards (NMFS 2008b), Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013a), the National Flood Plain Insurance Program (NMFS 2008c), and the Elwha River Fish Restoration Plan (Ward et al. 2008). We anticipate that the effects described in these previous analyses will continue into the future and therefore we incorporate those discussions 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 2006c; SSPS 2007). Puget Sound steelhead recovery planning is underway. Although state, tribal and local governments have developed plans and initiatives to benefit ESA listed salmon, 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.

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.

2.6 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), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species.

2.6.1 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. The analysis incorporates information discussed in the Status (Section 2.2.1.1), Environmental Baseline (Section 2.3.1) and Cumulative effects (Section 2.5) 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 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 populations 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.

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 action. These are discussed in Section 2.3.1 and 2.4.1. The Integration and Synthesis section summarizes and explains the considerations that lead to NMFS' biological opinion for the proposed action. 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 21which may 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 action are very low, and our analysis indicates that further harvest reductions in 2016 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 positive and stable, respectively, for the North Fork Nooksack population and positive for the South Fork population. The conservation hatchery programs are key components in recovery of the Nooksack early Chinook populations and should buffer demographic and genetic risks as they continue to meet their objectives. Under the proposed action, virtually all 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 action, and past patterns indicate exploitation rates under the proposed action are likely to be lower than anticipated. The South Fork Nooksack hatchery program has been in operation for several years but 2016 is the first year that adults returning from the program are expected to contribute to escapement and mitigate concerns related to low abundance.

Across the remaining regions in the ESU, only two would be affected by the proposed action. Furthermore, each affected region would have just one management unit affected by fisheries from May 1-31, 2016, the Whidbey/Main Basin Region (Skagit Spring Management Unit) and the Central/South Sound Region (White River Management Unit) (Table 11).

Within the Whidbey/Main Basin Region, the effects of the proposed action will meet the recovery plan guidance for every population in this region, including those populations 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 the proposed action to present a very low risk to populations where estimated impacts of the proposed fisheries are well below the RERs.

Similarly, within the Central/South Sound Region, the effects of the proposed action will meet the recovery plan guidance, including those populations specifically identified as needed for recovery of the Puget Sound Chinook ESU (White River and Nisqually). The only population NMFS expects to be affected by the proposed action, the White River population, is expected to meet its RER indicating low risk to the population. Under the proposed action the White River is expected to be well above its critical threshold. Growth rates for both natural-origin recruitment and escapement are positive. Growth rates of escapement are 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 in this region.

The status of the populations in the Hood Canal and Strait of Juan de Fuca Region, given their role in recovery of the ESU, is cause for concern. The combination of static growth rates in the case of Hood Canal, low productivity, and low levels of natural-origin escapement suggest these populations are at high risk for survival and recovery. However, these populations are not affected by the proposed action. Therefore it would not measurably affect the risks to survival or recovery of the spawning aggregations within the Hood Canal Region.

In summary, under the proposed action, the combined ocean and Puget Sound exploitation rates from May 1-31, 2016 for 12 of the 14 management units in the ESU (19 of 22 populations) are expected to be under their RER or RER surrogates (Table 11). The Mid-Hood Canal population exceeds one of the RER surrogates, but the proposed action does not effect this population so does not contribute to the exceedence (Table 11). NMFS considers the proposed action to present a low risk to populations that do not affect or do not exceed their RERs (NMFS 2004b).

Both populations in the Georgia Basin Region are expected to substantially exceed their RER (Table 11). For these populations (North and South Fork Nooksack), the analysis demonstrated that further constraints to fisheries occurring from May 1-31, 2016 would not provide substantive benefits to either population by providing sufficient additional spawners to significantly change its status or trends from what would occur without the fisheries.

