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

ESA Section 4(d), Limit 6, determination for the Skagit River steelhead fishery Resource Management Plan (RMP), as submitted by the Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, Skagit River System Cooperative, and the Washington Department of Fish and Wildlife (WDFW)

NMFS Consultation Number: WCR-2017-7053

Action Agency National Marine Fisheries Service (NMFS)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
Puget Sound Steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	No	No
Puget Sound Chinook salmon (*O. tshawytscha*)	Threatened	No*	NA	NA	NA
Southern Resident killer whales (*Orcinus orca*)	Endangered	No*	NA	NA	NA
Sturgeon, green – Southern Distinct Population Segment (*Acipenser medirostris*)	Threatened	No*	NA	NA	NA
Pacific Eulachon – Southern Distinct Population Segment (*Thaleichthys pacificus*)	Threatened	No*	NA	NA	NA

*Please refer to Section 2.12 for the analysis of species and critical habitat that are not likely to be adversely affected.

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	No	No

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

Issued by: ______________________________
Ryan J. Wulff
Assistant Regional Administrator
for Sustainable Fisheries

Date: 4/11/2018 (***Date expires: April 30, 2022***)

Table of Contents

Table of Figures

Table of Tables

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 federal actions proposed by the NMFS. This opinion considers impacts of the Proposed Action on the Puget Sound Steelhead Distinct Population Segment (DPS). NMFS has determined that the Proposed Action is not likely to adversely affect the other listed species occurring in the action area (Section 2.12

1.2 Consultation History

The 4(d) Rule for Salmon and Steelhead and inclusion of the Puget Sound Steelhead DPS

On July 10, 2000, NMFS issued the ESA 4(d) Rule establishing take prohibitions for 14 threatened salmon Evolutionary Significant Units (ESUs) and steelhead DPSs, including the Puget Sound Chinook Salmon ESU (65 Fed. Reg. 42422, July 10, 2000). The ESA 4(d) Rule provided 13 limits on the application of the take prohibitions, including specifying situations when take prohibitions would not apply to the plans and activities set out in the rule's limits. Limit 6 is for Joint Tribal/State Resource Management Plans developed under the *United States v. Washington* (*U.S. v. Washington* 1979) or *United States v. Oregon (U.S. v. Oregon* 2009*)* settlement processes (50 CFR 223.203(b)(6)). If NMFS determines that a joint resource management plan meets the criteria set out in Limit 6 of the 4(d) Rule, then the Section 9 take prohibitions will not apply to activities carried out under that resource management plan. In 2005, as part of the final listing determinations for 16 ESUs or DPSs of West Coast salmon and steelhead, 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 revised regulations, a set of 14 protective regulations 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 as threatened under the ESA in 2007 (72 Fed. Reg. 26722, May 11, 2007), NMFS applied these same 4(d) protective regulations to Puget Sound steelhead (73 Fed. Reg. 55451, September 25, 2008).

Fisheries Affecting the Puget Sound Steelhead DPS

Since the listing of the Puget Sound steelhead in 2007, incidental take of Puget Sound steelhead in fisheries targeting harvestable salmon and steelhead fisheries has been evaluated through a series of 4(d) Rule determinations and/or ESA Section 7 consultations.

Based on a thorough review of regulations in place at the time the Puget Sound steelhead DPS was listed under the ESA, which limited the incidental take of natural-origin Puget Sound steelhead, NMFS delayed the application of the protective regulations prohibiting the take of listed salmonids in fishery activities for the remainder of the ongoing Puget Sound fishery season (through June 1, 2009; 73 Fed. Reg. 55451, September 25, 2008). Fishery effects to Puget Sound steelhead for the 2009 fishery year were evaluated in NMFS' biological opinion for the 2008 Pacific Salmon Treaty Agreement (NMFS 2008d). For the 2010 Puget Sound fishery-year, NMFS completed a series of two Section 7 consultations on the impacts of programs administered by the Bureau of Indian Affairs (BIA) that supported Puget Sound tribal salmon fisheries and salmon fishing activities authorized by the U.S. Fish and Wildlife Service (USFWS) (NMFS 2010a and NMFS 2010b). A four-year RMP, covering the effects of Puget Sound salmon and steelhead fisheries, for fishery years 2011-2014, was submitted by the WDFW and Puget Sound Indian Tribes (PSIT) (together, referred to as the Co-managers) and approved in 2011(NMFS 2011). The Federal actions consulted on in the associated biological opinion included NMFS' 4(d) determinations, BIA program oversight and USFWS Hood Canal Salmon Plan related actions. For the years since 2014, NMFS has consulted, annually, under section 7 of the ESA on single year actions by the BIA, USFWS, and NMFS similar to those described above. NMFS issued one-year biological opinions for the 2014, 2015, 2016, and 2017 fishery cycles (May 1, 2014 through April 30, 2018) that considered actions based on this framework including similar actions by the BIA and USFWS (NMFS 2014a, NMFS 2015, NMFS 2016a, and NMFS 2017a).

On November 18, 2016, the Sauk-Suiattle Tribe, the Swinomish Indian Tribal Community, the Upper Skagit Indian Tribe, and the Washington Department of Fish and Wildlife (WDFW) (co-managers) submitted Skagit River Steelhead Fishery Resource Management Plan (Skagit RMP [Sauk-Suiattle Indian Tribe et. al, 2016]); and requested that NMFS make a determination as to whether the Skagit RMP meets the requirements of Limit 6 of the 4(d) Rule (Joseph (2016). The Skagit RMP proposes to utilize a Skagit River-specific steelhead management framework to manage impacts to natural-origin Skagit River steelhead, which are part of the listed DPS. The request relies on, as its basis, the information and commitments submitted by co-managers and proposed in the Skagit RMP. After thorough review of the Skagit RMP, NMFS responded to the applicants, on June 21, 2017 with confirmation that the plan was sufficient to begin the formal ESA consultation process (NMFS 2017b).

This opinion is based on information provided in the Skagit RMP, discussions with PSIT and WDFW 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.

1.3 Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.2). Under the MSA Essential Fish Habitat consultation, Federal Action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

NMFS proposes to issue a determination that the Skagit RMP meets the criteria required by Limit 6 of the ESA 4(d) Rule for salmon and steelhead. It is NMFS' issuance of the 4(d) Rule determination that is the Federal action requiring consultation under section 7 of the ESA. An ESA-authorized Skagit RMP would enable the Skagit co-managers to implement limited fisheries, directed at ESA-listed natural-origin Skagit River steelhead, in the Skagit River terminal area (Figure 1). The Skagit RMP would be implemented and enforced within the parameters set forth in *United States v. Washington* (U.S. v. Washington 1985).

The Skagit RMP creates a new Skagit Management Unit (SMU), for harvest management purposes only, comprised of the four Demographically Independent Populations (DIPs; Myers et al. 2015) of steelhead in the Skagit River basin, which have been identified as: 1) Skagit River Summer Run and Winter Run; 2) Nookachamps Creek Winter Run; 3) Sauk River Summer Run and Winter Run; and 4) Baker River Summer Run and Winter Run[1]. The Skagit RMP aggregates these four populations for the purposes of harvest management.

[1] Myers et al. (2015) noted that many of the Puget Sound Steelhead Technical Recovery Team (PSSTRT) members and reviewers consider the Baker River Summer and Winter Run to have been extirpated. Currently, O. mykiss have been observed passing downstream through dam passage structures on the Baker River and this migration (production from resident O. mykiss) may contribute to steelhead [migratory O. mykiss] population productivity. However, genetic analysis suggests that the Baker River O. mykiss are similar to Skagit River steelhead (Sauk-Suiattle Indian Tribe et. al, 2016).

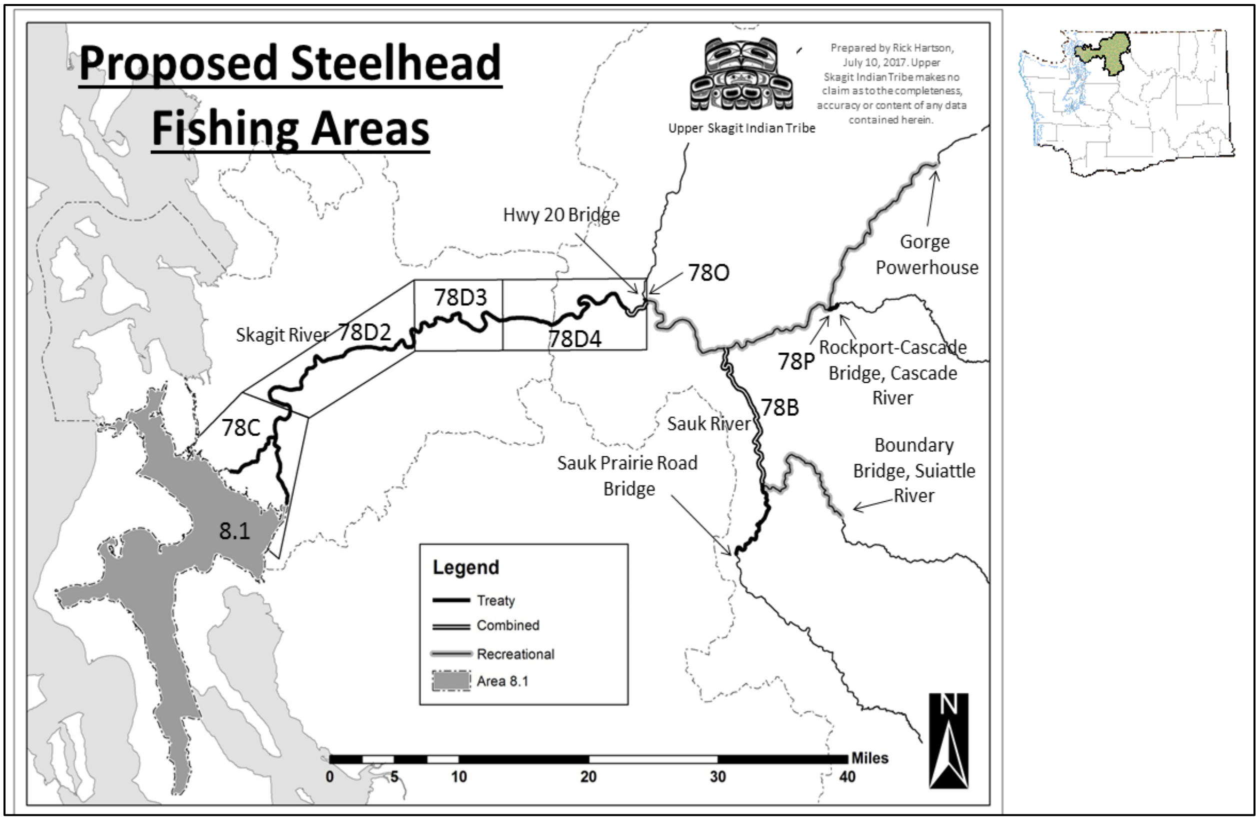


Figure 1. Skagit Terminal Area, comprised of the Skagit River freshwater areas and the Marine Area (8.1) directly outside of the Skagit River (Sauk-Suiattle Indian Tribe et al. 2017)

Under the Skagit RMP, the SMU would be independently managed, for fishery harvest limits, from the other populations in the Puget Sound steelhead DPS. (Section 2.4.1). The Skagit RMP would apply an abundance-based, stepped harvest regime ranging from 4% at abundance below 4,000 fish to 25% when the terminal run of steelhead in the Skagit basin exceeds 8,001 fish (Table 1). These harvest rates would include all steelhead mortality from both the existing incidental take in Skagit terminal area salmon fisheries as well as from the direct-take steelhead fisheries proposed in the Skagit RMP.

Table 1. Stepped harvest regime proposed for Skagit River steelhead fishery (Sauk-Suiattle Indian Tribe et al. 2016).

Preseason Forecast for Natural-Origin Skagit River Steelhead	Allowable Impact Rate Terminal Run
≤ 4,000	4%
4,001 ≤ Terminal Run <6,000	10%
6,001 ≤ Terminal Run <8,000	20%
Terminal Run ≥ 8,001	25%

The Skagit RMP proposes annual steelhead fisheries in the Skagit terminal area (Figure 1) from December 1 through April 30th during each of the 5-years of the Skagit RMP. The fisheries are identified by area and by fisher type—Treaty fisheries and Non-treaty recreational fisheries. These fisheries would be implemented in the following areas and times (McClure 2017):

Treaty Fisheries: Dec 1-April 15, annually, located in:

- Marine Area 8
- Freshwater Areas 78C; 78D-1, 78D-2, 78D-3, and 78D-4 to the mouth of the Baker River; 78O Baker River from the Skagit River to Hwy 20 bridge; 78B Sauk River from the Skagit River to the Sauk Prairie Road bridge; 78P Cascade River from the Skagit River to the Rockport/Cascade bridge.

Non-treaty (recreational) Fisheries: Feb 1-April 30, annually, located in:

- Skagit River mainstem – Dalles Bridge (approx. RM 54) in Concrete upstream to Gorge Powerhouse (approx. RM 94.3).
- Sauk River – mouth (enters Skagit River mainstem at RM 66) to Sauk Prairie Road Bridge.
- Suiattle River – mouth (enters Sauk at RM 13) upstream to Boundary Bridge (intersection of Forest Road 26 and 25, RM 12).
- The proposed recreational fishery will not occur in other tributaries

The proposed Skagit River steelhead fisheries would include Treaty-Indian ceremonial and subsistence (C&S) and commercial harvest by the Swinomish, Sauk-Suiattle and Upper Skagit tribes, utilizing both net and hook-and-line gear, as well as a recreational catch and release fishery, and a tangle-net assessment fishery collecting biological information. These fisheries would be managed, annually, within the time and areas identified above, based on the annual pre-season forecasted terminal Skagit River steelhead run size (Table 1). The Skagit RMP also contemplates that in the future the state of Washington may propose recreational fisheries that could retain Skagit River natural-origin steelhead, however this would require a change to the existing Washington Fish and Wildlife Commission regulations which prohibit natural-origin steelhead retention.

The Skagit RMP also proposes annual monitoring measures for the Skagit River steelhead populations. These monitoring measures would focus on annual run-size assessment, spawning distribution, run-timing, age structure, and genetic makeup. Annual fishery monitoring elements would include in-season assessment of harvest in both the Treaty and Non-treaty Skagit terminal area fisheries, annual assessment of all fishery-related steelhead mortalities, both in steelhead directed fisheries and fisheries directed at other species, including both retained steelhead and mortality associated with fish released during a fishery. Timing of harvest and interception of kelts (adult steelhead that have recently spawned) will also be monitored.

The Skagit RMP proposes several Conservation Actions to be continued or implemented to conserve or build the population structure and diversity of the Skagit River steelhead (Sauk-Suiattle Indian Tribe et al. 2016, Section 8.4- Additional Conservation Actions for Populations and Diversity). These include: Fishery management objectives that are protective of kelts; Fishery management objectives that are protective of the summer run-timing component of the Skagit populations; Fishery management objectives that are protective of the early run-timed Skagit Steelhead; and Fishery management objectives that are protective of the Nookachamps winter steelhead DIP.

The Skagit RMP proposes annual monitoring of the fisheries in the Skagit terminal area. These would include both Tribal net fisheries and hook-and-line fisheries directed at steelhead, as well as the monitoring of steelhead harvest or encounters in fisheries directed at other species. The tribes and WDFW communicate regularly during the fishery season to share data on run size, timing and catch to ensure appropriate management of steelhead impacts (Sauk-Suiattle Indian Tribe et al. 2016).

For Tribal net fisheries, retained steelhead for Tribal commercial sales and fish taken for ceremonial and subsistence purposes will be enumerated through normal catch accounting, i.e. fish tickets, which are corroborated by Tribal enforcement and/or Tribal biologists. The landings will be documented by fish tickets and compiled into a database managed by the co-managers. Retained steelhead will be assessed to determine if they are hatchery-origin: natural-origin composition via the presence or absence of adipose clip and scanned for a PIT tags. Scales will be collected from natural-origin steelhead sufficient to estimate age composition. Sex and spawning condition (pre-spawn to kelt) of landed steelhead and tissue samples will be collected for future genetic analyses. In addition, otoliths from retained steelhead will be collected to assess isotopic chemistry, so to inform managers on the contribution of resident *O. mykiss* to steelhead populations.

Recreational steelhead fisheries will be monitored through in-season creel surveys to ensure that impact limits are not exceeded. WDFW will conduct a ground -based creel survey conducted by trained personnel during the steelhead fishery to assess angler effort, catch, total harvest and impacts to other stocks and species. During the creel interview information collected will include angler effort and catch data. Information collected from angler interviews will include number in party, angler type (i.e., boat or shore), gear types used (conventional gear, fly), whether or not anglers have completed their trip, start and stop time, number of trailers and cars associated with the party, and the number of fish by species encountered and released or kept and any marks or tags. To the extent practical and with the primary consideration being the handling and condition of the fish, DNA samples and scale samples will be taken from natural-origin steelhead by samplers if they encounter an angler in the process of playing a fish. Because the fishery will be actively monitored and creel data entered and calculated as collected, the fishery will be managed on a daily or weekly basis. If encounter rates and thus potential mortality is greater than expected, the fishery impacts can be projected forward and the fishery will be closed with a minimum 48 hour notice to the public prior to the time the impact limit would be achieved.

The Skagit RMP also proposes an annual reporting schedule, to assess both the prior year's fishery results and to determine the allowable harvest rate in the fishery for the next year. The proposed reporting schedule is for a post-season report to be submitted prior to November 20^{th}, following a fishery year and a pre-season plan for the coming fishery-year to be submitted prior to the fishery beginning but no later than December 15 of the fishery year.

This opinion analyzes the effects of Skagit RMP on the Puget Sound steelhead DPS. The 4(d) Rule determination covers the five-year term of the Skagit RMP, from the first Skagit River steelhead fisheries implemented under this plan, plus the following four steelhead fishing seasons. More detailed information about the fisheries and associated conservation objectives proposed to occur during this period are included in the documents provided in the consultation request as described in Section 1.2 above.

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). There are no interrelated or interdependent action associated with this action.

Other Puget Sound treaty and non-treaty salmon fisheries occurring in the Action Area (Section 2.3), including fisheries for Chinook, coho, and chum salmon, which may incidentally impact Skagit River steelhead, would be included in the overall impact rates described in the Skagit RMP. The harvest rates proposed in the Skagit RMP would be incorporated into the annual Puget Sound salmon and steelhead fishery planning process, as provided under the Puget Sound Salmon Management Plan, implementation plan for *U.S. v Washington* (see *Washington, U. S. v.* 1985. 759 F.2d 1353 (9th Cir. 1985) (en blanc), Washington III. Seattle, Washington). (50 CFR 402.02).

2.0 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 action under the ESA on the Puget Sound Steelhead DPS.

NMFS has previously considered the effects of Puget Sound salmon and steelhead 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 2 identifies those opinions and determinations still in effect that address impacts to NMFS' ESA-listed species that are affected by Puget Sound salmonid fisheries in the Action Area. For each species listed in Table 2, NMFS concluded that the Proposed Action was 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. These opinions and determinations are incorporated here by reference.

Table 2. NMFS ESA determinations regarding listed species that are be affected by Puget Sound salmon and steelhead fisheries. Only the decisions currently in effect and the listed species represented by those decisions are included. Each determination is incorporated here by reference.

Date (Coverage)	Duration	Citation	ESU/DPS considered
May 3, 2017 (BO)	Until April 30, 2018	(NMFS 2017)	Puget Sound Chinook Salmon Puget Sound Steelhead* Puget Sound/Georgia Basin (PS/GB) bocaccio PS/GB yelloweye rockfish Southern Resident killer whales Eulachon Green Sturgeon

*This determination would remain in place for impacts to steelhead from Puget Sound salmon and steelhead fisheries outside of the Skagit terminal area (Section 1.3).

We have concluded that the Proposed Action is not likely to adversely affect Puget Sound Chinook salmon, Southern Resident killer whale, southern green sturgeon, southern eulachon, or their critical habitat. Those findings are documented in the "Not Likely to Adversely Affect" Determinations (section 2.11). There is no effect to Puget Sound/Georgia Basin bocaccio or Puget Sound/Georgia Basin yelloweye rockfish. Therefore, with the exception of Puget Sound steelhead, the other salmon ESUs and non-salmonid species, detailed in Table 2, above, will not be discussed in subsequent sections of this opinion.

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 means "a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

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

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). 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 PBFs 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 attributes 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* by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the Proposed Action poses to species and critical habitat. (Section 2.6).
- *Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.* 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

"Species" Definition: The ESA of 1973, as amended, 16 U.S.C. 1531 *et seq.* defines "species" to include any "distinct population segment (DPS) of any species of vertebrate fish or wildlife which interbreeds when mature." To identify DPSs of salmon species, NMFS follows the "Policy on Applying the Definition of Species under the ESA to Pacific Salmon" (56 FR 58612, November 20, 1991). Under this policy, a group of Pacific salmon is considered a DPS and

hence a “species” under the ESA, if it represents an evolutionarily significant unit (ESU) of the biological species. The group must satisfy two criteria to be considered an ESU: (1) It must be substantially reproductively isolated from other con-specific population units; and (2) It must represent an important component in the evolutionary legacy of the species. The Puget Sound steelhead DPS of the taxonomic species *Oncorhynchus mykiss* is considered a “species” under the ESA.

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 parameters 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 widespread enough to avoid concurrent extinctions from mass catastrophes but spatially close enough to allow functioning as metapopulations (McElhany et al. 2000).

One factor affecting the overall status of Puget Sound salmonids and aquatic habitat at large, is climate change. Below, we describe climate change and other ecosystem effects on Puget Sound salmon and steelhead. This section appears before the general status of the species section because climate change will likely have an overarching effect on all of the VSP attributes.