Table 21. Summary of factors considered in assessing risk by population in the Puget Sound Chinook ESU. Green = low risk, yellow = neutral risk, red = increased risk

Region	Population	≤ RER[1]	Population Status[2] (Avg/2016) (a)	Population Status[2] (Avg/2016) (b)	Escapement Trend[3]	Growth Rate Return/Escapement[3] (a)	Growth Rate Return/Escapement[3] (b)	Low impacts in PS fisheries[4]	PRA Tier
Strait of Georgia	N.F. Nooksack	red	yellow	red	green	green	yellow	green	1
	S.F. Nooksack	red	red	red	green	green	green	green	1
Whidbey/Main Basin	Upper Skagit	green	green	green	yellow	red	green	green	1
	Lower Skagit	green	yellow	green	yellow	red	red	green	1
	Lower Sauk	green	yellow	yellow	yellow	red	red	green	1
	Upper Sauk	green	green	green	green	red	green	green	1
	Suiattle	green	yellow	green	yellow	red	yellow	green	1
	Upper Cascade	green	yellow	yellow	green	red	green	green	1
	N.F. Stillaguamish	green	green	red	yellow	red	yellow	green	2
	S.F. Stillaguamish	green	red	red	red	red	red	green	2
	Skykomish	green	yellow	green	yellow	red	yellow	green	2
	Snoqualmie	green	yellow	yellow	yellow	red	red	green	3
South Sound	Sammamish	green	red	red	yellow	green	green	green	3
	Cedar	green	yellow	yellow	green	green	green	green	3
	Duwamish-Green	green	yellow	yellow	red	red	red	green	2
	White	green	green	yellow	green	green	green	green	1
	Puyallup	green	green	yellow	red	red	red	green	3
	Nisqually	green	yellow	yellow	green	red	yellow	green	1
Hood Canal	Mid-Hood Canal	yellow	red	yellow	yellow	red	green	green	1
	Skokomish	green	red	red	yellow	red	red	green	1
Strait of Juan de Fuca	Dungeness	yellow	red	red	yellow	green	green	green	1
	Elwha	yellow	red	red	yellow	red	red	green	1

[1]Table 11. 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 11 [3] Table 4 [4] Described in text of Section 2.4.1.2 for each MPG in the ESU

As described in the previous sections, NMFS also considers its trust responsibility to the tribes in evaluating the proposed actions and recognizes the importance of providing limited tribal fishery opportunity, as long as it does not pose a risk to the species that rises to the level of jeopardy. 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. 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. In addition, 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 a diverse range of non-fishing related activities. 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.

2.6.2 Puget Sound Steelhead

ESA-listed steelhead are likely to be incidentally caught in tribal marine and freshwater fisheries targeting spring Chinook salmon in the month of May 2016. To assess if incidental take from spring Chinook salmon fisheries described in the proposed action will affect the survival and recovery of ESA-listed steelhead within the DPS, NMFS incorporated information discussed in the Status (Section 2.2.1.2), Environmental Baseline (Section 2.3.1), Effects of the Action on Species and Designated Critical Habitat (Section 2.4.2.2 and 2.4.2.3), and Cumulative Effects (Section 2.5) sections. The NWFSC (2015) evaluated trends in abundance of natural origin steelhead over the most recent decade. Data on natural origin steelhead are still extremely limited or not available for the majority of summer, winter, or summer/winter run steelhead populations, particularly for summer populations. Where data are available regarding population abundance and productivity of Puget Sound steelhead, some DIPs are demonstrating increasing trends and others represent decreasing trends. The status of Puget Sound steelhead remains threatened and has not changed significantly since the time of listing.

Since available information on steelhead viable salmonid population (VSP) criteria to evaluate natural-origin steelhead viability continues to be limited, current abundance estimates, where available, were used to determine tribal fishery incidental impacts on natural-origin steelhead. The total number of natural-origin steelhead incidentally caught in tribal commercial, C&S, and test fisheries is anticipated to be 72 fish (3 steelhead in marine fisheries; 69 steelhead in freshwater fisheries). The anticipated combined harvest rates of the proposed fisheries range from 0.03% to 1.02% on DIPs within the Northern Cascade MPG and 0.02 to 0.04% on DIPs within the Central/South Sound MPG.[25]

The status of Puget Sound steelhead has not changed significantly since the time of listing (NWFSC 2016) and harvest effects continue to be within, and most recently lower than (1.9% harvest rate in freshwater fisheries; 144 in marine fisheries), the range of those observed at the time of listing (4.2% harvest rate in freshwater fisheries; 325 steelhead in marine fisheries; sections 2.3.1 and 2.4.2.1). Incidental effects from tribal marine and freshwater spring Chinook salmon fisheries range from negligible to very low and are unlikely to impede the Puget Sound steelhead DIPs from reaching viability. The PSSTRT criteria is 5 of the 11 winter steelhead populations must be viable. Therefore, because the anticipated harvest rates are not likely to prevent the Puget Sound DIPs from reaching viability, then the proposed fisheries are also not likely to impede the Northern Cascades and Central/South Sound MPGs. Since all Puget Sound steelhead MPGs must be viable for recovery of the DPS, the anticipated harvest rates under the proposed fisheries are not likely to prevent the Puget Sound Steelhead DPS as a whole from reaching viability.