Climate Change

Climate change is affecting the rangewide status of all listed Puget Sound salmon and steelhead, and salmon and steelhead critical habitat. 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 salmonids. 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 0.1-0.6ºC per decade (Mote and Salathé 2009). Warmer air temperatures will lead to more precipitation falling as rain rather than snow. As the snow pack diminishes, seasonal hydrology will shift to more frequent and severe early large storms, changing stream flow timing and increasing peak river flows, which may limit salmon survival (Mantua et al. 2009). The largest driver of climate-induced decline in salmon and steelhead populations is projected to be the impact of increased winter peak flows, which scour the streambed and destroy 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 higher 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 upper 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 Niňo/La Niňa, 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). Climatic 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 (2015) 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[2] is anticipated to continue. This 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 2015). Specifically, the exceptionally warm marine water conditions in 2014 and 2015 combined with warm freshwater stream temperatures lowered steelhead marine and freshwater survival (NWFSC 2015). Any rebound in viability parameters for Puget Sound steelhead are likely to be constrained under these conditions (NWFSC 2015).

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, Chasco et al. 2017). 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

[2] A positive pattern in the PDO has been in place since 2014.

during freshwater rearing and migration stages.

2.2.1.1 Status of Puget Sound Steelhead

The Puget Sound steelhead DPS was listed as threatened on May 11, 2007 (72 Fed. Reg. 26722). The NMFS issued results of a five-year status review on May 26, 2016 (81 FR 33469) and concluded that this species should remain listed as threatened. As part of the review, NOAA's Northwest Fisheries Science Center evaluated the viability of the listed species, providing updated information and analysis of the biological status of the listed species (NWFSC 2015). The NMFS status review incorporated the findings of the Science Center's report, summarized new information concerning the delineation of the DPS and inclusion of closely related salmonid hatchery programs, and included an evaluation of the listing factors (NMFS 2017c).

The Puget Sound steelhead DPS populations are grouped into three extant Major Population Groups (MPGs) containing a total of 32 Demographically Independent Populations (DIPs) based on genetic, environmental, and life history characteristics (Myers et al. 2015). 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 illustrates the Puget Sound Steelhead DPS, MPGs, and DIPs.

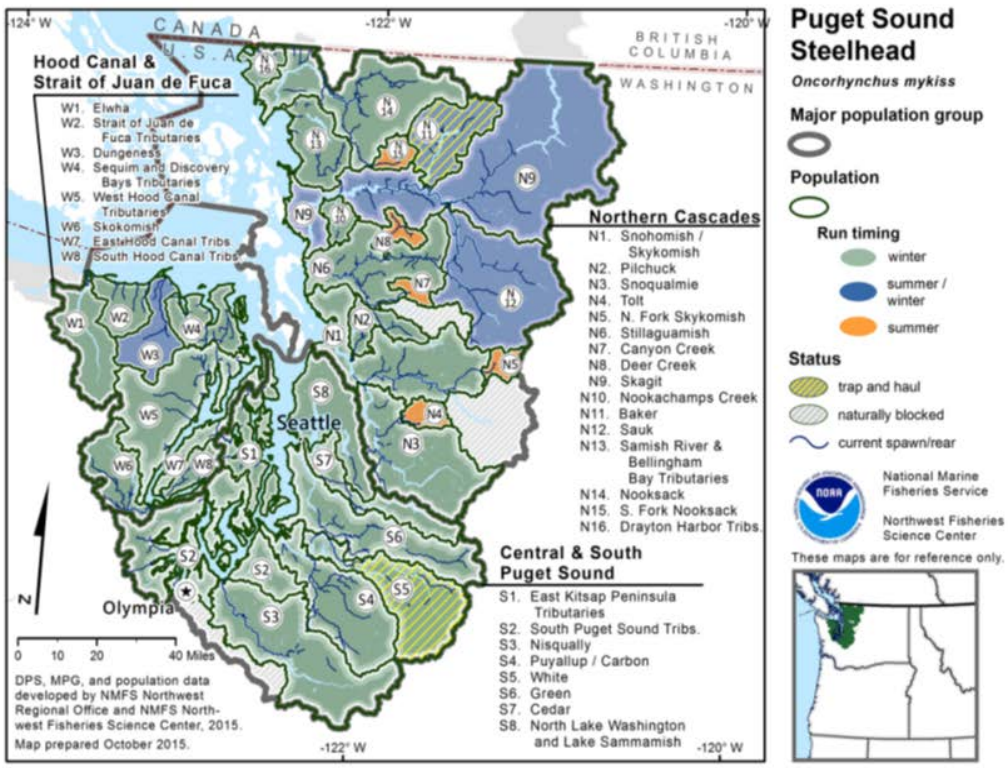


Figure 2. The Puget Sound Steelhead DPS showing MPGs and DIPs. The steelhead MPGs include the Northern Cascades, Central & Sound Puget Sound, and the Hood Canal & Strait of Juan de Fuca.

As part of the early recovery planning process, NMFS convened a technical recovery team to identify historic populations and develop viability criteria for the steelhead recovery plan. The Puget Sound Steelhead Technical Recovery Team (PSSTRT) delineated the Puget Sound steelhead populations (DIPs) (Myers et al. 2015) and completed a set of population viability analyses (PVAs) for these DIPs and the MPGs within the DPS (Hard et al. 2015). These documents present the biological viability criteria recommended by the PSSTRT. These documents do not, however, 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 (Hard et al. 2015). The PSSTRT developed Major Population Group (MPG) and Distinct Population Segment (DPS) viability criteria for Puget Sound steelhead. For MPGs, the viability criteria recommend how many steelhead Demographically Independent Populations (DIPs) must be viable in order for the MPG to be viable (Table 3). DPS viability depends only on one criteria: that each of its component MPGs is considered viable (Hard et al. 2015).

Table 3. PSSTRT recommended Number of viable DIPs required for DPS viability in each of the Puget Sound steelhead MPGs (Hard et al. 2015).

MPG	Life History Type	Number of DIPs	Number Viable DIPs needed
Northern Cascades	Summer-run	5	2
	Winter-run	11	5
Central and South Puget Sound	Summer-run	0	0
	Winter-run	8	4
Hood Canal & Strait of Juan de Fuca	Summer-run	0	0
	Winter-run	8	4

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 complete a draft Puget Sound steelhead recovery plan by the end of 2018 with a final plan completed by the end of 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.*

In 2013, the PSSTRT finalized its analyses of Puget Sound steelhead data available through 2011 to identify 32 demographically independent populations (DIPs) and 3 MPGs within the DPS (Myers et al. 2015) and develop viability criteria for the DPS (Hard et al. 2015). In its viability report, the PSSTRT concluded that the threatened Puget Sound Steelhead DPS is not currently viable. The PSSTRT found that low population viability is widespread throughout the DPS, across all three MPGs, and includes both summer-run and winter-run populations. Steelhead populations throughout the DPS showed evidence of diminished abundance, productivity, diversity, and spatial structure when compared with available historical evidence for the states of each of these salmonid population (VSP) parameters (NWFSC 2015).

Spatial Structure and Diversity

The Puget Sound Steelhead DPS includes all naturally spawned anadromous *O. mykiss* (steelhead) populations originating below natural and manmade impassable barriers 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, steelhead from six artificial propagation programs: the Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Off-station Projects in the Dewatto, Skokomish, and Duckabush Rivers; and the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program. (79 Fed. Reg. 20802, April 14, 2014). Steelhead included in the listing are the anadromous form of *O. mykiss* that occur in rivers, below natural and man-made impassable 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).

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-DPS hatchery steelhead from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Hard et al. 2007). Loss of diversity and spatial structure were judged to be “moderate” risk factors (Hard et al. 2007).

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 available and spawning habitat that is occupied compared to what is needed.[3] 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 (Hard et al. 2015). The Puget Sound Steelhead Technical Recovery Team concluded that low population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity (Hard et al. 2015). 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 were generally lower (NWFSC 2015). 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 2015).

[3] Intrinsic potential is the area of habitat suitable for steelhead rearing and spawning, at least under historical conditions (Hard et al. 2015).

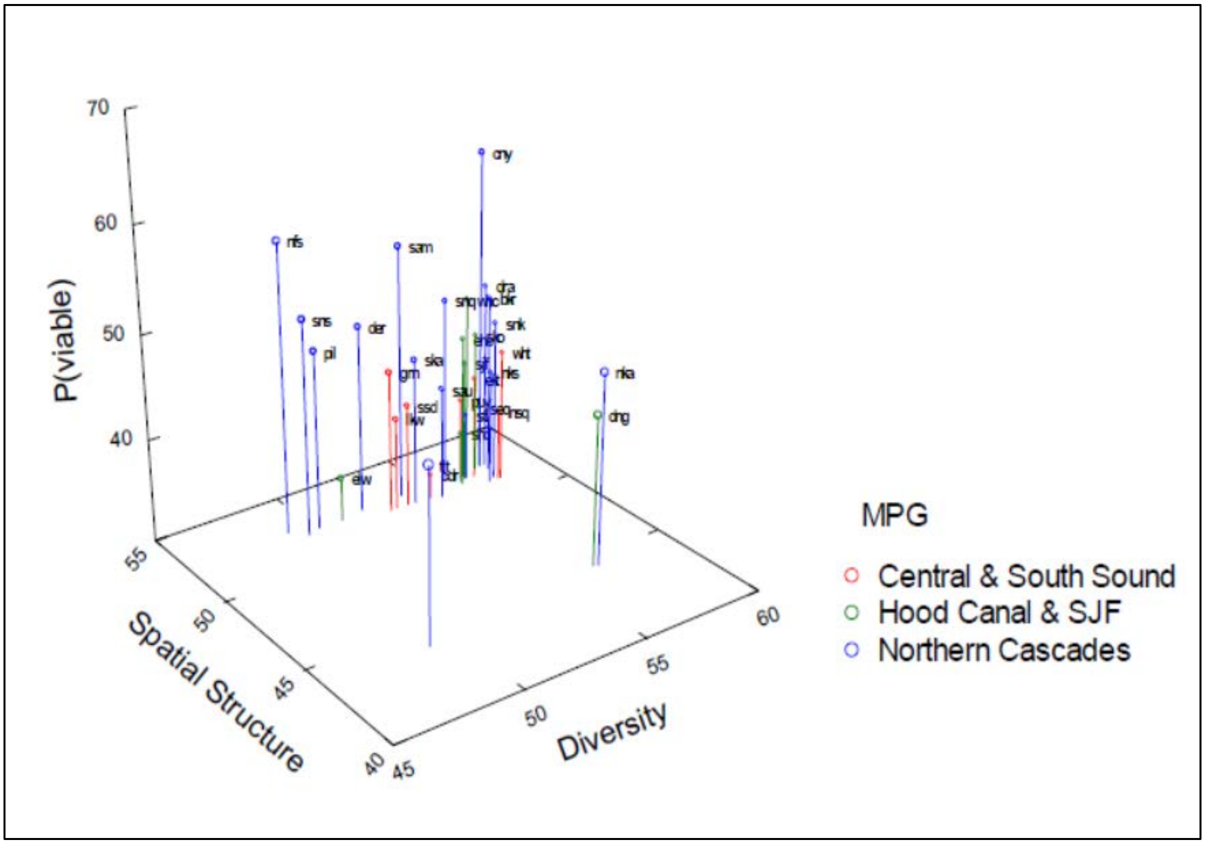


Figure 3. Scatter plot of the probabilities of viability for each of the 32 steelhead populations in the Puget Sound Steelhead DPS as a function of VSP parameter estimates of influence of diversity and spatial structure on viability (Hard et al. 2015).

Since the PSSTRT completed its review of Puget Sound steelhead in 2013, 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 2015). 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 2015). In addition, the fraction of hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015). 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 2015). 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 2015). In some river systems, e.g., Snohomish/Skykomish and Snoqualmie Rivers, levels of hatchery-origin fish on the spawning grounds 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); however, this fraction could also not be estimated for a substantial number of DIPs especially during the 2010 to 2014 period (Table 4) (NWFSC 2015).

Table 4. Puget Sound steelhead 5-year mean fraction of natural-origin spawners[1] for 22 of the 32 DIPs in the DPS for which data are available (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	1.00	1.00	1.00
	N. Lake WA/Lake Sammamish	1.00	1.00	1.00	1.00	
	Puyallup River/Carbon River	0.95	0.92	0.91	0.91	
	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
	West Hood Canal Tributaries		1.00	1.00	1.00	
	Nooksack River			0.96	0.97	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	0.94	0.95	0.94	0.96	
	Snoqualmie River	0.79	0.76	0.58	0.66	
	Stillaguamish River	1.00	0.88	0.75	0.81	
Summer	Tolt River	1.00	1.00	1.00	1.00	1.00

[1] The 5-year estimates represent the sum of all natural-origin spawner 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 heritable in salmonids.[4] 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 Puget Sound steelhead DPS.

Steelhead, as a species, are iteroparous and as such have the ability to survive after the spawning process, unlike Pacific salmon species. Myers et al. (2015) describes that in contrast to semelparous Pacific salmon, steelhead females do not guard their redds, but return to the ocean following spawning, although they may dig several redds in the course of a spawning season (Burgner et al. 1992). Spawned-out fish that return to the sea are referred to as kelts. Adult male

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

steelhead may be relatively less abundant among fish returning to the ocean after spawning, and males usually form a small proportion of repeat (multiyear) spawning fish, based on scale pattern analyses (McGregor 1986, McMillan et al. 2007). If there is lower postspawning survival of winter-run males overall, it may be due to the tendency of males to remain on the spawning ground for longer periods than individual females in an effort to spawn with multiple females, or fighting in defense of prime spawning areas or mates (Withler 1966).

Hard et al. 2015 described preliminary modelling efforts to demonstrate the effect of varying rates of iteroparity on the frequency of abundances in a simulated small winter steelhead population. The outcome of this work demonstrated, theoretically, that:

> *1. The average proportion of repeat spawners in an adult steelhead population is relevant to population abundance and stream capacity in two ways: first, relative to a population with no repeat spawners, for a given average capacity of juveniles, a population with repeat spawners will have a larger average adult spawning population; second, a given average number of adult spawners can be sustained by fewer juveniles when repeat spawners are present than when they are not. It is therefore likely that viable populations (DIPs) of steelhead can be sustained in smaller stream basins than is the case for Pacific salmon.*
>
> *2. When population resilience to environmental variation or harvest mortality is measured in terms of either the probability of declining below specific levels of annual spawner abundance or the expected frequency of the spawning population declining below some threshold of concern (quasi-extinction), repeat spawning provides increased levels of resilience compared to populations without repeat spawning. However, the impact of harvest mortality on the average proportion of repeat spawning confounds understanding of precisely how much resilience a given mean level of repeat spawning (measured under deterministic conditions) affords a population, especially at low levels of total abundance. The significance of repeat spawning may be weakened (or underestimated) when small population sizes are considered.*
>
> *3. When both harvest mortality and environmental variation in smolt survival are present, repeat spawning increases population resilience. The precise extent to which resilience is increased is sensitive to the harvest rate and to both the magnitude of the average value of life-stage survival rates subject to environmental variation and the amount of variation in the rate as measured by the coefficient of variation.*
>
> *4. From a population rebuilding and recovery perspective, for small population sizes such as the ones considered in this modeling exercise, it appears that the value of specific levels of repeat spawning to population resilience (and repeat spawning) are most likely to be realized under a zero harvest scenario, regardless of the level of environmental variation (at least for the range and kind of variation employed in the models).*

Hard et al. 2015 concluded that these analyses reinforce the PSSTRT's determination that iteroparity is an important consideration in a comprehensive evaluation of viability for steelhead. Iteroparity is also arguably an important factor for diversity (and also for population persistence through temporal risk spreading), but the PSSTRT did not consider this issue quantitatively. The PSSTRT has determined that the degree of iteroparity is likely to be especially influential on viability in small populations during periods when marine mortality varies widely.

In determining the viability of steelhead DIPs in the Puget Sound steelhead DPS, the TRT considered the potential influence of co-occurring resident *O. mykiss* on anadromous steelhead demographics (Hard et al. 2015). For the Puget Sound steelhead DPS, which are considered coastal *O. mykiss*, Hard et al. (2015) found that, in general, there appeared to be a relatively close relationship between sympatric resident and anadromous forms below long-standing natural barriers. This may be due in part to the relatively short geologic time period since the Pleistocene glaciations. It may also be that, below impassable barriers, truly resident populations do not exist. Rather, the degree of anadromy in an *O. mykiss* DIP may be somewhat plastic, with environmental and ecological cues influencing the relative rate of anadromy.

It is likely that the presence of resident *O. mykiss* that produce anadromous adult offspring, either by interbreeding directly with their anadromous counterparts or independently, contributes significantly to abundance dynamics of the anadromous population. This contribution may be especially important when ocean conditions are poor and the survival of the anadromous component is low. An *O. mykiss* population expressing a combination of migratory strategies and a heritable propensity to produce both types of progeny means residents can serve as a buffer when anadromous productivity is low and extinction risk is lower when residents are abundant (Hard et al. 2015).

More information on Puget Sound steelhead spatial structure and diversity can be found in NMFS's PSSTRT viability report (Hard et al. 2015) and NMFS's status review update on salmon and steelhead (NWFSC 2015).

Abundance and Productivity

The 2007 Biological Review Team (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 2015). Steelhead abundance estimates are available for 7 of the 11 winter-run DIPs and 1 of the 5 summer-run DIPs in the Northern Cascades MPG,[5] 6 of the 8 winter-run DIPs in the Central and South Puget Sound MPG,[6] and 8 of the 8 winter-run DIPs in the Hood Canal and Strait of Juan de Fuca MPG.[7] 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

[5] 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.

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

[7] 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.

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.

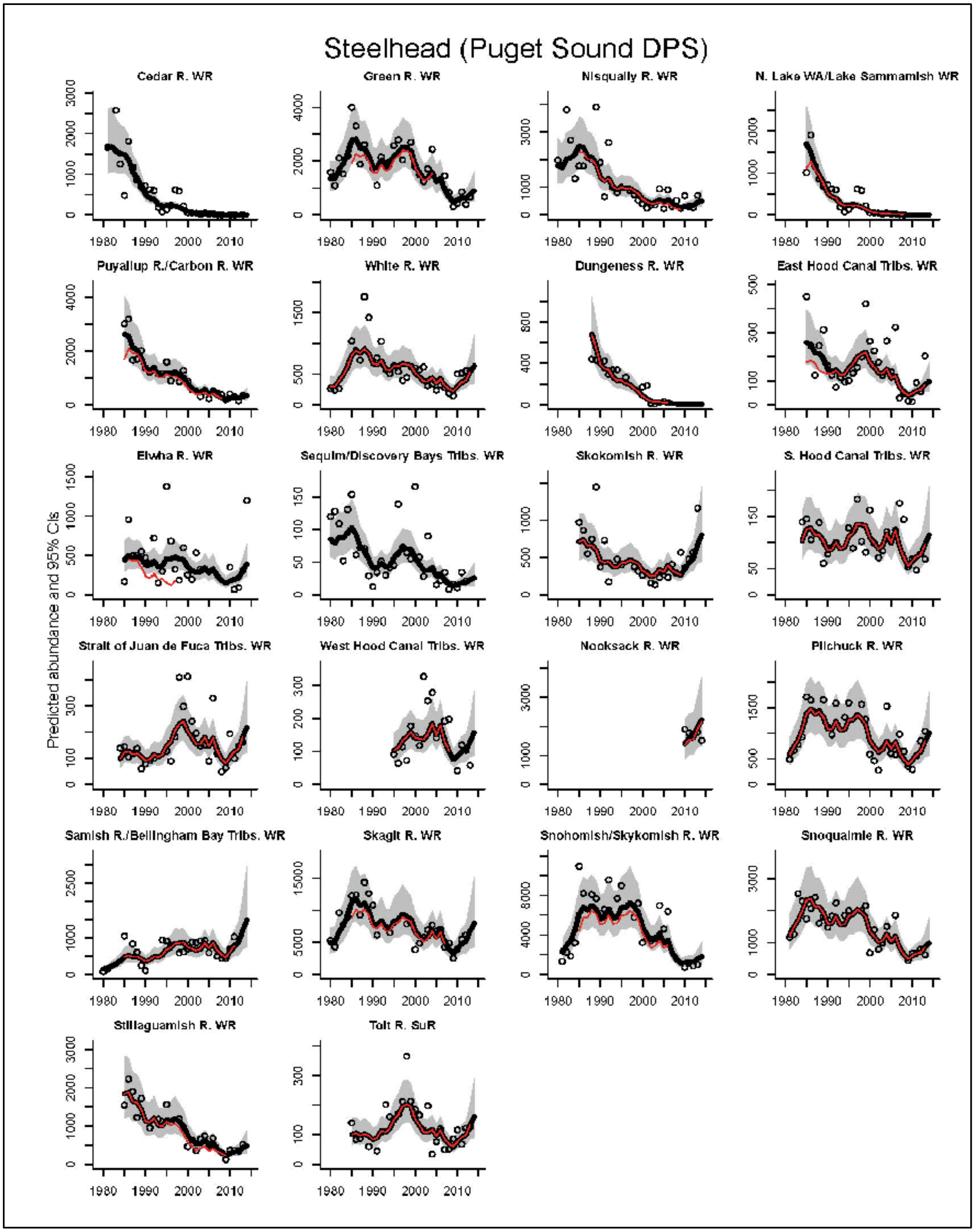


Figure 4. Trends in estimated total (black line) and natural (red line) population spawning abundance of Puget Sound steelhead. The circles represent annual raw spawning abundance data and the gray bands represent the 95% confidence intervals around the estimates.