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 and primarily be located in highly developed, lower river, areas exempt from the critical habitat designation. 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 complexity that supports juvenile growth and mobility. 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. The resulting minimization of contact with the habitat would result in 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 2004c). Development activities 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.

[25] The Puget Sound steelhead DIPs affected by marine and freshwater tribal fisheries include: Mainstem Skagit River, Nookachamps Creek, Baker River, Sauk River, Snohomish/Skykomish Rivers, Puyallup/Carbon Rivers, and White River winter-run steelhead.

2.7 Conclusion

2.7.1 Puget Sound Chinook

After reviewing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of the Puget Sound Chinook salmon ESU or adversely modify its designated critical habitat.

2.7.2 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 or adversely modify proposed designated critical habitat for the Puget Sound Steelhead DPS.

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). 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.

2.8.1 Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take would occur as follows:

2.8.1.1 Puget Sound Chinook

NMFS anticipates incidental take of listed Puget Sound Chinook to occur in Puget Sound salmon and steelhead fisheries from May 1, 2016 through May 31, 2016 through contact with fishing gear. NMFS anticipates the salmon fisheries occurring during this time together with ocean and Puget Sound fisheries approved under existing consultations will not exceed the exploitation rates summarized in Table 11 in the column titled Ocean+Puget Sound during this period. These exploitation rates account for landed and non-landed mortality of listed Puget Sound Chinook encountered in the consultation fisheries analyzed in this opinion. Test, research, update and evaluation fisheries that inform fishery management decisions are included as part of the fishery-related mortality summarized in Table 11. 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.

2.8.1.2 Puget Sound Steelhead

NMFS anticipates incidental take of Puget Sound natural-origin steelhead to occur in Puget Sound tribal marine and freshwater commercial, ceremonial and subsistence, and test fisheries for spring Chinook salmon from May 1, 2016 through May 31, 2016 through contact with tribal net fishing gear.

NMFS anticipates that no more than 3 incidental steelhead mortalities will occur in marine tribal fisheries targeting spring Chinook salmon in the Skagit Bay and Tulalip Bay in May 2016.

NMFS also anticipates that the harvest on natural-origin steelhead in freshwater tribal fisheries targeting spring Chinook salmon in the Nooksack, Skagit, Puyallup, and White Rivers will be no more than 69 steelhead.

2.8.2 Effect of the Take

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

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 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 2.4.1.2 and 2.4.2.2) and defined in Section 2.8.1.

(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) Provide post season reports of take on listed salmon and steelhead in the proposed fisheries.

(5) Improve escapement monitoring for the salmon and steelhead populations that are affected by the proposed action.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and BIA or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The BIA or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, the protective coverage for the proposed action would likely lapse.

The BIA 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.

1a. The BIA, to the extent of their authority, shall work with the Puget Sound treaty tribes to ensure that in-season management actions taken during the course of the fisheries are consistent with the levels of anticipated take.

1b. The BIA, to the extent of their authority, shall work with the Puget Sound treaty tribes to provide weekly reports of Chinook and steelhead catch in the proposed fisheries that are subject of this opinion to the Sustainable Fisheries Division, West Coast Region.

1c. 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.[26]

1d. The BIA, to the extent of their authority, shall work with the Puget Sound treaty tribes to complete preseason annual steelhead fishing plans for the winter steelhead management units identified in this biological opinion (i,e., Skagit, Snohomish, and Puyallup winter run), as described in Section 2.4.2, prior to implementation of the following steelhead fishing season (e.g., no later than December 15, 2016). Preseason fishing plans will include the annual fishing regime and incidental harvest rates of steelhead in salmon and steelhead fisheries in compliance with the take estimates (Section 2.8.1.2).

[26] 1-855-542-3935 (WA Dept ofFish and Wildlife) or 360-733-1725 (Northwest Straits), http://www.derelictgeardb.org/reportgear.aspx, or a tribal fishery manager.