In the most recent status review, for ESA-listed West Coast salmon and steelhead, the Northwest Fisheries Science Center (2015) found that, in general, broad patterns of steelhead abundance across the Puget Sound DPS are similar to those summarized in the prior status review which had considered data through 2009 (Ford et al. 2011). Since 2009, 10 of the 22 populations indicate small to modest increases in abundance.[8] Most steelhead populations in the Puget Sound steelhead DPS remain small. From 2010 to 2014, 8 of the 22 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 22 steelhead populations had fewer than 500 natural spawners (Table 5**;** NWFSC 2015). Smoothed trends in abundance indicate modest increases since 2009 for 13 of the 22 DIPs (Samish River and Bellingham Bay Tributaries WR, Pilchuck River WR, White River WR, Skokomish River WR, Strait of Juan de Fuca Tributaries WR, Skagit River WR, Green River WR, West Hood Canal Tributaries WR, and Nooksack River WR; East Hood Canal Tributaries WR, Dungeness River WR, Elwha River WR, and Tolt River SuR also show early signs of an upward trend). However, several of these upward trends are not statistically different from neutral, and most populations remain small (NWFSC 2015). Between the two most recent five-year periods (2005-2009 and 2010-2014), the geometric mean of estimated abundance in the Puget Sound steelhead DPS increased by an average of 5.4%. For seven populations in the Northern Cascades MPG, the increase was 3%; for five populations in the Central & South Puget Sound MPG, the increase was 10%; and for six populations in the Hood Canal & Strait of Juan de Fuca MPG, the increase was 4.5% (Table 5; NWFSC 2015).

[8] Pilchuck River, Samish River/Bellingham Bays Tributaries, Nisqually River, White River, Sequim/Discovery Bay Tributaries, Skokomish River, and Strait of Juan de Fuca Tributaries winter-run steelhead populations and Tolt River summer-run steelhead population with Skagit River and Stillaguamish River also showing early signs of upward trends.

Table 5. 5-year geometric mean of natural spawner counts for Puget Sound steelhead. Numbers not in parentheses represent the estimated natural-origin spawners (the raw total spawner count, which is in parentheses, times the fraction of natural spawner estimate (Table 4), if available). Percent change between the most recent two 5-year periods is shown on the far right (NWFSC 2015). The Skagit River population included all 4 DIPs combined.

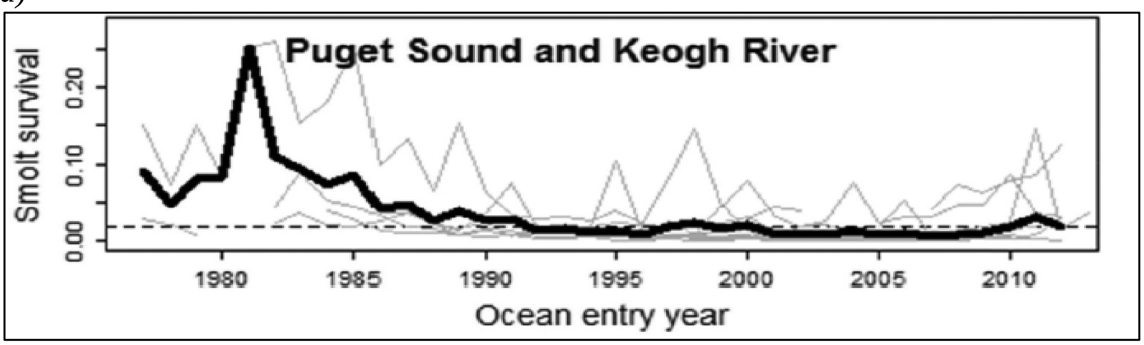
MPG	**Run**	**Population**	**1990-1994**	**1995-1999**	**2000-2004**	**2005-2009**	**2010-2014**	**% Change**
Northern Cascades	Winter	Nooksack River	--	--	(80)	--	1779 (1834)	--
		Pilchuck River	1300 (1300)	1465 (1465)	604 (604)	597 (597)	614 (614)	3 (3)
		Samish River/Bellingham Bay	316 (316)	717 (717)	852 (852)	534 (534)	846 (846)	58 (58)
		Skagit River	**7189 (7650)**	**7656 (8059)**	**5424 (5675)**	**5547 (4767)**	**(5123)**	**(7)**
		Snohomish/Skykomish River	3634 (3877)	4141 (4382)	2562 (2711)	2945 (3084)	(930)	(-70)
		Snoqualmie River	1832 (2328)	2060 (2739)	856 (1544)	1396 (1249)	(680)	(-46)
		Stillaguamish River	1078 (1078)	1024 (1166)	401 (550)	259 (327)	(392)	(20)
	Summer	Tolt River	112 (112)	212 (212)	119 (119)	73 (73)	105 (105)	44 (44)
Central/ South PS	Winter	Cedar River	(321)	(298)	(37)	(12)	(4)	(-67)
		Green River	1566 (1730)	2379 (2505)	1618 (1693)	(716)	(552)	(-23)
		Nisqually River	1201 (1208)	759 (759)	413 (413)	375 (375)	442 (442)	18 (18)
		N. Lk WA/Lk Sammamish	321 (321)	298 (298)	37 (37)	12 (12)	--	--
		Puyallup River/Carbon River	1860 (1954)	1523 (1660)	907 (1000)	641 (476)	(277)	(-42)
		White River	696 (696)	519 (519)	466 (466)	225 (225)	531 (531)	136 (136)
Hood Canal/ SJF	Winter	Dungeness River	356 (356)	--	182 (186)	--	(141)	--
		East Hood Canal Tribs.	110 (110)	176 (176)	202 (202)	62 (62)	60 (60)	-3 (-3)
		Elwha River	206 (358)	127 (508)	(303)	--	--	--
		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 (-43)
		Strait of Juan de Fuca Tribs.	--	275 (275)	212 (212)	244 (244)	147 (147)	-40 (-40)
		West Hood Canal Tribs.	--	97 (97)	210 (210)	174 (149)	(74)	(-50)

Marine survival is an important factor affecting the abundance of Puget Sound steelhead and periods of high and low survival are evident (Scott and Gill 2008). Kendall et al. (2017)

analyzed the times series of smolt-to-adult returns (SAR) for 48 Washington, Oregon, and British Columbia steelhead populations for ocean entry years (OEYs) 1977 through 2012. Although substantial variability existed between years, between populations, and between regions, several high-level patterns emerged. Similarities in values and trends in SARs were evident across broad geographic regions. The Puget Sound and Johnstone Strait populations (Figure 5a) were identified as a group distinct from the Strait of Juan de Fuca populations, the lower Columbia River populations, and the Washington and Oregon coastal populations. Within each group, breakpoints were identified where the trend or average SAR changed. Kendall et al. (2017) identified four periods for the Puget Sound and Johnstone Strait group (Figure 5b):

Kendall et al. 2017 notes that mean smolt survival values for three of the four regions identified showed different periods of stability, declining values, and increasing values between the late 1970s and 2012, suggesting that important environmental variables may have been acting at these smaller spatial scales. However, the three regions exhibited consistent breakpoints (mid- to late 1990s) that match the timing of a climate regime shift in the North Pacific Ocean (1998: Overland et al. 2008; Peterson and Schwing 2003).

(a)



(b)

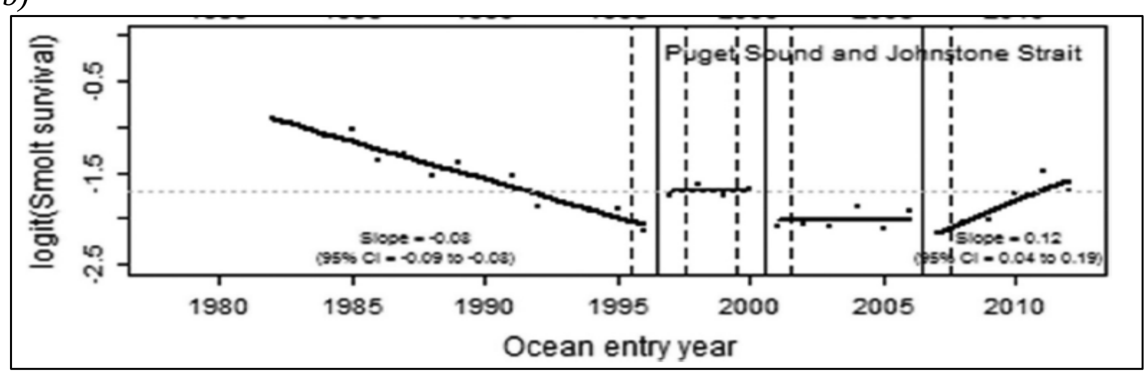


Figure 5. *(a)* Steelhead smolt-to-adult survival estimates for the Puget Sound and Johnstone Strait, BC populations (excerpted from Kendall et al. 2017), *(b)* Time series breakpoints and trends for historical Puget Sound and Johnstone Strait, BC steelhead population smolt-to-adult survival estimates (excerpted from Kendall et al. 2017).

Marine survival can have implications to overall steelhead life-cycle productivity. Puget Sound Steelhead productivity has been variable for most populations since the mid-1980s. In the

NWFSC (2015) 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. These six steelhead populations include, the Stillaguamish River winter-run in the Northern Cascade MPG, the North Lake Washington and Lake Sammamish, Puyallup Rover/Carbon River and Nisqually winter-run populations in the Central and South Puget Sound MPG, and the Dungeness and Elwha winter-run populations 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 2015). Some steelhead populations are showing signs of productivity that has been above replacement in the last two or three years available, prior to 2015 (Figure 6). 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.

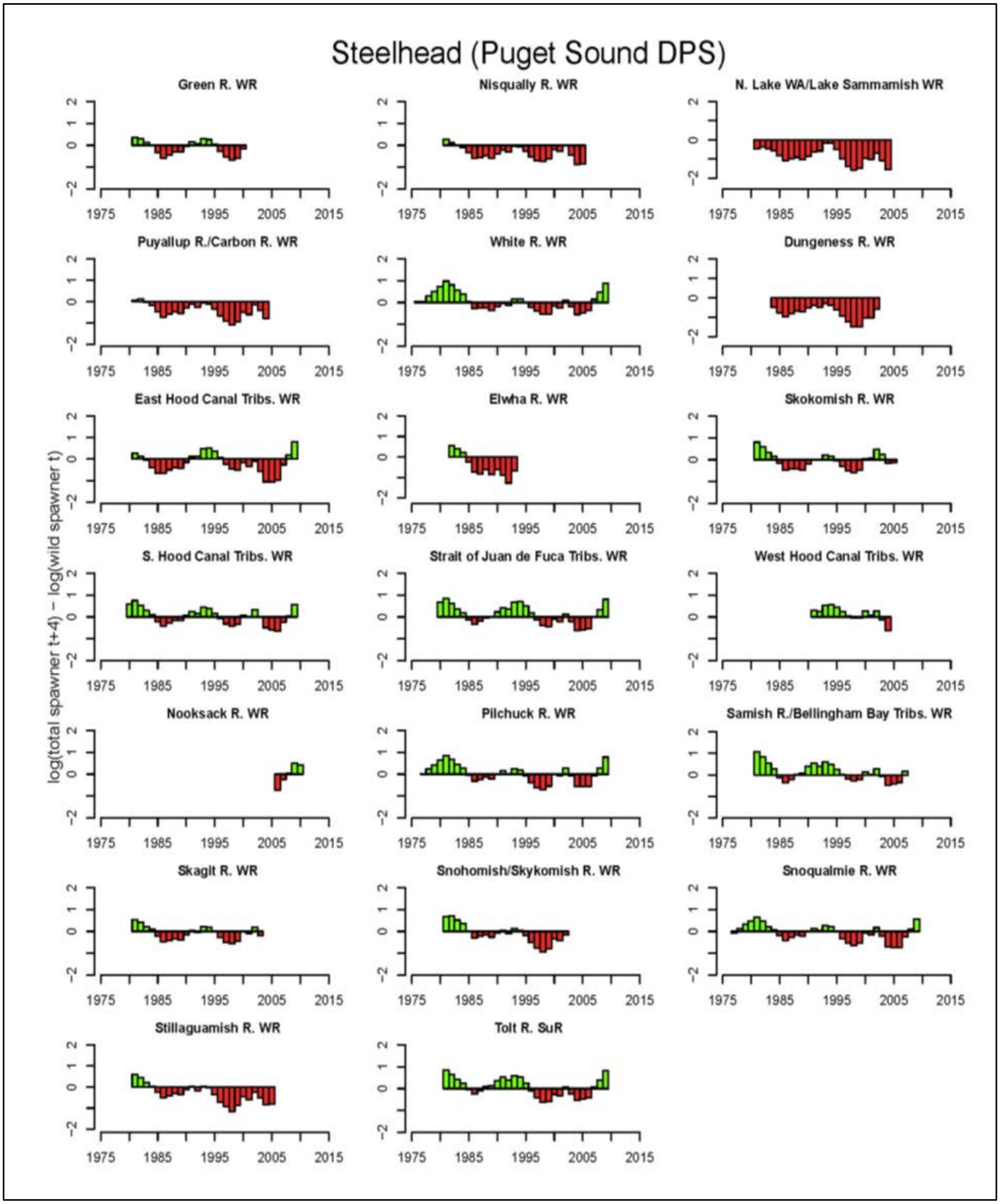


Figure 6. Trends in population productivity of Puget Sound steelhead, by run-year (NWFSC 2015).

Overall, the status of Puget Sound steelhead based on the best available data on spatial structure, diversity, abundance, and productivity has not changed since the prior status review which was completed in 2011 (NWFSC 2015). 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 2015). The production of hatchery fish of both run types (winter and summer) continues 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 include only one to a few years of data, thus, the patterns of improvement in productivity are not widespread nor considered certain to continue at this time.

2.2.1.1.1 Skagit River Steelhead Status

The Skagit River contains 4 steelhead DIPs, as identified in Myers et al. (2015). The DIPs include: 1) Skagit River Summer Run and Winter Run; 2) Nookachamps Creek Winter Run; 3) Sauk River Summer Run and Winter Run; and 4) Baker River Summer Run and Winter Run (Myers et al. 2015).

Historically, the Skagit River steelhead populations have been monitored and forecasted as an aggregate population. Because of this, most of the available information about the status, trends, and distribution are not available at the DIP level. Much of the information on the status of the Skagit River steelhead, in the following section, is therefore presented at this basin-wide scale. Where information is available at the DIP level, it is also presented. As described, above, for the entire Puget Sound steelhead DPS, we will now look at the status of the Skagit River steelhead, relative to the VSP attributes; spatial-structure and diversity, and abundance and productivity.

Skagit River Steelhead Spatial Structure and Diversity

Skagit steelhead Adult and juvenile distribution

Annual spawning ground surveys, performed by the tribal and state fisheries staffs, occur throughout the basin and are conducted by foot, by floating stream sections, and by fixed-wing or helicopter aerial surveys, depending on stream size and visibility. Surveys are conducted on index reaches on tributary streams on a 10-14-day rotation typically from late February/early March depending on where in the basin the stream is located through June or early July (Sauk-Suiattle Indian Tribe et al. 2016). These surveys are conducted in both mainstem areas of the Skagit and Sauk Rivers, as well as in several smaller tributary streams to each of these rivers. These areas include: the mainstem Skagit River from river mile (RM) 22-94 and Skagit River tributaries—Alder, Diosbud, Rocky, O'Toole, Cumberland, Day, Sorenson, Hansen, and Jones Creeks (Figure 7); the surveys also include the Sauk River mainstem, from the mouth to RM 41, the lower two miles of the South Fork Sauk River, and Sauk River tributaries—White, Day, Murphy, and Falls Creeks (Sauk-Suiattle Indian Tribe et al. 2016) (Figure 8). These surveys provide broad-scale spatial coverage of adult spawning utilization that includes both mainstem and tributary areas. The broad coverage also encompasses the variation in the ecological differences contained in the Skagit basin, with coverage for the Lower Skagit mainstem tributaries, which are predominantly rain-fed systems and the Sauk and upper Skagit River areas, which encompass both snow and ice-fed systems and rain-fed systems.

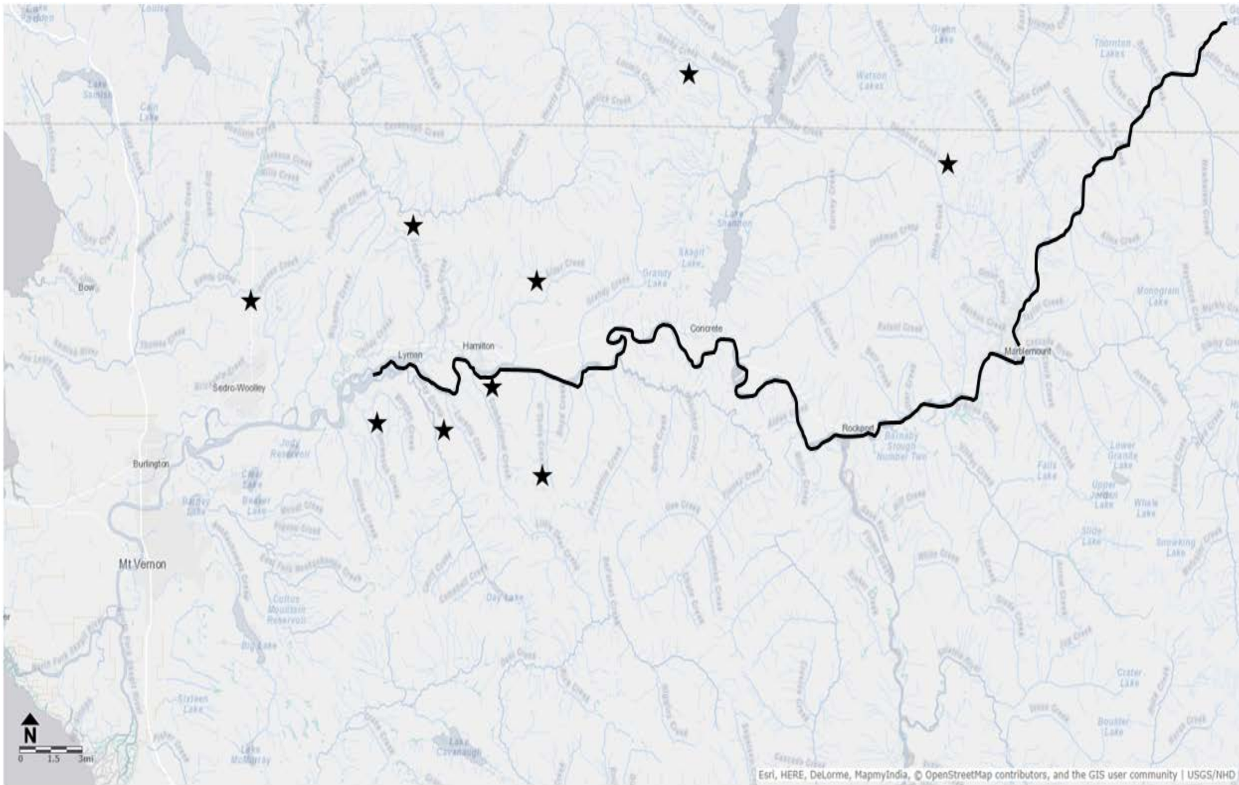


Figure 7. Annual steelhead spawning ground survey location in the Skagit River mainstem and tributaries, Nookachamps Creek circled. (base map, WDFW Salmon Scape).

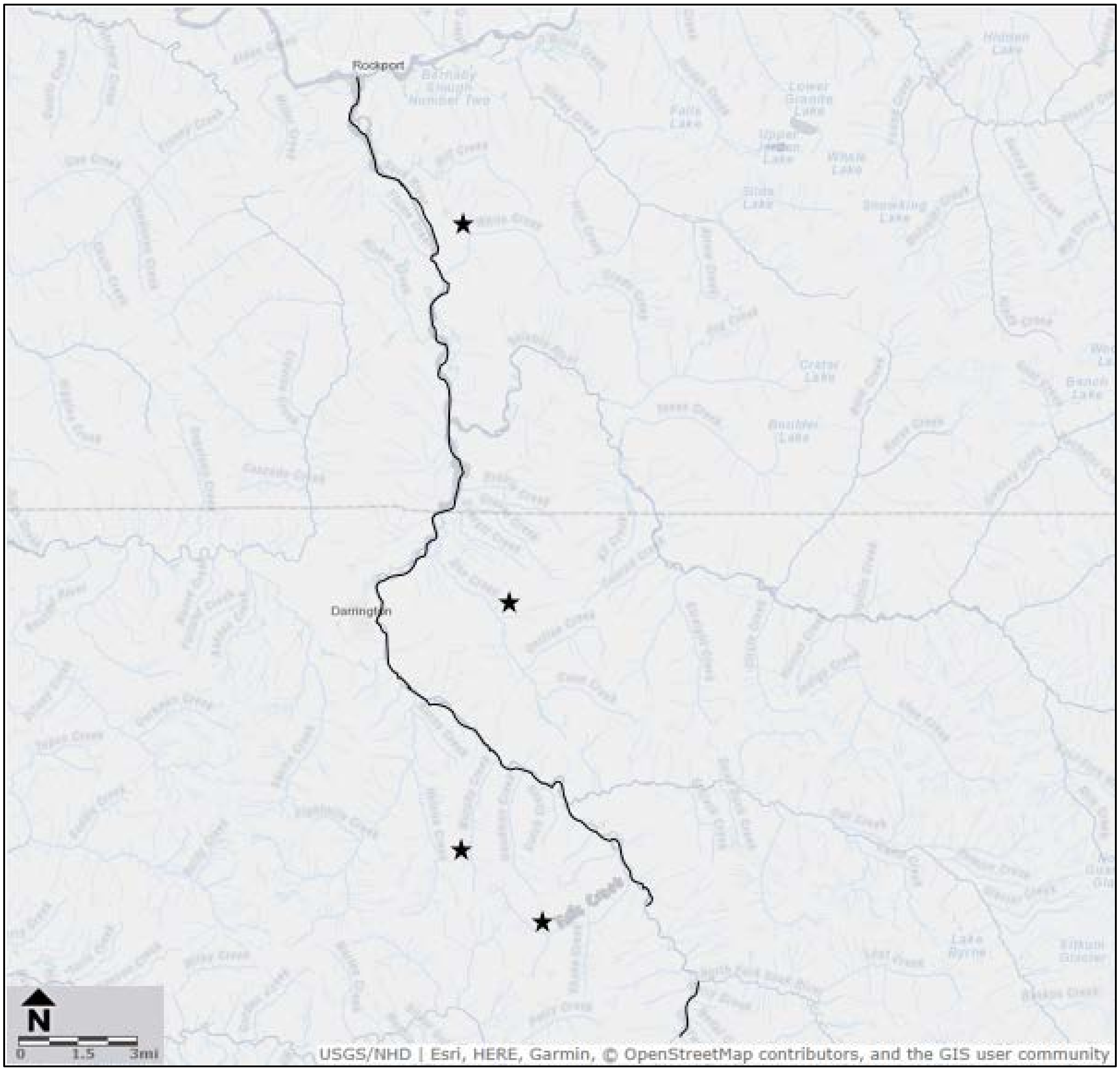


Figure 8. Annual steelhead spawning ground survey location in the Sauk River and its tributaries (base map, WDFW Salmon Scape).

Sauk-Suiattle Indian Tribe et al. (2018) notes that Skagit River steelhead escapement surveys have been conducted on the Skagit River on a 10-14 day rotation. Since steelhead spawn timing varies throughout the basin, surveys can begin as early as late February/early March in some locations and continue through June or early July. Analysis of the survey data indicates that spawning of the Skagit population occurs primarily from April through mid-June with peak spawning occurring in mid-May (Figure 9).

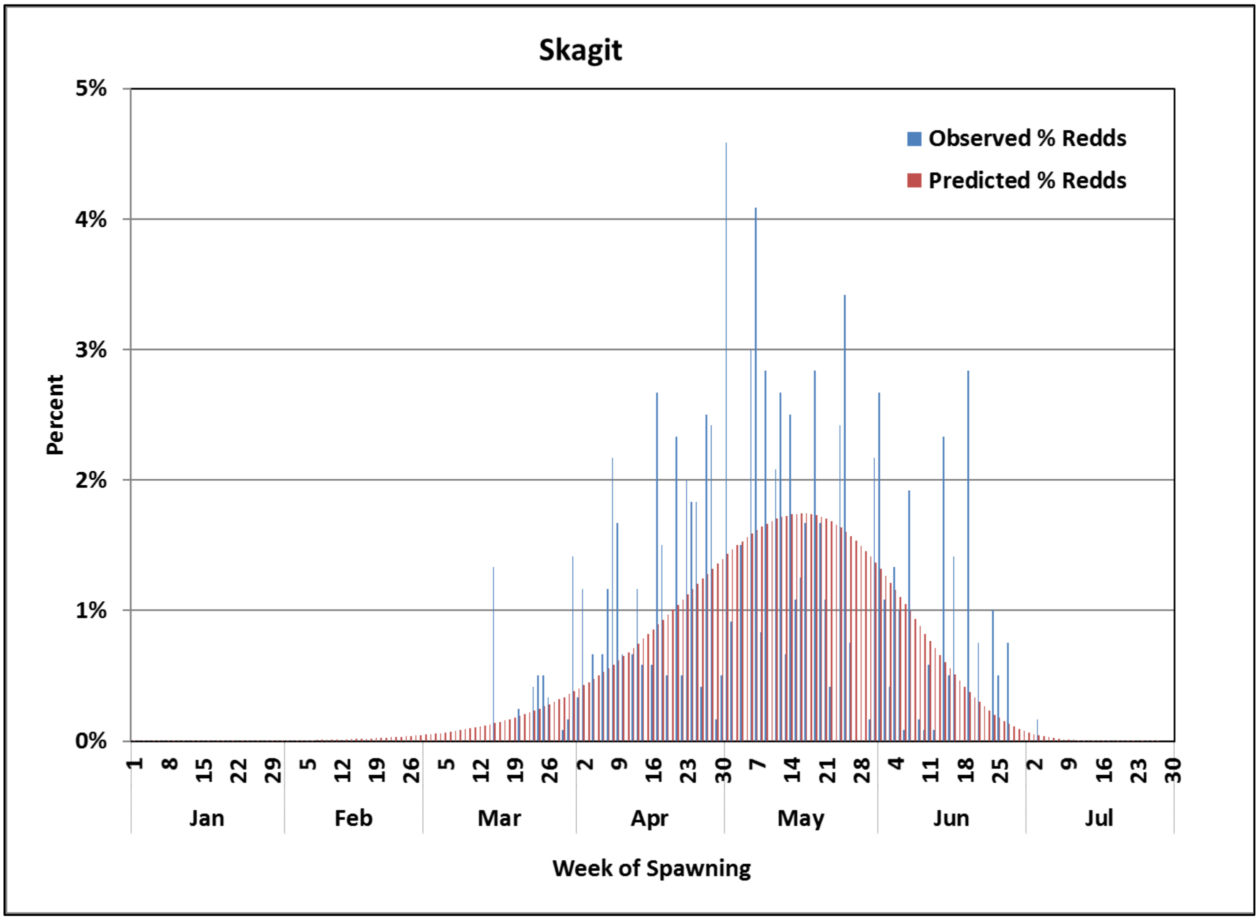


Figure 9. Skagit River winter steelhead observed and predicted red distribution (Sauk-Suiattle Indian Tribe et al. 2018).

There has also been recent work in the Skagit basin to survey and monitor juvenile steelhead spatial distribution and presence throughout the watershed. Sauk-Suiattle Indian Tribe et al. 2018 indicates that juvenile *O. mykiss* are found throughout the entire anadromous zone of the Skagit River basin, with surveys in 2011 and 2012 indicating that *O. mykiss* occupied 95% of the sites surveyed (Table 6) (Upper Skagit Indian Tribe (USIT) and Seattle City Light, unpublished data; in Sauk-Suiattle Indian Tribe et al. 2018).

Table 6. Juvenile *O. mykiss* densities per lineal meter of stream for sites in the Skagit River basin sampled in the summer of 2011 and winter of 2012.

Sample Site	Site Number	Summer 2011	Winter 2012	Present at Site
Hansen Creek (lower)	1	0.569	0.044	Yes
Skagit @ Mill Creek	2	0.205	0.178	Yes
Suiattle Below Buck Creek	3	0.020	0.015	Yes
Sauk @ Skull Creek	4	0.070	0.163	Yes
Skagit @ Damnation Creek	5	0.000	0.031	Yes
Finney Creek (upper)	6	0.440	0.335	Yes
Skagit @ Illabott Creek	7	0.667	0.686	Yes
Sauk above Whitechuck River	8	0.402	0.360	Yes
Sauk above Whitechuck River	9	0.336	0.194	Yes
E. Fork Nookachamps Creek	10	5.468	0.110	Yes
Suiattle Mouth	11	0.000	0.142	Yes
Above Hatchery	12	0.000	0.000	No
Ross Island Slough	13	0.574	0.362	Yes
Sauk @ Old Sauk Trail	14	0.236	0.057	Yes
Suiattle @ Circle Creek	15	0.115	0.644	Yes
Skagit @ Cockerham Island	16	0.000	0.007	Yes
Skagit @ Jackman Creek	17	0.248	0.126	Yes
Skagit @ Jackman Creek	18	0.097	0.202	Yes
Buck Creek	19	0.016	0.031	Yes
Buck Creek	20	0.123	0.139	Yes
Day Creek	21	0.119	0.150	Yes
Sauk below Hilt Creek	22	0.051	0.032	Yes
Cascade @ Marble Creek	23	0.135	0.018	Yes
Skagit below Goodell	24	0.027	0.055	Yes
Above Sauk mouth	25	0.000	NS	No
Illabott Creek	26	0.115	0.024	Yes
Hansen Creek (upper)	27	0.077	0.112	Yes
Cascade @ Mineral Creek	28	0.025	NS	Yes
Upper Nookachamps	29	0.010	0.000	Yes
Bacon Creek above Oakes Creek	30	0.059	NS	Yes
Finney Creek (lower)	31	0.272	NS	Yes
Average Density		0.338	0.156	
95% CI		± 0.36	± 0.07	
Percent Occupied	84%	93%	94%	

Additionally, the WDFW and the USIT have operated juvenile fish traps throughout the Lower and Upper Skagit River basin since 2012, monitoring juvenile steelhead smolt production and collecting data on age structure and life-stage (Figure 10). The total number of individual sites monitored, annually, has been reduced since 2012, with the focus shifting to the two primary tributary locations: Illabot Creek in the upper Skagit; Hansen Creek in the Lower Skagit (both highlighted in green), and the lower mainstem trap near Mt Vernon, WA (Figure 11).

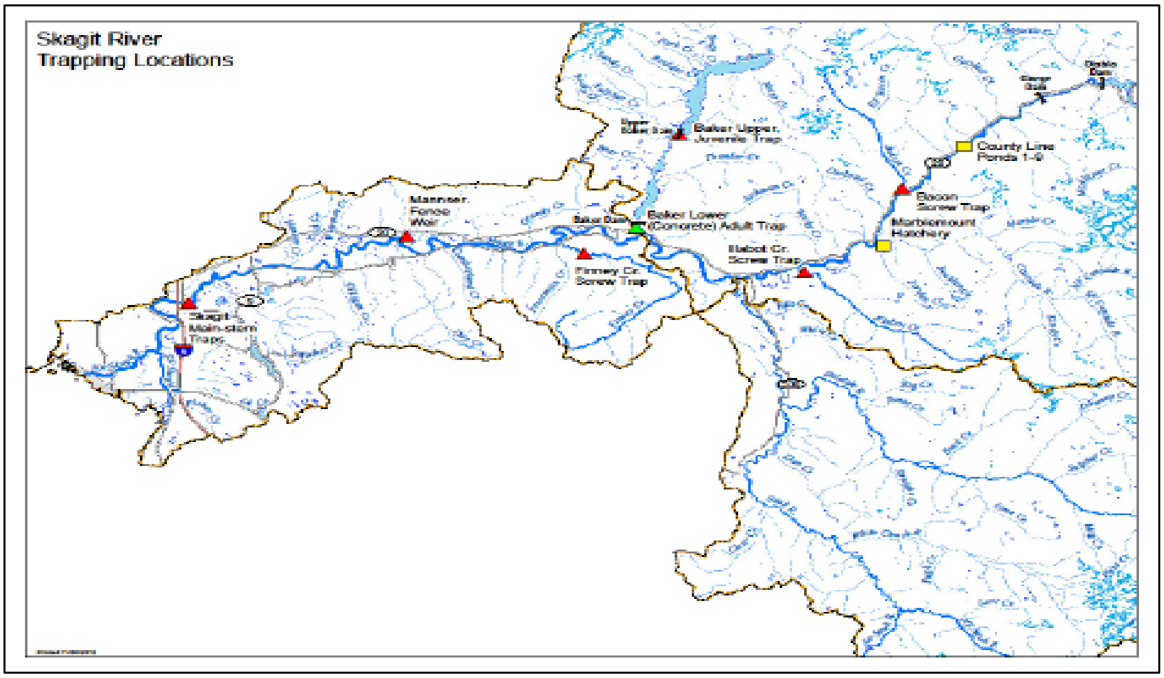


Figure 10. Skagit River steelhead juvenile trapping sites, Spring 2012 (Kinsel et al. 2013).

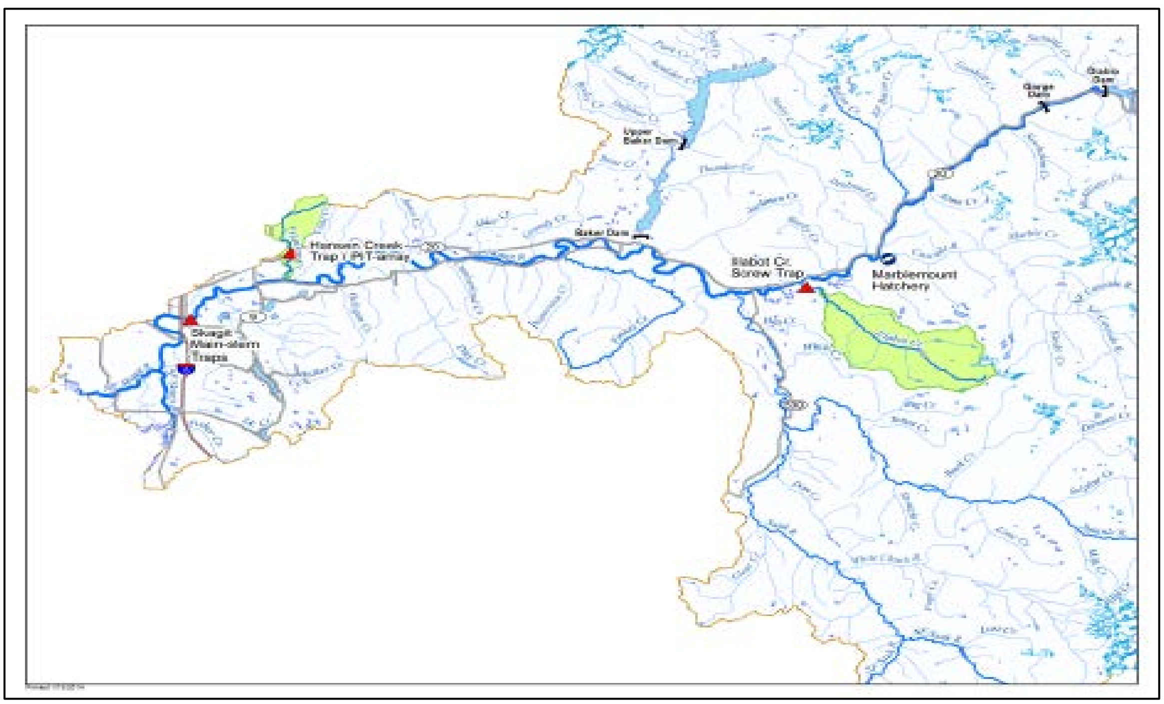


Figure 11. Skagit River steelhead juvenile trapping sites, spring 2016 (Kinsel et al. 2016).

Although these data sets are currently limited in length, they give some indication of the smolt production numbers and variability in these Skagit River tributaries (Figure 12). These monitoring projects are expected to continue which will provide for continued juvenile production trend monitoring and potential use as references for developing empirically-based Skagit basin productivity models.

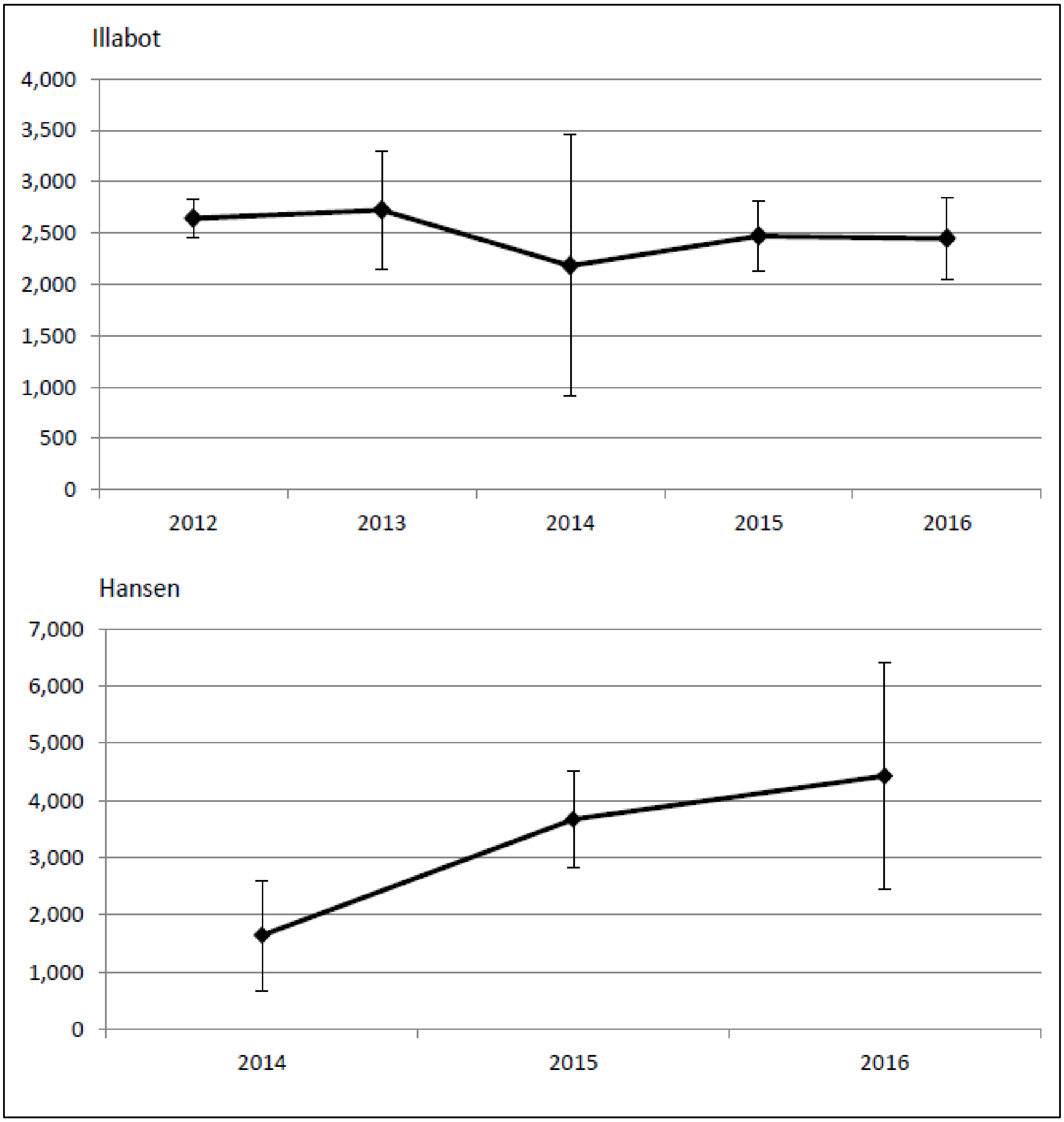


Figure 12. Steelhead smolt abundances within the Skagit River basin at Illabot (2012-2016) and Hanson (2014-2016) creeks (Kinsel et al. 2016).

Skagit steelhead Summer-run Timing

As described above, two of the four Skagit River basin steelhead DIPs contain a summer-run component—the Skagit summer and winter DIP and the Sauk summer and winter DIP. While winter-run steelhead return to freshwater during the winter and early spring months and spawn relatively soon after entering freshwater, summer-run (stream-maturing) steelhead return to freshwater during late spring and early summer in a relatively immature state and hold there until spawning in the following winter/spring (Myers et al. 2015). The life history of summer-run steelhead is highly adapted to specific environmental conditions. Because these conditions are not commonly found in Puget Sound, the relative incidence of summer-run steelhead populations is substantially less than that for winter-run steelhead. Summer-run steelhead have not been widely monitored, in part because of their small population size and the difficulties in monitoring fish in their headwater holding areas where summer-run are most likely to be found (Myers et al. 2015).

In the Skagit River, there appears to be some temporal separation between the two runs (winter and summer) in spawning times, although genetic information is not available to establish whether there is complete reproductive isolation (Myers et al. 2015). Historically, summer-run steelhead were reported in Day and Finney creeks and the Cascade River (Donaldson 1943, WDG no date-a). In the case of these three summer-run steelhead–bearing tributaries, cascades or falls may present a migrational barrier to winter-run fish but not summer-run fish (Myers et al. 2015).

While there is considerable information that summer-run steelhead existed historically in the Skagit River tributaries, recent surveys suggest that the summer-run component is at a critically low level. Locations where summer-timed fish have been reported include Finney Creek, Day Creek, the Cascade River, the upper Sauk River, and the South Fork Sauk River. However, despite extensive surveys by the co-managers, river miles 8.0 to 11.6 of Finney Creek is the only location where summer-timed fish are currently known to spawn. The summer-timed steelhead enter Finney Creek in October and November, with spawning occurring primarily from February through March (Sauk-Suiattle Indian Tribe et al. 2018).

Skagit steelhead Early returning winter steelhead

The Skagit River steelhead DIPs all have winter-run timing, either as one component of their life history—Skagit summer and winter run, Sauk, Baker River summer and winter run—or, as the entirety of their run timing—Nookachamps winter steelhead. As described above in the *Summer-run Timing* section, winter-run steelhead return to freshwater during the winter and early spring months and spawn relatively soon after entering freshwater (Myers et al. 2015). River entry timing and spawn timing are more closely aligned in winter run steelhead, as they enter the rivers in a more mature reproductive state. More broadly, there are concerns that fisheries directed at the harvest of early-returning hatchery fish may have resulted in the loss of the early-run timed component of Puget Sound natural-origin steelhead (NMFS 2016a).

Historical accounts indicate that the run of steelhead in the Skagit River extended from

November 15 up to the following spring (Wilcox 1895). Only a "scattering" of steelhead were reported prior to December and a light run continued through the winter (Wilcox 1902). In 1899, steelhead marketed in La Conner, Washington (Skagit River), averaged 5 kg (11 lb). Little (1898) indicated that large numbers of "steel-heads" entered the Baker River and spawned from March to April (Myers et al. 2015).