2. The BIA, to the extent of their authority, shall work with 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, to the extent of their authority, shall work with 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. This includes:

i. Ensuring that the fisheries included in this opinion are sampled for contribution of hatchery and natural-origin fish and the collection of biological information (age, sex, and size) to allow for a thorough post-season analysis of fishery impacts on listed species; and,

ii. Evaluating the potential selective effects of fishing on the size, sex composition, or age composition of steelhead populations as data become available.

iii. Post season, NOR Chinook and wild steelhead encounters and mortalities will be reported by population. This includes apparent summer run steelhead encounters and mortalities, and having tissues taken and analyzed for DNA from the 2016 fisheries.

4a. The BIA, to the extent of their authority, shall work with the affected tribes to provide post season reports that include estimates of catch and encounters of listed Chinook in the fisheries that are the subject of this opinion and other relevant information described in Section 7.5 in the 2010 Puget Sound Chinook Harvest Management Plan (PSIT and WDFW 2010a). The reports will also include escapement estimates for the populations and DIPs affected by this proposed action and the results of the work described in 3.

4b The BIA, to the extent of their authority, shall work with the affected treaty tribes to provide postseason annual reports for the month of May on all steelhead DIPs affected by the proposed fisheries as identified in this opinion, where data are available.

For steelhead, the report should be provided to NMFS no later than November 30, 2016 prior to the following winter steelhead season. The postseason summaries will include:

i. Identification of compliance with the fishery regime and incidental harvest rates of steelhead in the tribal spring Chinook salmon fisheries considered in this opinion;

ii. A description of any changes to the estimation methodologies for assessing escapement and/or harvest rates; and,

iii. Estimates of steelhead incidental morality in Puget Sound tribal spring Chinook salmon fisheries along with a description of the method used to estimate postseason harvest in the postseason summary.

5. The BIA, to the extent of their authority, shall work with the affected tribes to implement or improve escapement monitoring for the salmon and steelhead populations that are affected by the proposed action to improve escapement estimates and to determine and/or augment harvest rate estimates on natural-origin stocks. For steelhead, much of this effort will occur as part of the NMFS' Viable Salmonid Parameters (VSP) ongoing monitoring inventory endeavor of ESA-listed Puget Sound steelhead. In an effort towards this goal, watershed priorities and monitoring will be identified during the Puget Sound steelhead recovery planning process to secure funding for improvement of steelhead escapement and harvest methodologies.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. 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 in cooperation with the Puget Sound treaty tribes.

(1) The BIA in collaboration with 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 in collaboration with 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 in collaboration with 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.

2.10 Reinitiation of Consultation

This concludes formal consultation for the impacts of programs administered by the Bureau of Indian Affairs that support Puget Sound tribal salmon fisheries described in this opinion and occurring May 1-31, 2016.

As 50 CFR 402.16 states, 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 taking specified in the incidental take statement 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.

2.11 "Not Likely to Adversely Affect" Determinations

NMFS does not anticipate the proposed actions will take Southern Resident killer whales, southern green sturgeon or southern eulachon which occur in the action area or adversely affect their critical habitat.

The final rule listing Southern Resident killer whales as endangered identified several potential factors that may have caused their decline or may be limiting recovery. These are: quantity and quality of prey, toxic chemicals which accumulate in top predators, and disturbance from sound and vessel traffic. The rule also identified oil spills as a potential risk factor for this species. The final recovery plan includes more information on these potential threats to Southern Residents (NMFS 2008g).

Southern Resident killer whales spend considerable time in the Georgia Basin from late spring to early autumn, with concentrated activity in the inland waters of Washington State around the San Juan Islands, and then move south into Puget Sound in early autumn. While these are seasonal patterns, Southern Residents have the potential to occur throughout their range (from central California to southeast Alaska) at any time of year. Southern Residents are not likely to occur in the vicinity of the proposed fishing. However, the whales may be indirectly affected through effects to their primary prey, Chinook salmon. Ongoing and past diet studies of Southern Residents have conducted sampling during spring, summer, and fall months in inland waters of Washington State and British Columbia (i.e., Ford and Ellis 2006, Hanson et al. 2010, Ford et al. 2016). Scale and tissue sampling in inland waters from May to September indicate that the Southern Residents' diet consists of a high percentage of Chinook salmon (approximately 80 percent Chinook salmon across the timeframe and monthly proportions) and coho contributing to a larger proportion (approximately 40%) of the late summer diet (Hanson et al. 2010, Ford et al. 2016). Southern Residents predominantly consume older and larger Chinook salmon (Ford & Ellis 2006, Hanson et al. 2010) particularly 4-5 year olds that are returning to natal streams to spawn.