Myers et al. (2015) acknowledged that historical surveys suggest that the winter run of steelhead in the Sauk River basin was significantly earlier than that in the mainstem Skagit River, specifically in the Suiattle River, citing that: "Of considerable biological importance is the persistent report that the early run of steelhead in the Skagit River system proceed up the Sauk River" (WDG no date-a). It was suggested that the early run timing allowed fish to access spawning grounds while stream conditions were good and prior to the spring glacial runoff. This presumption is somewhat supported by the results from acoustic tagging and tracking of Skagit River adult steelhead, as reported in Pflug et al. (2013). The results of this work showed that the month that the adults were tagged had a relationship to where the fish was likely heading, in the system, to spawn. Pluge et al. 2013 found that fish tagged in February were heading into the Sauk and Suiattle subbasins and there was a large delay between steelhead tagging and their arrival to the spawning ground, indicating a long pre-spawn holding pattern (Figure 13).

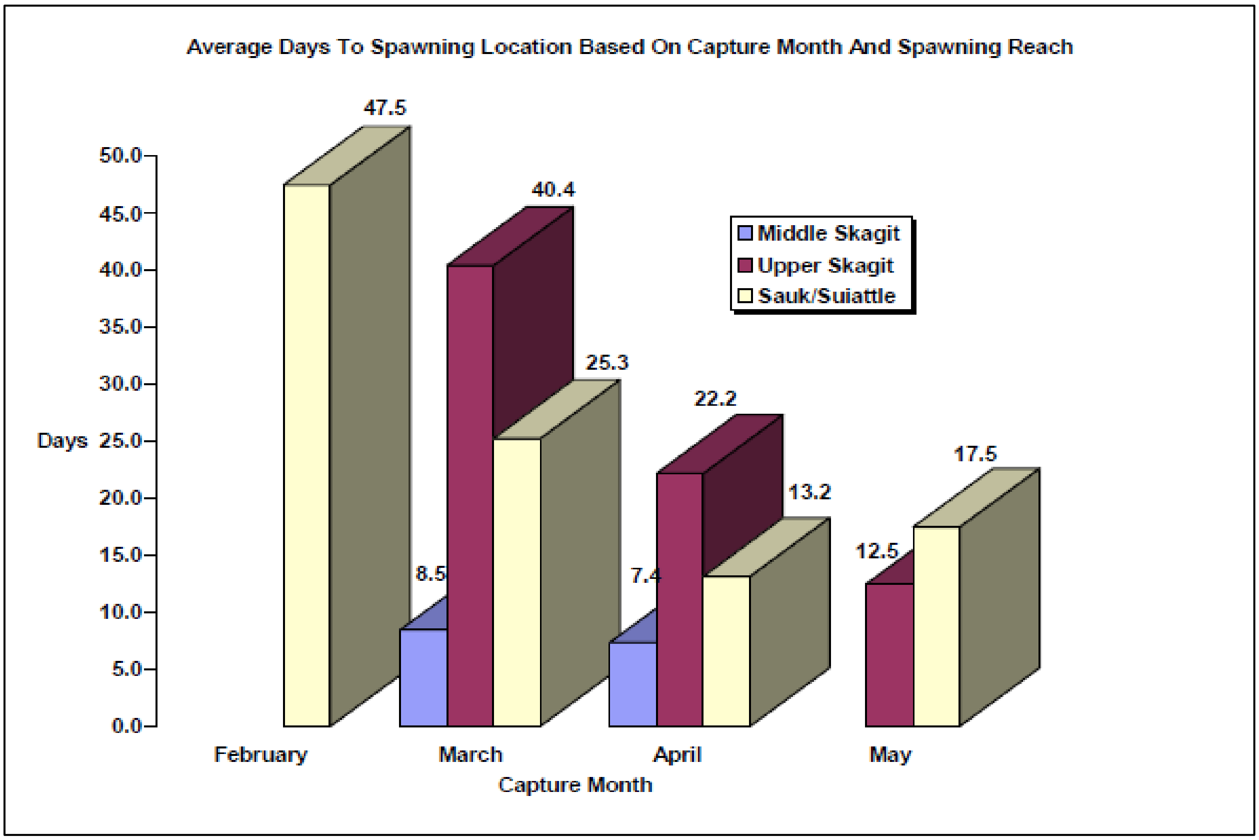


Figure 13. Average days to spawning location by natural-origin steelhead based on capture (tag) month and spawning reach (excerpted from Pflug et al. 2013; Figure 9).

Myers et al. (2015) states that much of the life history information taken early in the 1900s comes from the collection and spawning of steelhead intercepted at hatchery weirs. The U.S. Fish Commission Hatchery at Baker Lake initially collected steelhead returning to Baker Lake using gill nets. Fish were collected from March 9 to May 8, few survived to spawn, and no spawning date was given (USBF 1900). Later attempts to collect fish from Finney (also referred to as Phinney creek) and Grandy creeks in March met with limited success; based on a survey of these creeks and the Skagit River, it was concluded that much of the run entered the rivers in January (Ravenel 1901).

In 2009 and 2010, as part of an acoustic tagging project in the Skagit River, Pflug et al. (2013) noted that "During 2009 and 2010 tagging was spread over a 20-week time period spanning the return timing of natural-origin steelhead in the Skagit" (Table 7). This project is the most recent work indicating the potential breadth of the current Skagit River winter steelhead run timing in the mid and upper Skagit Basin.

Table 7. Acoustic tags deployed by month in natural-origin adult steelhead during return years 2008-2011; excerpted from Pflug et al. 2013, Table 9).

Return Year	January	February	March	April	May	Total
2008	-	-	-	10	-	10
2009	-	2	20	14	2	38
2010	1	9	36	34	2	82
2011	1	-	1	1	-	3
Total	2	11	57	59	4	133

It's important to note the information presented above, from Pflug et al. (2013), represents the Skagit River steelhead run, as sampled in the mainstem Skagit river, below the confluence with the Sauk and may not represent the entirety of the present run timing of the winter steelhead in the lower tributaries of the Skagit Basin, such as Nookachamps Creek.

The Nookachamps Creek winter steelhead DIP occurs in the Nookachamps Creek subbassin, in the lower portion of the Skagit River, near Burlington, WA (Figure 7). In contrast to much of the Skagit Basin, this lowland subbasin exhibits a rain-driven hydrology, with peak flows in December and January and low flows in August and September. Given the lowland ecology, it is thought that Nookachamps Creek only supported winter-run steelhead and that there may have been a difference in run timing between these steelhead and other steelhead returning to snow-dominated tributaries higher in the Skagit Basin (Myers et al 2015). However, the spawn-timing of the Nookachamps DIP may also have been affected by fisheries directed at early returning hatchery-origin steelhead, and thus, the spawn-timing of the Nookachamps Creek population has been altered relative to historical conditions (Hard et al. 2015). Recent surveys in Nookachamps Creek in 2015 and 2016 (Fowler and Turnbull 2016; WDFW unpublished data) have produced spawner estimates of approximately 250 steelhead (Sauk-Suiattle Indian Tribe et al. 2016).

As described above, in the Puget Sound DPS status section, the long-standing and widespread use of the Chambers creek early-winter and Skamania summer hatchery stocks in the Puget Sound have likely contributed to an overall reduction in the diversity of the DPS. Hatchery releases of steelhead in the Skagit River basin, historically, were predominately early-winter steelhead from the Chambers stock, although, there were hatchery summer steelhead released in smaller number from the 1970s-1990s (Figure 13; Pflug et al. 2013). As mentioned previously, the releases of hatchery steelhead were discontinued in the Skagit River basin in 2013.

While the overall genetic effect of the past and recent use of these hatchery stocks to the historical Skagit River DIPs is difficult to estimate, more recent work, looking at contemporary estimates of the genetic effects in the Skagit River, shows relatively low rates of genetic introgression between the early-winter hatchery steelhead releases and the natural-origin steelhead populations. Warheit (2014) estimated gene flow from returning hatchery-origin adult to natural-origin Skagit River steelhead and found that rates ranged from 2% for the Skagit and Nookachamps populations to 4% for the Sauk population. Similarly, Hard et al. (2015) concluded that the hatchery program had only a nominal effect on the diversity of Skagit River steelhead populations.

In addition to the genetic risks to diversity that the use of early-winter steelhead posed, the fisheries which targeted these early-run hatchery fish concentrated heavy harvest rates on any natural-origin fish returning in this early (November-January) time frame. NOAA (2016) noted the concern that fisheries directed at the harvest of early-returning hatchery fish may have resulted in the loss of the early-run timed component of natural origin steelhead and that, in particular, the spawn-timing of the Nookachamps DIP may have been affected by fisheries directed at early returning hatchery-origin steelhead (Hard et al. (2015).

Skagit steelhead Repeat Spawning

Scott and Gill (2008) reported that repeat spawners averaged 6% (range of 0% to 12%) of the total number of steelhead spawners in the Skagit River from the 1985-1986 spawning year through the 2004-2005 spawning year. Based on tagging and tracking studies completed, as part of a larger experiment (Pflug et al. 2013), the highest numbers of kelts observed leaving the Skagit system occurred in May, followed by June (Figure 14).

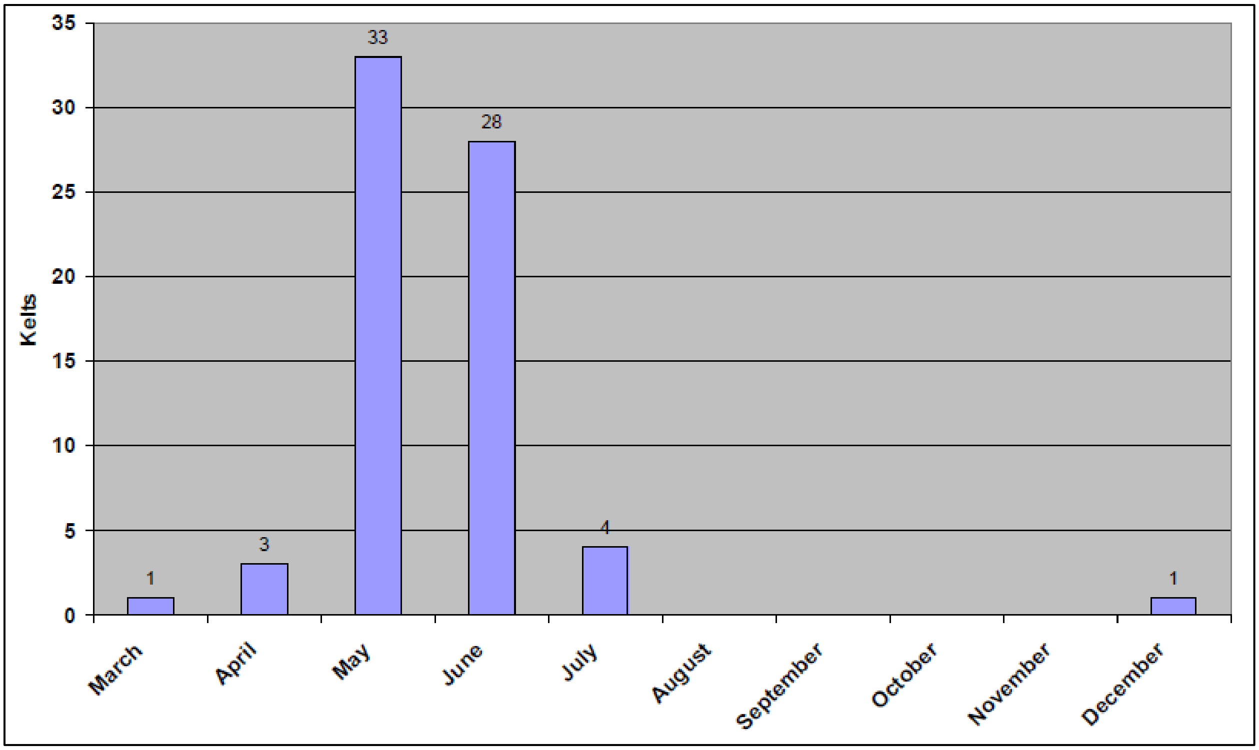


Figure 14. Marine entry-timing of Skagit River steelhead kelts—numbers observed by month (Pflug et al. 2013).

Skagit River Resident life-history

As described above, in the Puget Sound steelhead DPS-wide status section, resident *O. mykiss* have a vital role in the overall stability of the anadromous life-form of steelhead, providing productivity reservoirs that can buffer against low marine survival periods and providing added breeder abundances when the resident and anadromous forms interact reproductively, helping to increase genetic diversity in the overall *O. mykiss* population and to buffer against demographic risk at low anadromous abundances.

Within the Skagit SMU, resident *O. mykiss* are genetically indistinguishable from anadromous forms in the anadromous zone (Pflug et al. 2013). It is common for resident *O. mykiss* above long-standing barriers to be found within the anadromous zone. Juvenile *O. mykiss* are consistently collected at the downstream collection facility at Baker Lake, suggesting that these were smolts expressing anadromy from resident *O. mykiss*. Genetic work also identified genetic signature of isolated residents above impassible structures within the anadromous zone (Pflug et al. 2013).

Skagit River Steelhead Abundance and Productivity

As described above, many populations in the Puget Sound steelhead DPS have experienced long-term significant reductions in population abundances, with only minimal improvement in the recent years. Skagit River steelhead, in aggregate, while also experiencing reductions in spawning abundance, relative to the higher levels in the 1980s, have generally maintained several thousand adult spawners per year, remaining the largest natural population in the Puget Sound DPS. From 1978 to 2014, the available spawner estimates result in a long-term average of 6,956 fish (Figure 15). Looking at the spawner abundance in increments of years, the most recent ten-year average (5,821; 2005-2014) was below this long-term average, as were the most recent three five-year incremental averages: 5,582 from 2000-2004; 4,954 from 2005-2009; and 6,688 from 2010-2014 (Figure 15). There have been recent increases in spawner abundance, from the low of 2,502 in 2009 up to a recent high of 9,084 in 2014 (Figure 15). However, based on the available annual, total spawning abundance estimates provided in the Skagit RMP during 1978-2014, there is not a significant trend (R^2=0.087; P=0.074) in the overall abundance of Skagit River steelhead, over this period. The PSSTRT has developed preliminary viability abundance levels (criteria) for the Skagit DIPs. These are: 2,514 for the Baker River summer run and winter run; 616 for Nookachamps Creek winter run; 32,388 for the Skagit River summer run and winter run; and 11,615 for the Sauk River summer run and winter run (Hard et al. 2015). However, the PSSTRT noted, in referencing the development of these interim criteria, Puget Sound-wide, that “under any potential scenario, it is likely that considerable time and effort will be required to reach the viability criteria” (Hard et al. 2015).

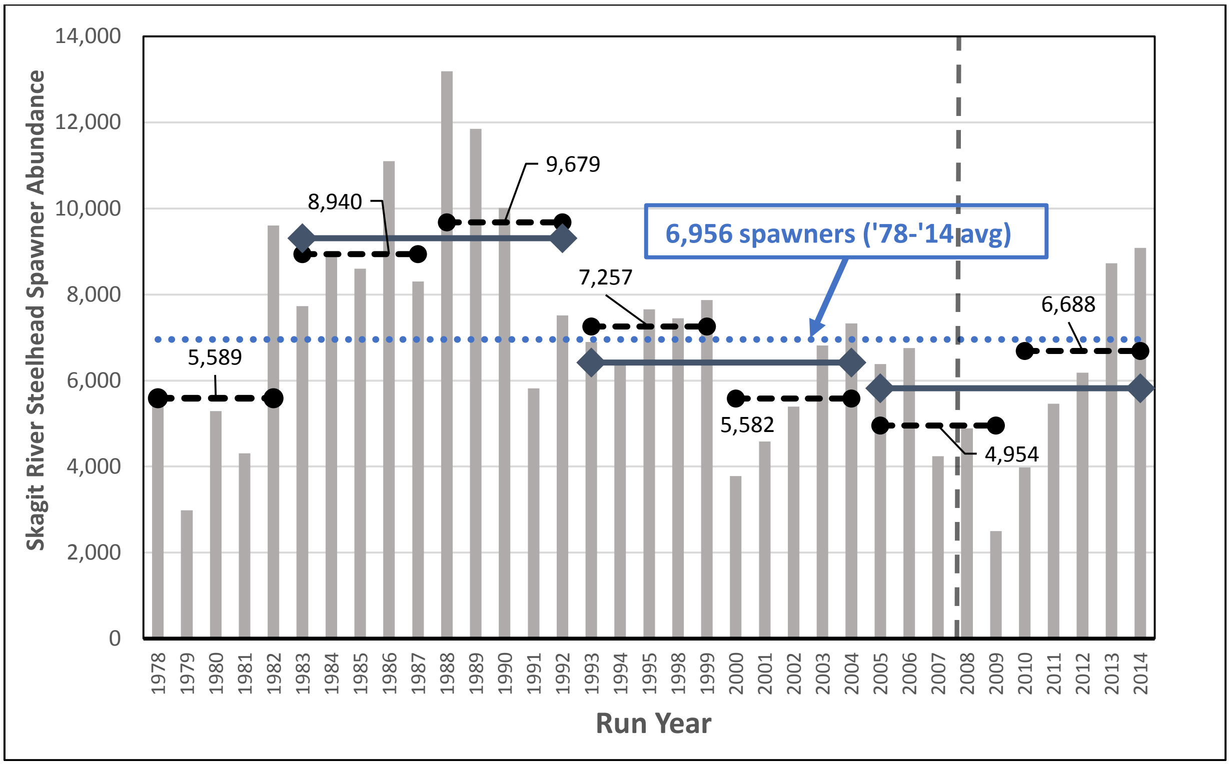


Figure 15. Skagit natural-origin steelhead spawner abundance (gray vertical bars) for the 1978-2014 run years; incremental average spawning abundance in 5-year (black, dashed horizontal lines with round ends) and 10-year (dark-gray, solid horizontal lines with diamond ends) increments, backward from most recent. Vertical dashed dark-gray line (2007-08) represents the ESA-listing of the Puget Sound steelhead

DPS. Source data: Appendices A-1 and A-2; *Sauk-Suiattle Indian Tribe et al. 2016*. Note that abundance estimates for 1996 and 1997 are not available.

The productivity of the four Skagit River steelhead DIPs, combined, has been variable over the available historical time frame (1978-2007), with generally fewer positive (>1.0) recruitment rates and more negative rates (< 1.0) in the years since 1986. (Figure 16). The available time series of recruitment (Recruits/spawner) does show a negative trend over this period (y = -0.0368x + 1.8607), however, this relationship is not strongly correlated (R^2=0.25; P=0.014).

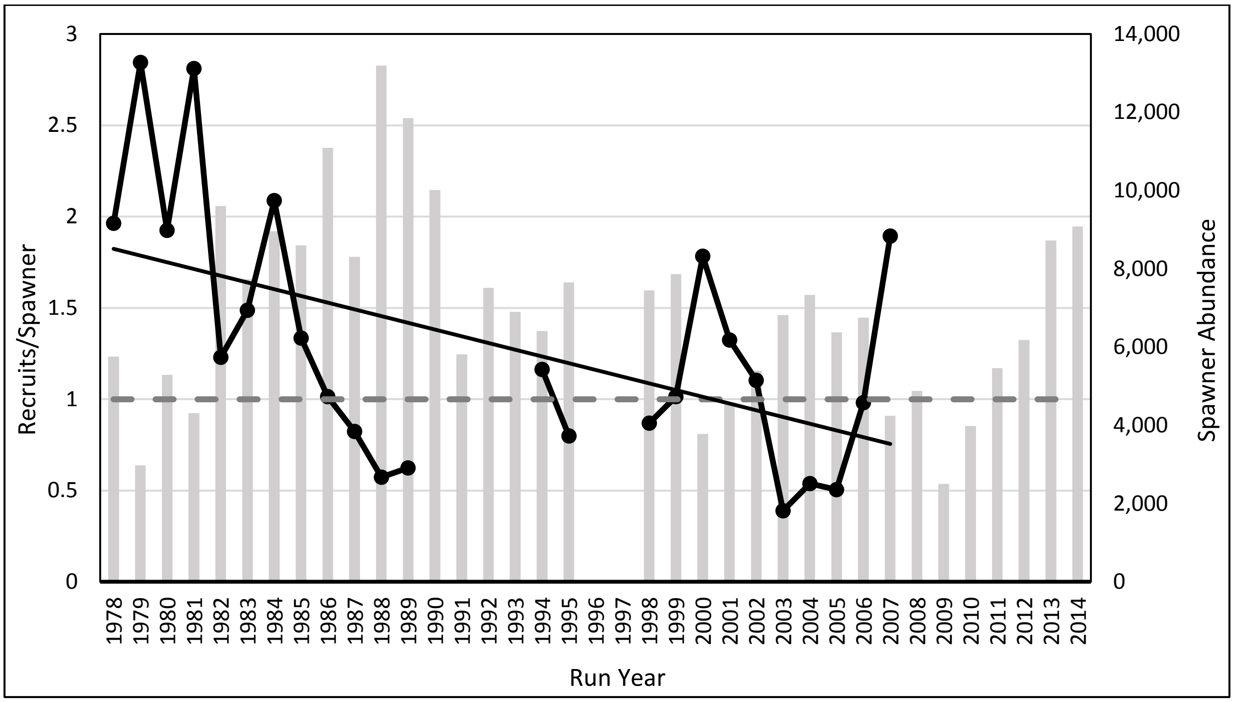


Figure 16. Skagit River steelhead recruits per spawner estimates (black, solid line and points) over historical spawner abundance estimates (gray vertical bars). Black trend line for recruitment rate over time (using only years with estimates [n=24]). The dashed, horizontal dark-gray line indicates replacement (1 recruit per spawner). *Recruits/spawner trendline is solid black line. Source data: Appendices A-1 and A-2;* Sauk-Suiattle Indian Tribe et al. 2016.