The proposed tribal fishing may indirectly affect Southern Resident killer whales by reducing their primary prey, Chinook salmon. Spatially, only a fraction of the Chinook salmon targeted would have overlap with the Southern Resident's range and diet. Also, because the proposed fishing would occur at the mouths of the Skagit, Nooksack, and Puyallup/White rivers, and area 8D, the reduction in prey would occur when the Chinook salmon are no longer available to the whales. Therefore, based on the location and timing of the fishing, the impacts to the whales would not occur in the same year as the fishing. Furthermore, the exploitation rates resulting from the proposed action (Table 11) are well below the exploitation rate ceilings that have been found to be consistent with survival and recovery of the salmon populations. Given that the anticipated Puget Sound exploitation rates on these stocks are much lower than the exploitation rate ceilings, we anticipate an insignificant effect over the long term on the Southern Resident killer whales. The proposed fishing would create a negligible reduction in future prey because it is an extremely small percent of the total prey available to the whales in the action area in subsequent years. Therefore, NMFS anticipates that any salmonid take up to the aforementioned maximum extent described in the ITS would result in an insignificant reduction in prey resources for SR killer whales that may intercept these species within their range.

Southern Resident Killer Whale Critical Habitat

Critical habitat for the SR killer whale includes approximately 2,560 square miles of Puget Sound, excluding areas with water less than 20 feet (6 m) deep relative to extreme high water. The PCEs for SR killer whale critical habitat are:

(1) Water quality to support growth and development

(2) Prey species of sufficient quantity, quality, and availability to support individual growth, reproduction and development, as well as overall population growth

(3) Passage conditions to allow for migration, resting, and foraging

The action area is within the inland waters of Washington where the marine ranges of the killer whales and affected Chinook salmon overlap. Any salmonid take up to the aforementioned maximum extent and amount described in the ITS would result in an insignificant reduction in prey resources for Southern Resident killer whales that may intercept these species within their range. Therefore, NMFS anticipates that direct effects on Southern Resident killer whale prey quantity would be insignificant. Additionally, the potential for vessels from the proposed fishing to interfere with Southern Resident killer whale passage is expected to be discountable (i.e., it is extremely unlikely the whales will be within the vicinity of the proposed fishing).

Therefore, we find that the potential adverse effects of the proposed fishing on SR killer whale critical habitat are discountable or insignificant and determine that the proposed fishing may affect, but is not likely to adversely affect, SR killer whale critical habitat.

Green Sturgeon
Individuals of the southern DPS of green sturgeon are unlikely to be caught in Puget Sound salmon fisheries. 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 also 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) 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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate, and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within 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 groundish (PFMC 2014a), coastal pelagic species (PFMC 2011) and Pacific coast salmon (PFMC 2014b) 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 is described in section 1.4. It includes areas that are designated EFH for various life stages of Pacific Coast salmon and coastal pelagic species managed by the PFMC.

Marine EFH for Chinook, coho and Puget Sound pink salmon in Washington, Oregon, and California includes all estuarine, nearshore and marine waters within the western boundary of the EEZ, 200 miles offshore. Freshwater EFH for Pacific salmon includes all those streams, lakes, ponds, wetlands, and other water bodies currently, or historically accessible to salmon in Washington, Oregon, Idaho, and California, except areas upstream of certain impassable man-made barriers, and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). Designated EFH within 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 those waters, it includes the areas used by Chinook, coho and pink adults (migration, holding, spawning), eggs and alevins (rearing) and juveniles (rearing, migration). A more detailed description and identification of EFH for salmon is found in Appendix A to Amendment 18 to the Pacific Coast Salmon Plan (PFMC 2014b).

Essential fish habitat for groundfish includes all waters, substrates and associated biological communities from the mean higher high water line, or the upriver extent of saltwater intrusion in river mouths, seaward to the 3500 m depth contour plus specified areas of interest such as seamounts. A more detailed description and identification of EFH for groundfish is found in the

Appendix B of Amendment 19 to the Pacific Coast Groundfish Management Plan (PFMC 2014a).

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. A more detailed description and identification of EFH for coastal pelagic species is found in Amendment 8 to the Coastal Pelagic Species Fishery Management Plan (PFMC 2011).