Within the period of 1977-2016, several estimates of the growth rate for the four Skagit River steelhead DIPs combined have been calculated (Sauk-Suiattle Indian Tribe et al. 2016) (Table 8). The majority of the time series have produced point estimates of growth rates near but slightly below 1.0, indicating an overall slight decreasing population growth-rate trend. However, the majority of these year range-specific growth rate estimates (excluding 1985-2009; Ford et al. 2011) have confidence intervals that encompass 1.0 (Table 8). The most recent of these estimates (Cram et al., in prep) has a preliminary point estimate of slightly over 1.0 (1.018, Table 8) but also has a comparatively broad confidence interval. Taken together, and in consideration of the multi-decadal timeframe of these periods, it appears that the overall, aggregated Skagit River steelhead population has been in a long period of decreasing-to-stable population growth, with potential recent increases in growth rate.

Table 8. Estimates of population growth rate λ (lambda) (95% CI) for the Skagit River natural-origin steelhead across different year ranges, over the 1977-2016 period (Sauk-Suiattle Indian Tribe et al. 2016). Here, the Skagit Management Unit represents all of the four Skagit River DIPs, combined.

Management Unit	Time Series	λ	95% CI	Source
Skagit River	1977-2011	0.997	0.921-1.079	Hard et al. 2015
Skagit River	1978-2013	0.987	0.913-1.053	Cram 2015
Skagit River	1985-2009	0.969	0.954-0.985	Ford et al. 2011
Skagit River	1995-2009	0.978	0.931-1.029	Ford et al. 2011
Skagit River	1995-2011	0.966	0.494-1.891	Hard et al. 2015
Skagit River	2004-2016	1.018	0.588-1.987	Cram et al. (in prep)

2.2.1.2 Limiting factors- Puget Sound Steelhead DPS

NMFS, in its listing document and designation of critical habitat (77 FR 26722, May 11, 2007; 76 FR 1392, January 10, 2011), noted that the factors for decline for Puget Sound steelhead also persist as limiting factors. Information reviewed by NWFSC 2015 did not identify any new key emergent habitat concerns for the Puget Sound steelhead DPS since the 2011 status review. Following is a list of the limiting factors on Puget Sound steelhead:

- 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.
- 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, urbanization 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.
- Widespread declines in adult abundance (total run size), despite significant reductions in harvest over the last 25 years. Harvest is not as a significant limiting factor for Puget Sound steelhead due to limited fisheries.
- Threats to diversity posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania) inconsistent with natural-origin stock diversity throughout the DPS. However, the risk to the species' persistence that may be attributable to hatchery-related effects has decreased since the last status review, based on hatchery risk reduction measures that have been implemented, and new scientific information regarding genetic effects noted

above (NWFSC 2015). Improvements in hatchery operations associated with on-going ESA review and determination processes are expected to further reduce hatchery-related risks. Further, hatchery releases of Puget Sound steelhead have declined.
- Declining diversity in the Puget Sound DPS, including the uncertain, but likely weak, status of summer run fish in the DPS.

In addition to the limiting factors, there are potential negative impacts to Puget Sound steelhead due to limitations in existing regulatory mechanisms, including a lack of documentation or analysis of the effectiveness of land-use regulatory mechanisms and land-use management plans, lack of reporting and enforcement for some regulatory programs, and certain Federal, state, and local land and water use decisions made without the benefit of ESA review. State and local decisions have no Federal nexus to trigger the ESA Section 7 consultation requirement, and thus certain permitting actions could result in species take and/or adverse habitat effects.

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[9]; 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; NMFS 2005) evaluated the quantity and quality of habitat features (for example, spawning gravels, wood and water condition, side channels), the relationship of the area compared to other areas within the species' range, and the significance to the species of the population occupying that area. Thus, even a location that has poor quality 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 to the population it served (e.g., a population at the extreme end of geographic distribution), or the fact that it serves another important role (e.g., obligate area for migration to upstream spawning areas).

2.2.2.1 Puget Sound Steelhead Critical Habitat

Critical habitat for the Puget Sound Steelhead DPS was proposed for designation on January 14,

[9] 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" (NMFS 2005).

2013 (78 Fed. Reg. 2726). 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. NMFS 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 of 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.

There are 72 HUC5 watersheds occupied by Puget Sound steelhead within the range of the Puget Sound 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 sub-adult life phases before returning to spawn in their natal streams (NMFS 2012a). NMFS could not identify "specific areas" within the marine and ocean range that meet the definition of critical habitat. Instead, NMFS considered the adjacent marine areas in Puget Sound when designating steelhead freshwater and estuarine critical habitat. Critical habitat information 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.

Physical or biological factors (PBFs) 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 activities affecting PBFs 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 2006), and consultations on Washington State Water Quality Standards (NMFS 2008b), the National Flood Insurance Program (NMFS 2008c), the Washington State Department of Transportation Preservation, Improvement and Maintenance Activities (NMFS 2013), and the Elwha River Fish Restoration Plan (Ward et al. 2008). In 2012, the Puget Sound Action Plan was developed 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 of these activities on habitat, including primarily critical habitat, are also addressed in Section 2.3.1 and 2.4.1.

2.2.2.1.1 Critical Habitat in the Skagit River Basin

Within the Puget Sound steelhead DPS, the Skagit River system contains designated critical habitat for steelhead. Under the Proposed Action, fishing activities will occur in the mainstem Skagit River (upper and Lower), as well as sections of the Sauk and Suiattle Rivers, and Marine Area 8.1. There are no fishing activities proposed in tributary areas of the Skagit Basin, other than those in the mainstem Sauk and Suiattle Rivers (technically tributaries of the Skagit River). Areas of designated critical habitat are contained within each of these rivers (Figure 17); NMFS 2016, 81 FR 9251). No critical habitat for Puget Sound steelhead was designated in the marine waters of Area 8.1. As Skagit River steelhead are part of the Puget Sound steelhead DPS, the major management activities affecting critical habitat, and the criteria for determining critical habitat are the same as outlined for the DPS, in Section 2.2.2.1, above.

Below is a description of each of the subbasins within the Skagit River basin. Information is from NMFS (2015) - *Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead, FINAL Biological Report*

Upper Skagit Subbasin (HUC4# 17110005)
The Upper Skagit subbasin is located in northern Puget Sound and contained in Skagit and Whatcom counties, Washington. The subbasin contains five watersheds occupied by the Puget Sound steelhead DPS and these watersheds encompass approximately 999 mi2 (2,587 km2). Fish distribution and habitat use data identify approximately 170 miles (274 km) of occupied riverine habitat in the watersheds (WDFW, 2015; NWIFC, 2011). Analyses by the PSSTRT (Myers et al., 2015) have identified one ecological zone/MPG (Northern Cascades) containing two winter-run populations (Baker River and Skagit River) in this subbasin. After reviewing the best available scientific data for this subbasin, the CHART concluded that all of the occupied areas in this subbasin contain one or more PCEs for this DPS.

Sauk Subbasin (HUC4# 17110006)
The Sauk subbasin is located in northern Puget Sound and contained in Skagit and Snohomish counties, Washington. The subbasin contains four watersheds occupied by the Puget Sound steelhead DPS and these watersheds encompass approximately 741 mi2 (1,919 km2). Fish distribution and habitat use data from identify approximately 154 miles (248 km) of occupied riverine habitat in the watersheds (WDFW, 2015; NWIFC, 2011). Analyses by the PSSTRT (Myers et al., 2015) have identified one ecological zone/MPG (Northern Cascades) containing one winter-run population (Sauk River) in this subbasin. After reviewing the best available

scientific data for this subbasin, the CHART concluded that all of the occupied areas in this subbasin contain one or more PCEs for this DPS.

Lower Skagit Subbasin (HUC4# 17110007)

The Lower Skagit subbasin is located in northern Puget Sound and contained in Skagit and Snohomish counties, Washington. The subbasin contains two watersheds occupied by the Puget Sound steelhead DPS and these watersheds encompass approximately 447 mi2 (1,158 km2). Fish distribution and habitat use data identify approximately 210 miles (338 km) of occupied riverine/estuarine habitat in the watersheds (WDFW 2015; NWIFC 2011). Analyses by the PSSTRT (Myers et al., 2015) have identified one ecological zone/MPG (Northern Cascades) containing four winter-run populations (Baker River, Nookachamps Creek, Sauk River, and Skagit River) in this subbasin. After reviewing the best available scientific data for this subbasin, the CHART concluded that all of the occupied areas in this subbasin contain one or more PCEs for this DPS.

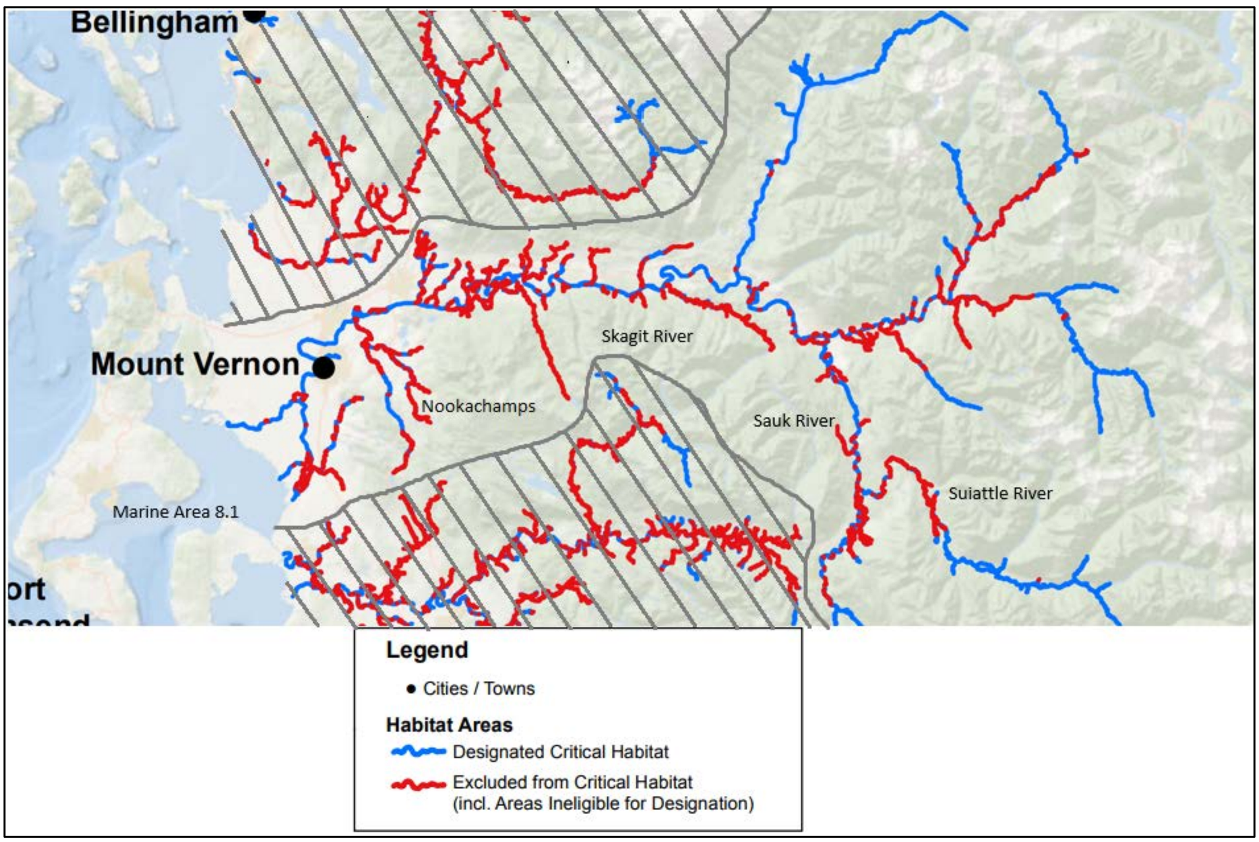


Figure 17. Map of steelhead Designated Critical Habitat in the Skagit River Basin—Skagit River, Nookachamps Creek, Sauk River, and Suiattle River (adapted from NMFS 2016b).

2.3 Action Area

“Action area” means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). For the purposes of this opinion, the Action area includes all of the Skagit River basin (Figure 18) accessible to steelhead as well as the proximate marine area (8.1) of Puget Sound (Skagit Bay and Saratoga Passage, Figure 19). This area is selected because it is the extent of the potential fisheries managed under the Skagit RMP and the extent of the effects of fisheries to Skagit River steelhead.

Within the Skagit River, the Action area includes all mainstem and tributary waters utilized by Skagit River steelhead for migration and emigration of adult and juvenile steelhead as well as holding, spawning, and rearing areas. Included in the freshwater portion of the Action area are the Skagit River tributaries: the Upper Skagit River subbasin tributaries, including but not limited to the Cascade River; the Sauk River subbasin and tributaries, including but not limited to the Suiattle River; the middle and lower Skagit River and its tributaries, including but not limited to Finney Creek and Nookachamps Creek. The areas above hydro-impoundments on the Upper Skagit and Baker River (Figure 18) are not included in the Action Area.

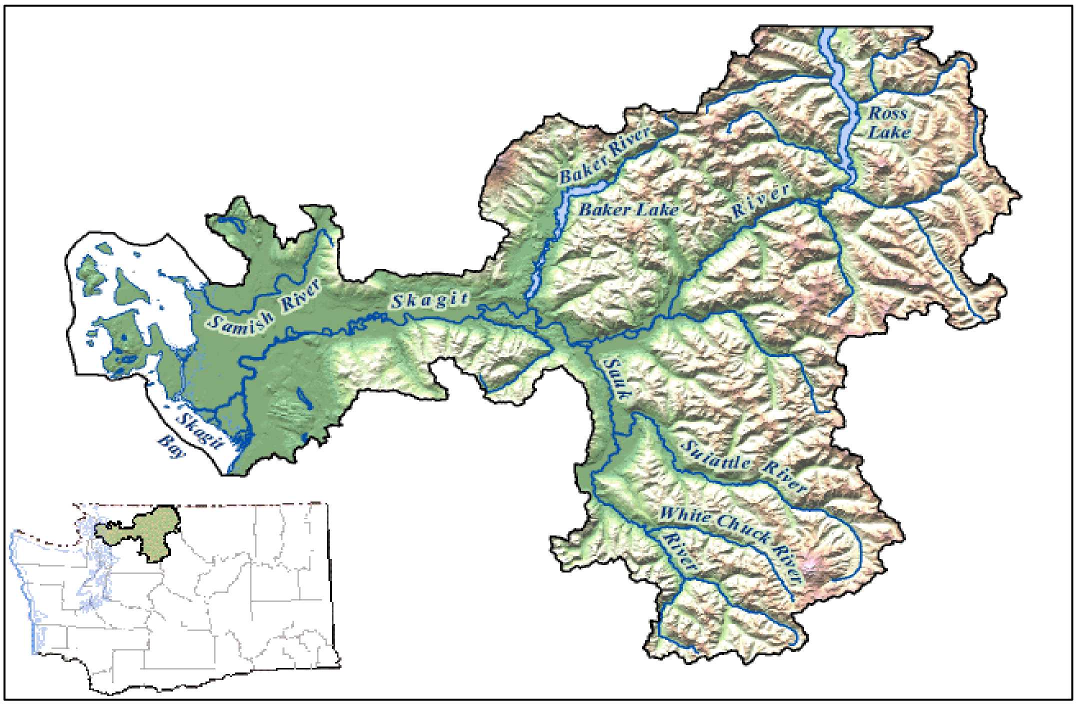


Figure 18. Map of the Skagit River basin, including the Sauk River (WDFW).

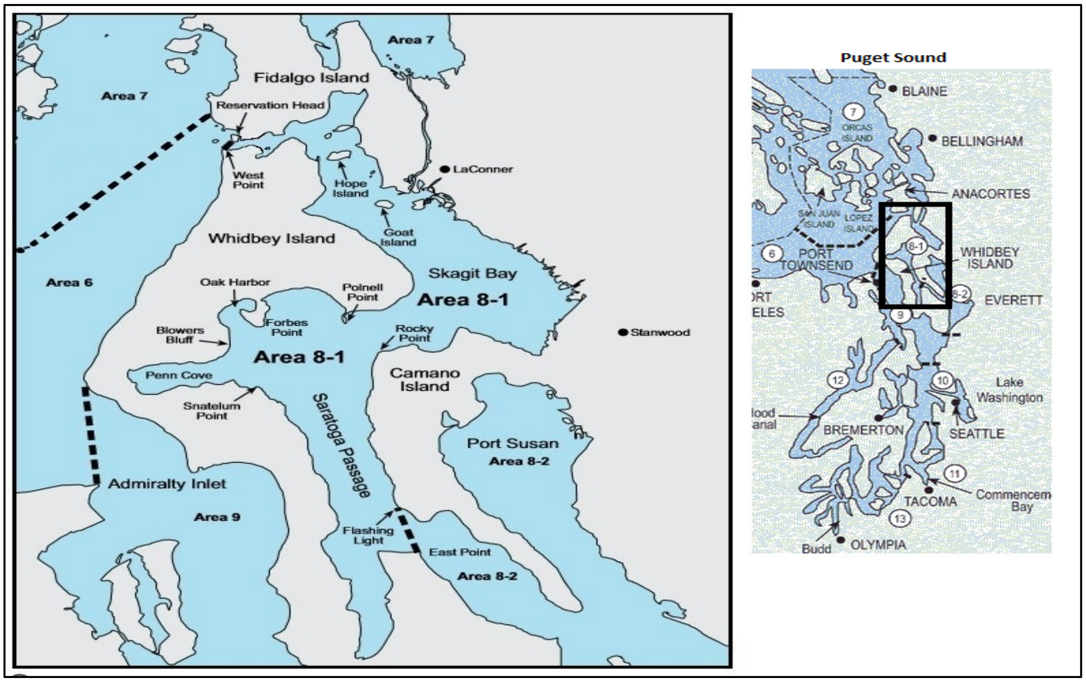


Figure 19. Marine catch area 8-1—Skagit Bay and Saratoga Passage (WDFW).

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02). The environmental baseline for the species affected by the proposed actions includes the effects of many activities that occur across the broad expanse of the action area considered in this opinion. The status of the species described in Section 2.2 of the biological opinion is a consequence of those effects.

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

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

2.4.1 Puget Sound Steelhead

NMFS has convened recovery planning efforts across the Pacific Northwest to identify what actions are needed to recover listed salmon and steelhead. In 2014, a Puget Sound Steelhead Recovery Team was established and recovery planning for Puget Sound steelhead is underway. NMFS anticipates completing a draft Puget Sound steelhead recovery plan by the end of 2018 with a final plan completed by the end of 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*. NMFS expects that both Federal and State steelhead recovery and management efforts will provide new tools and data and technical analyses to 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. Future consultations will incorporate information from the recovery planning process as it becomes available.

In this section we will describe the categories of past and present activities in the Action Area that have impacted the Puget Sound steelhead DPS and contributed to its status, as described above in Section 2.2.1.

Harvest

Harvest can affect the overall abundance and the productivity of steelhead populations. 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[10] at over 60% (Figure 20). Harvest rates on natural-origin steelhead varied widely among watersheds but have declined

[10] Green River and Nisqually River populations.

since the 1970s and 1980s and are now stable and generally less than 5%, which is all incidental take (NWFSC 2015). Current incidental take rates are low enough that they are unlikely to reduce spawner abundance for steelhead populations in Puget Sound (NWFSC 2015).

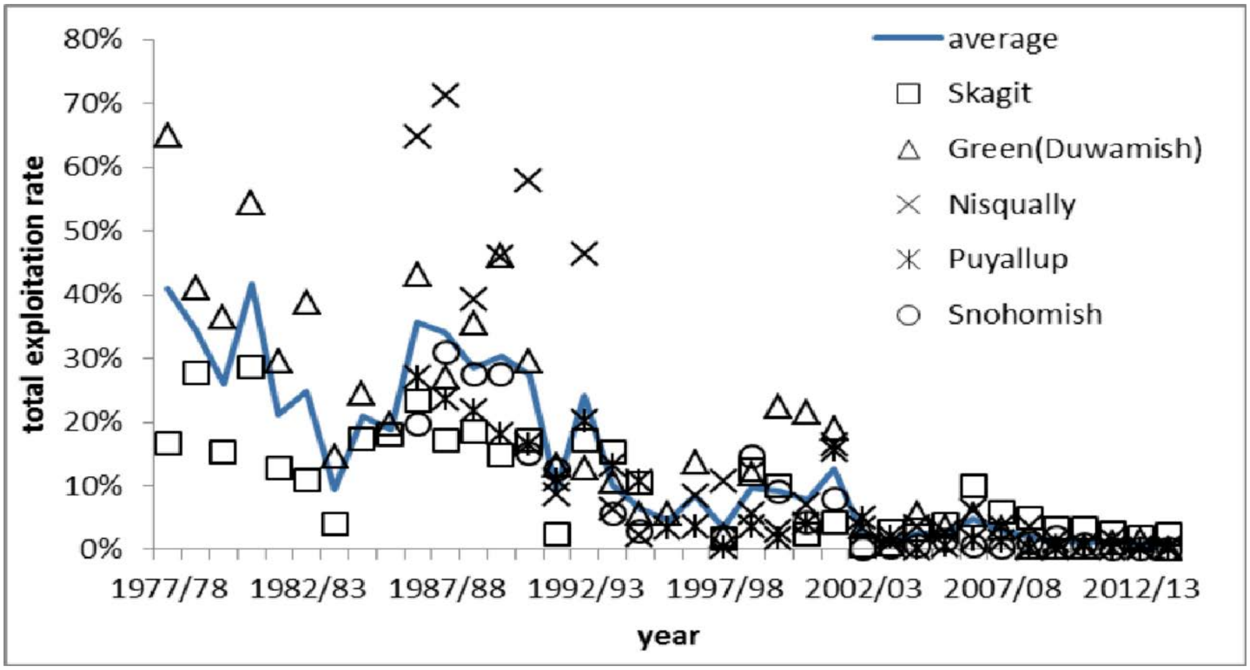


Figure 20. Total harvest rates on several natural-origin steelhead populations in Puget Sound (WDFW 2010 in NWFSC 2015).