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 18 of the Pacific Coast Salmon Plan (PFMC 2014b). The PFMC identified five fishing-related activities that may adversely affect EFH including: (1) fishing activities; (2) derelict gear effects; (3) harvest of prey species; (4) vessel operations; and (5) removal of salmon carcasses and their nutrients from streams. 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 for addressing these effects are already included in the proposed action.

Fishing Activities

Most of the harvest related activities from the proposed action occur from boats or along river banks, in terminal areas. The gear fishermen use include drift and set gillnets, and beach seines. The types of salmon fishing gear that are used in these fisheries in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. 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 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 proposed fisheries (i.e., recreational boating and marine species fisheries). Therefore, the proposed fisheries would have a negligible additional impact on the physical environment.

Derelict Gear

When gear associated with commercial or recreational fishing breaks free, is abandoned, or becomes otherwise lost in the aquatic environment, it becomes derelict gear. In commercial fisheries, trawl nets, gillnets, long lines, purse seines, crab and lobster pots, and other material, are occasionally lost to the aquatic environment. Recreational fisheries also contribute to the problem, mostly via lost crab pots.

Derelict fishing gear, as with other types of marine debris, can directly affect salmon habitat and can directly affect managed species via "ghost fishing." Ghost fishing is included here as an impact to EFH because the presence of marine debris affects the physical, chemical, or biological properties of EFH. For example, once plastics enter the water column, they contribute to the properties of the water. If debris is ingested by fish, it would likely cause harm to the individual. Another example is in the case of a lost net in a river. Once lost, the net becomes not only a potential barrier to fish passage, but also a more immediate entanglement threat to the individual.

Derelict gear can adversely affect salmon EFH directly by such means as physical harm to eelgrass beds or other estuarine benthic habitats; harm to coral and sponge habitats or rocky reefs in the marine environment; and by simply occupying space that would otherwise be available to salmon. Derelict gear also causes direct harm to salmon (and potentially prey species) by entanglement. Once derelict gear becomes a part of the aquatic environment, it affects the utility of the habitat in terms of passive use and passage to adjacent habitats. More specifically, if a derelict net is in the path of a migrating fish, that net can entangle and kill the individual fish.

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; James 2015) fewer nets have become derelict in recent years compared to several years ago. In addition, the tribes have active reporting systems and a record of derelict gear retrieval. Of note, most of these lost nets were reported by the fishermen or state or tribal fisheries authorities. Because of the terminal nature and limited scope of the fisheries, the proposed action should not adversely affect salmon EFH.

Harvest of Prey Species

Prey species can be considered a component of EFH (PFMC 2014b). For Pacific salmon, commercial and recreational fisheries for many types of prey species potentially decrease the amount of prey available to Pacific salmon. Herring, sardine, anchovy, squid, smelt, groundfish, shrimp, crab, burrowing shrimp, and other species of finfish and shellfish are potential salmon prey species that are directly fished, either commercially or recreationally. The proposed action will have no adverse effect on prey species.

Vessel Operation

A variety of fishing and other vessels on the Pacific Coast can be found in freshwater streams, estuaries, and the marine environment within the action area. Vessel that operate under the proposed action range in size from small to moderate sized vessels used in streams and estuaries. Section 4.2.2.29 of Appendix A to Amendment 18 of the Pacific Coast Salmon Plan (PFMC 2014b) regarding Vessel Operations provides a more detailed description of the effects of vessel activity on EFH. 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. Also these activities would occur to some degree through implementation of fisheries or activities other than the proposed salmon fisheries, i.e., recreational boating and marine species fisheries.

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. 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. 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 are an integral component of the management of the proposed fisheries.

3.2.2 Groundfish

The proposed action would not have an adverse effect on groundfish EFH. The proposed fisheries targeting salmon would not appreciably alter habitats used by groundfish species.

3.2.3 Coastal Pelagic EFH

The proposed action would not have an adverse effect on coastal pelagic EFH. The proposed fisheries targeting salmon would not appreciably alter habitats used by coastal pelagic species.

3.3 Essential Fish Habitat Conservation Recommendations

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.

3.4 Supplemental Consultation

The BIA 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

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

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. 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 of this opinion were provided to the BIA and the applicants. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

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

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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Appendix A

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 levels5 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 ($\geq$ 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:

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

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.

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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:

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

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

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

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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