Steelhead are caught in marine areas and in river systems throughout Puget Sound by fisheries targeting salmon species, as well as hatchery steelhead, in some rivers. NMFS observed that previous harvest management practices likely contributed to the historical decline of Puget Sound steelhead, but concluded in the Federal Register Notice for the listing determination (72 FR 26732, May 11, 2007) that the elimination of the direct harvest of natural-origin 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 reduce spawner abundance of most Puget Sound steelhead populations (NWFSC 2015).

Since the listing of the Puget Sound steelhead in 2007, incidental take of steelhead in fisheries for salmon and unlisted steelhead has been evaluated through a series of 4(d) Rule determinations and/or ESA Section 7 consultations, detailed as follows:

The application of the 4(d) Rule protective regulation and limits to Puget Sound steelhead, in September of 2008, occurred in the middle of the annually-planned 2008-09 Puget Sound fishery season, when there were ongoing salmon and steelhead fisheries. NMFS had thoroughly reviewed the past, recent, and existing (2008-09) Puget Sound Indian Tribes (PSIT) and Washington Department of Fish and Wildlife (WDFW) harvest regulations, on fisheries affecting Puget Sound steelhead, and determined that the regulations that were in place for these fisheries were sufficiently protective for Puget Sound steelhead. Based on this review, NMFS delayed the application of the protective regulations on fishery activities for the remainder of the ongoing fishery season (through June 1, 2009; 73 Fed. Reg. 55451, September 25, 2008)

Fishery effects to Puget Sound steelhead for the 2009 fishery year were evaluated in NMFS' biological opinion on the 2008 Pacific Salmon Treaty Agreement (NMFS 2008). For the 2010 Puget Sound fishery-year, NMFS completed a series of two Section 7 consultations on the impacts of programs administered by the Bureau of Indian Affairs (BIA) that supported Puget Sound tribal salmon fisheries and salmon fishing activities authorized by the U.S. Fish and Wildlife Service (USFWS) (NMFS 2010a and NMFS 2010b).

A four-year RMP, covering the effects of Puget Sound salmon and steelhead fisheries, for fishery years 2011-2014, was submitted by the WDFW and PSIT and approved in 2011(NMFS 2011). The Federal actions consulted on in the associated biological opinion included NMFS' 4(d) determinations, BIA program oversight and USFWS Hood Canal Salmon Plan related actions. For the years since 2014, NMFS has consulted under section 7 of the ESA on single year actions by the BIA, USFWS, and NMFS similar to those described above. This series of consultations considered the effects of Puget Sound salmon fisheries on listed species (including Puget Sound steelhead) based on the general management framework described in the 2011-2014 RMP as amended for stock specific management changes. NMFS issued one-year biological opinions for the 2014, 2015, 2016, and 2017 fishery cycles (May 1, 2014 through April 30, 2018) that considered actions based on this framework including similar actions by the BIA and USFWS (NMFS 2014a, NMFS 2015, NMFS 2016a, and NMFS 2017a).

Puget Sound—Marine Area Fisheries

In marine areas, the majority of fisheries target salmonid species other than steelhead. However, Puget Sound treaty marine commercial and ceremonial and subsistence (C&S) fisheries do encounter steelhead. An annual average of 116 (range 21-586) summer and winter steelhead were landed incidentally in treaty marine commercial and C&S, from all Puget Sound marine areas, combined, during the 2003/2004 to 2013/2014 time period (Table 9) (Sauk-Suiattle Indian Tribe et al. 2016). Not all tribal catch is sampled for marks so these estimates represent catch of ESA-listed steelhead, unlisted hatchery steelhead, and hatchery and natural-origin fish from Canada (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) (Jording 2010). Over the most recent eight-year period from 2009 to 2016, 32 steelhead were encountered in 2,959 net sets estimated at 4 steelhead per year (Henry 2017). 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 2015) 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 ESA-listed steelhead, unlisted hatchery steelhead, and hatchery and natural-origin fish from Canada.

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 100 (range 22 – 213) 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 2015/2016-time period (Kraig 2017). The catch of steelhead in recreational fisheries has therefore declined by 49.5% in recent years. There is some additional mortality associated with the catch-and-release of unmarked steelhead in the recreational fishery. However, the mortality rate associated with catch-and-release is 10%, so the additional total mortality is assumed to be low (NMFS 2017a).

Table 9. Annual Puget Sound marine area catches of steelhead from the 2003-04 season to the 2013 /14 season. Treaty harvest represents mixed natural- and hatchery-origin steelhead. Non-treaty Recreational harvest is hatchery-origin only (Sauk-Suiattle Indian Tribe et al. 2016).

Year	**Puget Sound Marine Catch of Steelhead**[11]						
	Treaty commercial & C&S					**Non-Treaty Recreational** (Hatchery steelhead)	**Total**
	Strait of Juan de Fuca	**San Juan Is. Point Roberts**	**Central Sound**	**South Sound**	**Total Treaty Comm. & C&S**		
2003-04	58	1	0	5	64	160	**224**
2004-05	25	7	0	0	32	260	**292**
2005-06	128	2	28	0	158	102	**260**
2006-07	80	4	0	0	84	114	**198**
2007-08	69	21	0	0	90	163	**253**
2008-09	14	94	0	0	108	72	**180**
2009-10	136	450	0	0	586	110	**696**
2010-11	11	19	0	0	30	169	**199**
2011-12	22	20	0	0	42	231	**273**
2012-13	11	48	0	0	59	157	**216**
2013-14	11	10	0	0	21	-	**-**
Mean (St Error)	**51 (14.2)**	**62 (39.7)**	**3 (2.5)**	**<1 (0.5)**	**116 (48.6)**	**154 (18)**	**279 (47.7)**

[11] Steelhead caught in Puget Sound marine areas are mixed origin (hatchery and natural) and may be ESA-listed natural and hatchery-origin stocks or non-listed natural and hatchery-origin fish of Puget Sound or Canadian origin (Sauk-Suiattle Indian Tribe et al. 2016).

Puget Sound—Freshwater Fisheries

Currently, 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 currently prohibits the retention of natural-origin steelhead (those without a clipped adipose fin) in recreational fisheries. 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 rivers 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 steelhead spawning period (winter-spring), and are located primarily in lower and mid-mainstem river reaches, where natural-origin summer steelhead (if present) are believed not to hold for an extended period (PSIT and WDFW 2010). Currently, some natural-origin late winter and summer run steelhead, including kelts (repeat spawners), are intercepted in Skagit River salmon and steelhead fisheries. A small number of natural-origin summer steelhead are also encountered in Nooksack River spring Chinook salmon fisheries.

Currently, NMFS is not able to estimate the rate of total bycatch (number of listed steelhead incidentally caught compared with estimated listed steelhead abundance) for every Puget Sound population, because the data needed to produce full run reconstruction (escapement and harvest) in order to assess the impact of harvest rates are currently insufficient for most Puget Sound steelhead DIPs. Sufficient information is available for five Puget Sound Rivers, representing a large portion of roughly of the total steelhead DPS abundance. Based on the available data, NMFS has calculated that the incidental take of listed steelhead averaged 4.2% of steelhead abundance, annually, in Puget Sound fisheries during the 2001/2002 to 2006/2007 time period (NMFS 2017a) (Table 10). Average incidental take rates for natural-origin steelhead have been 1.6% in Puget Sound fisheries during the 2007/2008 to 2015/2016 time period (Table 10). These estimates include sources of non-landed mortality such as hooking mortality and net dropout, 10% and 2% respectively. Overall, the average incidental take rate for these five indicator populations declined by 62% in recent years (i.e., 4.2% to 1.6% harvest rate = 61.9% decline). Incidental take rates on natural-origin Skagit River steelhead have averaged 3.1% and have been under 3.0% since 2012 (Table 10).

Table 10. Tribal and non-tribal terminal harvest rate (HR) percentages on natural-origin steelhead for a subset of Puget Sound steelhead populations for which catch and run size information are available. (NMFS 2017a).

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 2001-07	**4.3**	**2.6**	**6.4**	**4.3**	**3.3**
Total Avg HR	**4.2%** total average harvest rate across these 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	1.25	1.00	1.05	0.54	0.89
2015-16	1.12	0.09	0.92	0.06	0.2
Avg HRs 2008-16	**3.1**	**1.1**	**1.5**	**0.4**	**1.8**
Total Avg HR	**1.6%** total average harvest rate across these populations from 2007-08 to 2015-16				
Total average HR 2001-02 to 2015-16	**2.88**				

[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.

In the period preceding the years discussed above (2002-2016), estimated harvest rates on Skagit River natural-origin steelhead were generally much higher than the more recent years. For the available reconstructed Skagit River steelhead runs between 1985 and 2001, the harvest rate averaged 13.7%, with a high in 1987 of 24.6% and a low in 1998 of 1.6% (Figure 21). As mentioned above, NMFS concluded in the final steelhead listing determination (72 Fed. Reg. 26722) that previous harvest management practices likely contributed to the historical decline of Puget Sound steelhead, but that the elimination of the directed harvest of natural-origin 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 that the harvest impacts to natural-origin steelhead remain low, and that those rates are not likely to substantially affect steelhead spawner abundance in the DPS (NWFSC 2015).

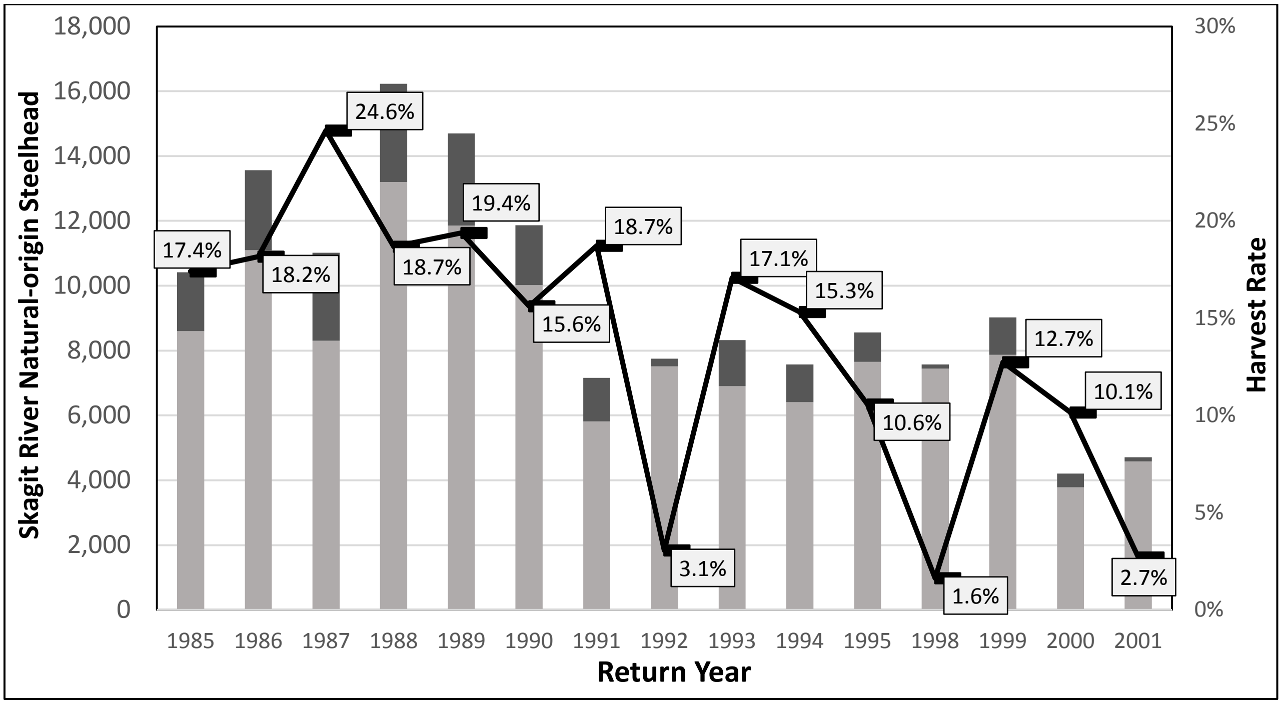


Figure 21. Skagit River steelhead estimated total natural-origin steelhead spawning escapement (light gray), total estimated natural-origin steelhead harvested (charcoal), and annual harvest rates (black markers and line) from 1985-2001. Spawner abundance estimates for run years 1996 and 1997 are not available. Source: Sauk-Suiattle Indian Tribe et al. 2016 (Appendix- tables A-1 and A-2).

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.

There are currently 13 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 from these 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 have 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 functioned to rebuild native stock winter-run steelhead abundances in the Dewatto, Duckabush, and South Fork Skokomish river watersheds. That program has been terminated with the last adult fish produced returning in 2019. 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 genetically 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. One new steelhead program has been proposed for the Puget Sound DPS. The Fish Restoration Facility winter-run steelhead program propagates winter-run steelhead native to the Green River to mitigate for lost natural-origin steelhead abundance and harvest levels associated with the placement and operation of Howard Hanson Dam (Jones 2015).

Five other hatchery programs in the Puget Sound region produce early winter-run steelhead that are not considered part of the Puget Sound Steelhead DPS: Dungeness River Hatchery, Kendall Creek Hatchery, Whitehorse Ponds, Snohomish/Skykomish River (Wallace River Hatchery and Reiter Ponds Hatchery), and Tokul Creek Hatchery. These five programs have been authorized by NMFS under ESA 4(d) rule, Limit 6 for effects on ESA-listed steelhead and Chinook salmon (NMFS 2016c, 2016d). As described above in Section 2.2.1, Status of the Listed Species, a sixth early winter-run steelhead program, in the Skagit River was discontinued, with the last juveniles release taking place in the spring of 2013 and adults from this release returning in the winter of 2014-15.

Three other harvest augmentation programs propagate non-listed early summer-run steelhead derived from Columbia River, Skamania stock. These summer-run steelhead programs have yet to receive ESA approval from NMFS. The early winter-run steelhead and early summer-run steelhead stocks reared and released as smolts through the eight 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 naturally spawning fish produced by the eight harvest augmentation hatchery programs may pose genetic risks to natural-origin steelhead (NMFS 2016e). However, in evaluating and approving the early winter-run steelhead programs for effects on listed fish (NMFS 2016d) and based on analyses of genetic data provided by WDFW (Warheit 2014), NMFS determined that gene flow levels for the five early-winter steelhead programs were very low and unlikely to pose substantial genetic diversity reduction risks to natural-origin winter-run steelhead populations. Of particular importance to this harvest evaluation is that early winter-run steelhead have been artificially selected to return and spawn 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. This timing difference, in addition to other factors, including hatchery risk reduction management measures that reduce natural spawning and natural spawning success by early winter-run steelhead act to reduce gene flow and associated genetic risks to natural-origin steelhead.

On April 15, 2016, NMFS announced the release of a final Environmental Impact Statement (FEIS; NMFS 2016e) and signed a Record of Decision (ROD) evaluating the five early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. The FEIS and 4(d) assessment reviewed five Hatchery and Genetic Management Plans for early winter steelhead hatchery programs submitted by the co-managers for review and approval under section 4(d) of the ESA. NMFS subsequently approved the programs as consistent with ESA requirements (Turner 2016a, Turner 2016b).

The PSSTRT concluded that production of hatchery fish of both run types—winter run and summer run—has posed considerable risk to diversity in natural steelhead in the Puget Sound steelhead DPS (NWFSC 2015). Because of the origin and aspects of the propagation history of these fish in Puget Sound, the PSSTRT considered continued hatchery production of steelhead a major threat to the diversity VSP component for the DPS. Winter-run fish produced in hatcheries across the DPS are derived from the Chambers Creek stock in southern Puget Sound, which has been selected repeatedly for early spawn timing for decades, a trait known to be heritable in salmonids (the natural population is now extinct); summer-run hatchery fish are derived from the Skamania River stock in the lower Columbia River Basin (i.e., out-of-DPS origin) (NWFSC 2015).

As described in Section 2.2.1.2, NWFSC (2015) 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 steelhead annually (NMFS 2014b) to about 1,504,750 steelhead annually (Appendix A in NMFS 2016c). Hatchery programs propagating unlisted early winter steelhead account for the majority of hatchery-origin steelhead smolt releases (531,600) for a total of 841,600 unlisted smolts released annually (including 310,000 summer steelhead) in Puget Sound (Appendix A in NMFS 2016c).

As described above, Skagit basin releases of hatchery steelhead were discontinued in 2013 and the returning adults returned in the 2014-15 winter season. The Skagit River basin has had hatchery produced fish releases since the early 20th Century, with early collections of eggs from native runs from the Baker River, Day Creek, Grandy Creek, Illabot Creek, and Finney Creek during the early 1900s (Myers et al. 2015). Initial hatchery releases were primarily smaller fry and subyearling fish. These releases had varying degrees of success, although in the absence of marking hatchery-reared fish, it is difficult to estimate return rates. Work by Pautzke and Meigs (1941) demonstrated the importance of rearing juveniles for at least 1 year prior to release (Myers et al. 2015). The vast majority of the hatchery steelhead historically released into the Skagit system have been winter hatchery steelhead. There was, however, smaller and consistent releases of hatchery summer steelhead during the second half of the 20th century, from 1971 through their discontinuation in 1998 (Figure 22).

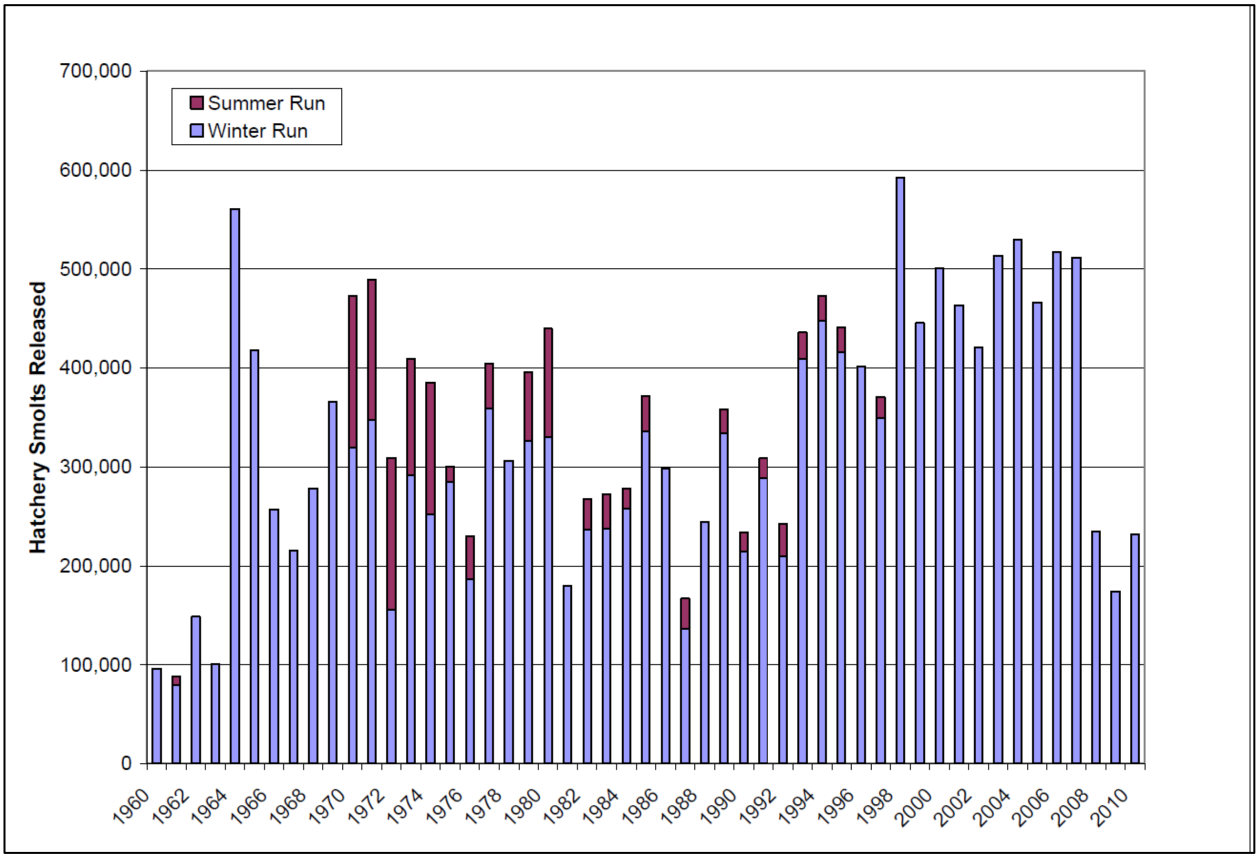


Figure 22. Mean annual release numbers for winter run and summer run hatchery smolts in the Skagit River basin, 1960-2010 (Pflug et al. 2013).

As described in Section 2.2.1, above, the fisheries which targeted these early-run hatchery fish concentrated heavy harvest rates on any natural-origin fish returning in this early (November-January) time frame. NMFS (2016c) noted the concern that fisheries directed at the harvest of early-returning hatchery fish may have resulted in the loss of the early-run timed component of natural-origin steelhead. Hard et al. (2015) found that, in particular, the spawn-timing of the Nookachamps DIP may have been affected by fisheries directed at early returning hatchery-origin steelhead.

Habitat

Puget Sound

Human activities have degraded extensive areas of salmonid spawning and rearing habitat in Puget Sound. Most devastating to the long-term viability of salmonids 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 salmonids 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 fish 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 polluted waterways, raised water temperatures, decreased large woody debris recruitment, decreased gravel recruitment, reduced river pools and spawning areas, and dredged and filled estuarine rearing areas (Bishop and Morgan 1996). Hardening of nearshore bank areas with riprap or other material has altered marine shorelines, thereby changing sediment transport patterns and reducing important juvenile habitat (SSPS 2005). The development of land for agricultural purposes has resulted in reductions in river braiding, sinuosity, and side channels through the construction of dikes, hardening of banks with riprap, and channelization of the river mainstems (EDPU 2005, SSPS 2005). Poor forest practices in upper watersheds have resulted in bank destabilization, excessive sedimentation and removal of riparian and other shade vegetation important for water quality, temperature regulation and other aspects of salmon rearing and spawning habitat (SSPS 2005, SSPS 2007). There are substantial habitat blockages by dams in the Skagit and Skokomish River basins. There were dam blockages in the Elwha until 2013, and are minor blockages, including impassable culverts, throughout the 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[12] river basins (Appendix B in NMFS 2012a). 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).

[12] 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.

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 (Appendix B in NMFS 2012a). The loss of wetland and riparian habitat has dramatically changed the hydrology of many streams, with increases in flood frequency and peak low flow 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 in the foreseeable future (72 Fed. Reg. 26722, May 11, 2007). Because of their limited distribution in upper tributaries, summer run steelhead may be at higher risk than winter run steelhead from habitat degradation in larger, more complex watersheds (Appendix B in NMFS 2012a).

Skagit River

The information below summarizes habitat in the Skagit River Basin taken from (Skagit Chapter; SSPS 2005). Critical habitat is designated for Puget Sound steelhead throughout the Skagit River basin. However, areas can be excluded from designation (Figure 8) if they: (1) are covered by an existing HCP (Habitat Conservation Plan), (2) are part of designated tribal lands, (3) have potential economic benefits that outweigh the conservation benefits of designation, or (4) are located within sections controlled by the United States military and have qualifying integrated natural resource management plans. In the Skagit River, stream sections are excluded from designation due to existing HCPs and proximity to tribal lands (Table 11).

Table 11. Habitat areas within the Skagit River basin excluded from critical habitat designation for Puget Sound Steelhead. WDNR=Washington Department of Natural Resources; WFP= Washington Forest Practices. Adapted from 81 FR 9251 (2016).

Watershed Code	Watershed Name	Area(s) excluded
1711000504	Skagit River/Gorge Lake	WFP HCP lands
1711000505	Skagit River/Diobsud Creek	WDNR and WFP HCP lands
1711000506	Cascade River	WDNR and WFP HCP lands
1711000507	Skagit River/Illabot Creek	WDNR and WFP HCP lands
1711000508	Baker River	WFP HCP lands
1711000601	Upper Sauk River	WFP HCP lands
1711000603	Lower Suiattle River	WDNR and WFP HCP lands
1711000604	Lower Sauk River	Indian lands; WDNR and WFP HCP lands
1711000701	Middle Skagit River/ Finney Creek	WDNR and WFP HCP lands
1711000702	Lower Skagit River/Nookachamps Creek	WDNR and WFP HCP lands

Most areas in the Skagit River Basin have some level of riparian degradation. In the Lower Skagit River, riparian areas have been heavily degraded. The loss of riparian trees has reduced suitable spawning habitat in some tributaries and caused increased stream temperatures. In the mainstem, a majority of the river has at least moderately impaired riparian function. In the Upper Skagit River (above the confluence with the Sauk River), riparian habitat (except Illabot Creek) has significant to moderate impairment of riparian function. In the Lower Sauk River, wood has been lost from the lower Sauk River because of heavy logging and ongoing agricultural practices. In the upper Sauk River, riparian degradation was classified as moderate. Additionally, significant wood removal has occurred in the mainstem of the Suiattle River. There has been little riparian degradation in the Cascade River.

Increases in sediment levels in freshwater habitat are largely due to mass wasting events associated with logging roads and timber harvest. A sediment budget created for the Skagit watershed has shown that sediment levels are greater than historic levels, which contributes to increased scour and fill of the channel bed. Hence, salmon and steelhead eggs are more easily and more frequently dislodged or buried, and emergence of fry can be blocked. For freshwater rearing fry, increased sediment reduces benthic invertebrate production and the value of edge habitat cover by filling the spaces between cobbles, boulders, and large woody debris.

In the lower Skagit River, it is believed that spawning habitat is very poor for incubation survival. Aerial surveys of the mainstem have shown areas of extensive fine sedimentation that were formerly graveled. The recent heavy accumulation of silt in the mainstem and mass wasting and loss of pool-riffle sections in the tributaries has caused both a loss of spawning area and poor egg-to-fry survival. In contrast, incubation habitat in the upper Skagit River is relatively good. Due to recent heavy accumulation of silt in the mainstem, mass wasting and loss of pool-riffle sections in the tributaries, it is believed that spawning habitat in the lower Sauk River is among the poorest in the system for incubation survival. This problem is compounded by accelerating glacial melt from Glacier Peak, which, since about 1991, has deposited huge amounts of silt on the spawning grounds downstream of the Suiattle River, which further reduces incubation survival. The upper Sauk River is rated impaired due to forest management activities and geology. In addition, migration of salmon through the lower Sauk River, during rearing and outmigration, further subjects them to these sediment effects. Although most streams in the Suiattle River system are in relatively pristine condition, past forest practices and geological instability have caused sediment impairment in a few areas.

As noted for the Puget Sound population as a whole, flooding greatly impacts egg to fry survival. While floods are natural events, human activities, such as increasing impervious surfaces, land clearing, and extending drainage networks associated with roads can increase the severity and frequency of floods. The flooding problem is especially severe in the lower Skagit, which absorbs the full brunt of floods, and where stresses due to flooding are amplified because of the alterations to lower basin hydrology. Additionally, hydromodification has a particularly large impact in the Skagit River watershed as the Skagit River was naturally a highly dynamic system. Historically, flooding periodically created productive new channels, for both spawning and rearing. However, high levels of hydromodification have prevented the formation of new channels.

In the lower and upper Skagit River high levels of hydromodification have reduced the area of natural banks and backwaters by about 60% and have prevented the formation of new channels. The Sauk River is still highly dynamic, but in some cases now has decreased new channel formation and limited re-opening of old channels. Parts of the mainstem, mainly between Darrington and the Suiattle River, have also experienced a loss of preferred spawning habitat due to hydromodification. In the Suiattle River, four locations in the mainstem channel are impaired due to stream bank hardening. There is no known hydromodification in the upper Cascade River.

Competition for water in the Skagit River basin is an ongoing issue. Salmon and steelhead need a continuous supply of cool, oxygen-rich water to survive and must compete with other water users for the limited supply of water in the Skagit River Basin. A 1996 Memorandum of Understanding between the Skagit tribes and several other government entities, and a 2001 instream flow rule, are intended to limit water withdrawals so that fish are protected. However, instream flow studies demonstrate that existing flows are often below optimum, and there are pressures for additional withdrawals from exempt wells, over-appropriation of water rights, and illegal withdrawals. Such withdrawals, in addition to those due to dam operations, can cause dewatering of off channel habitat, exacerbation of water quality problems, particularly temperature, increased predation, reduction of available rearing habitat, and amplification of simplified habitat.

In the delta, post settlement diking, dredging, and filling have severely limited the historic extent of delta habitat. Under present day conditions, the contiguous habitat area of the Skagit River delta that is exposed to tidal and river hydrology totals about 3,118 hectares, while the historic area equaled 11,483 hectares. This results in a seventy-three percent (73%) loss of tidal delta wetlands and channels (i.e., delta footprint). These estimates of delta habitat loss do account for gains in delta habitat caused by progradation (growth of the delta farther out into the sea) occurring between the 1860s and 1991, with a net addition of tidal delta habitat of 68 hectares over the last 50-years of this.

NMFS has completed several ESA section 7 consultations on large scale projects affecting listed species in Puget Sound and the Skagit River. Among these are the Washington State Forest Practices Habitat Conservation Plan (NMFS 2006), and consultations on Washington State Water Quality Standards (NMFS 2008b), Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013), the National Flood Insurance Program (NMFS 2008c), and the Elwha River Fish Restoration Plan (Ward et al. 2008). These documents considered the effects of the Proposed Action that would occur during 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

Habitat Conservation Plans, in addition to the watershed specific information in the Puget Sound Salmon Recovery Plan mentioned above, provide a current and comprehensive overview of baseline habitat conditions in Puget Sound and are incorporated here by reference.

2.4.2 Scientific Research

The listed Puget Sound steelhead DPS in this opinion is the subject of scientific research and monitoring activities occurring throughout the Puget Sound. 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. 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 total fishery impacts 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 12). In a separate process, NMFS also has completed the review of the state and tribal scientific research programs under ESA section 4(d) Limit 7. Table 12 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A) for the listed Puget Sound steelhead.

Table 12. Annual take allotments for research on listed Puget Sound Steelhead, in general, and Skagit River Steelhead in 2013-2017 (Dennis 2017 and 2018).

Species	Life Stage	Production/Origin	Total Take	Lethal Take
Puget Sound steelhead (DPS-wide)	Juvenile	Natural	71,414	1,393
		Listed hatchery intact adipose	1,211	14
		Listed hatchery clipped adipose	6,226	131
	Adult	Natural	1,484	31
		Listed hatchery intact adipose	4	
		Listed hatchery clipped adipose	38	6
Skagit River Steelhead	**Juvenile**	**Natural**	**4,555**	**4**
	Adult	**Natural**	**150**	**4**

Actual take levels associated with these activities are almost certain to be substantially lower than the permitted levels for three reasons. 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.

Over recent years, the number of landed natural-origin steelhead in retention fisheries have decreased and has reduced the co-managers' ability to monitor Skagit River steelhead populations and provide for in-season updates. The Upper Skagit Tribe has implemented a non-retention tangle net test fishery to ensure biological information are being collected to adequately characterize sex ratios, age structure, timing, detection of out-of-basin strays (hatchery or natural-origin), and collection of DNA material useful to better assess abundance and to provide information essential to development of the Skagit RMP. These non-retention tangle net fisheries operate starting in management week 8 (Mid-February) until management week 18 (beginning May), when no other fisheries or monitoring of steelhead currently occur. During tangle net fisheries, each steelhead encountered is measured for length, assessed for marks and PIT tag (and are PIT tagged if not present), sex, and a tissue sample is collected for future DNA analysis. These fish are sampled and released.

2.5 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.

2.5.1 Puget Sound Steelhead

2.5.1.1 Assessment Approach

For the overall assessment of the effects of the Proposed action on listed Puget Sound steelhead, NMFS will utilize the information and analyses presented in the Skagit RMP, supplemental information and analysis provided by the co-managers, as well as existing data and information available from agency reports, scientific literature and communications with resource experts.

The RMP proposes, for harvest management purposes, to treat all mortality of adult, natural-origin steelhead in the Action area, from salmon and steelhead fisheries, as Skagit River steelhead (Sauk-Suiattle Indian Tribe et al. 2016). All impacts (direct and incidental) to natural-origin steelhead, in all salmon and steelhead fisheries in the Action area, would be subject to the proposed RMP limits on harvest (4%-25%, depending on run size forecasted; Table 1). The NMFS' assessment of the effects from the Proposed Action will focus on the direct effects to the Skagit River steelhead DIPs, as the Proposed action is likely limited, in its affect, to the steelhead run bound for the Skagit River.

The Skagit RMP contains an effects assessment performed by the Skagit co-managers. The assessment looks at the likely effects of the proposed abundance-based, stepped harvest regime on the spawning abundance of the aggregate Skagit River steelhead. To accomplish this assessment the co-managers utilized several abundance thresholds, representing critical, viable, and rebuilding reference points to compare the effects of the proposed fishing regime against. For the critical abundance threshold (C), the co-managers employed several methods to calculate low threshold abundance threshold levels, considering risks associated with: productivity depensation, effective population breeder thresholds, and levels associated with "Quasi Extinction Thresholds" or QET (Hard et al. 2015). The co-managers decision was to utilize spawner abundance value of 500 for Skagit River steelhead DIPs (excluding Baker River), combined, as the critical threshold for their assessment, which is higher than the three methods they reviewed. The result of these reviews and the final value used for the analysis are presented in Table 13.

Table 13. Methods and estimated Critical threshold (C) abundances considered in the development of the C used in the Skagit RMP assessment of effects and the final value used.

Method	Source	Criteria	Critical Threshold
Depensation	Peterman (1977,1987)	5% of Equilibrium Spawners (8,949) (Sauk-Suiattle Indian Tribe et al. 2016; Appendix B)	447
Effective Pop Size	Waples 1990, 2004; Heath et al. 2002; Arden and Kapuscinski 2003	For each Skagit DIP, $N_b \geq 50$ if ratio of N_b/N_c is at least 0.4	375
Quasi-extinction Threshold	Hard et al. 2015	Nookachamps=27 Skagit S and W=157 Sauk S and W=103	287
Critical Threshold value used in RMP analysis			**500**

As described earlier in Section 2.4, Environmental Baseline, the Puget Sound Steelhead Recovery Plan is currently in development. For this reason, for the viable abundance threshold (V), the co-managers used the preliminary recommended viability abundances from the Puget Sound TRT's viability assessment (Hard et al. 2015). These are: Nookachamps=616; Skagit summer and winter=32,338; and Suak summer and winter=11,615, for a total viable threshold of 44,619 spawners. The RMP does not include the Baker River summer and winter run DIP preliminary viability objective in calculating the (V) threshold for their analysis, citing that the PSTRT, in identifying the Historical Populations for the PS DPS (Myers et al. 2015), noted that many of the PSTRT members and reviewers considered this population to be extirpated. For reference, and as described in Section 2.2.1.1.1, the Baker River summer and winter steelhead preliminary viability abundance level is currently 2,514.

The co-managers included two additional abundance thresholds, which they identified as "Rebuilding" thresholds. These thresholds are associated with spawner abundances that maximize the long-term productivity of the population—rebuilding maximum sustained yield (R_{MSY}), or spawner abundances that can produce run-size large enough to "probe" the system for underutilized habitat on a regular basis (R_{60}- 60% of the estimated equilibrium abundance).

The full set of abundance thresholds used in the co-managers assessment are presented in Table 14.

Table 14. Critical, viable, and rebuilding thresholds used in the Skagit RMP assessment.

Threshold	Spawner-Recruit Function	
	Ricker	Beverton-Holt
Critical (C)	500	
Viable (V)	44,619	
Rebuilding – MSY (R_{MSY})	3,912	2,127
Rebuilding – 60% Equilibrium (R_{60})	5,370	4,844

The RMP assessment employed the available annual total spawning ground abundance estimates from 1978-2007, as well as the resulting total adult recruits (offspring) from fully reconstructed, brood lines associated with these spawning years (brood years). There were several years in this overall time frame (1978-2007) where not all of the necessary information to estimate the recruits per spawner or estimate the spawning abundance were available (1990-93 and 1996-97, respectively). The resulting data set is comprised of 24 annual estimates of spawning abundance and the resulting, total adult recruitment.

From this data set of spawners and their resulting recruits, the co-managers developed recruitment functions for the aggregate Skagit River steelhead, based on a Ricker recruitment function and a Beverton-Holt recruitment function (Sauk-Suiattle Indian Tribe et al. 2016; Appendices B and C, respectively). The results of this work produced estimates for the density-independent parameters (α) and the density-dependent parameters (β) for each of the functions (Table 15). The co-managers then utilized both of these functions in their simulations to assess how the effects of the proposed harvest regime changed under the different density-dependent relationships contained in each function—Ricker vs Beverton-Holt (Sauk-Suiattle Indian Tribe et al. 2016).

Table 15. Transformed parameter and standard deviation estimates for the Skagit RMP spawner-recruit analysis (Sauk-Suiattle Indian Tribe et al. 2016).

Parameter	Point Estimate	Standard Deviation
Ricker: $R = \alpha S e^{-\frac{S}{\beta}}$		
α	2.56	1.95
β	9,529	2,962
Error Variance	0.22	
Beverton-Holt: $R = \frac{S}{\alpha + \beta S}$		
α	7.23	14.12
β	10,321	3,574
Error Variance	0.27	

The graphical representation of the median recruitment functions and ranges produced from the co-managers' analyses are shown in Figures 23 (Ricker) and Figure 24 (Beverton Holt).

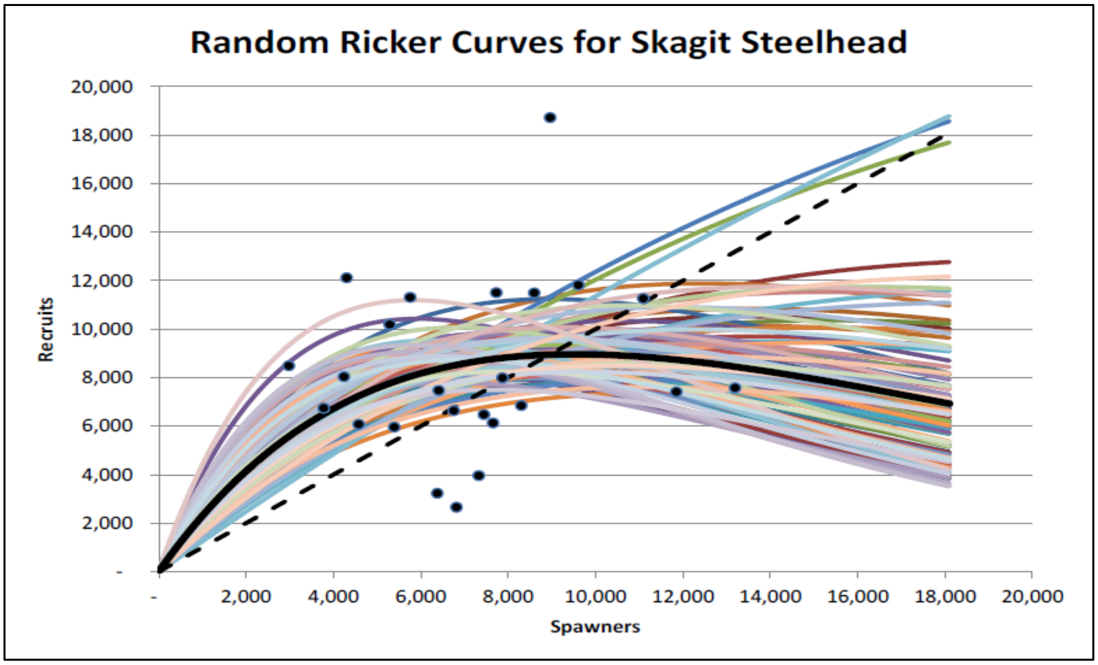


Figure 23. Random Ricker curves generated from the analysis of the 1978-2007 spawner-recruit data. The dashed black line represents the one-to-one relationship between spawners and recruits. The solid black line (curve) represents the median curve and the function (relationship) used in the modeling (Ricker) of the proposed harvest regime (Sauk Suiattle et al. 2016, Appendix B).

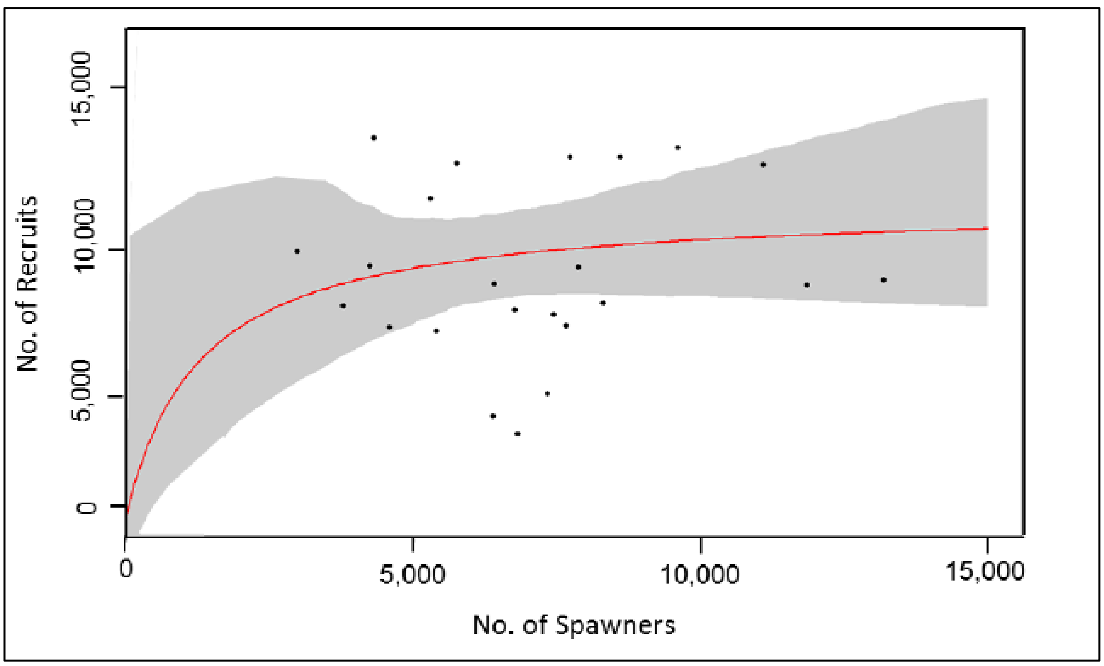


Figure 24. Median Beverton-Holt spawner-recruit curve (red line) and range of Beverton-Holt curves generated (grayed area) (n=642). The red line represents the curve and the function (relationship) used in the modeling (Beverton-Holt) of the proposed harvest regime (Sauk Suiattle et al. 2016, Appendix C).

These parameters were then used in iterative modeling exercises—based on the Ricker or Beverton-Holt functions—to simulate the response of the Skagit River steelhead population (in aggregate) to the proposed abundance-based, stepped harvest regime (Table 1). The simulations took the following steps (Sauk-Suiattle Indian Tribe et al. 2016):

1. Initiate the simulation with the number of spawners randomly drawn from a normal distribution with mean and standard deviation estimated from the observed spawners from 1978-2007.
2. Apply the proposed harvest rate [4%, 10%, 20%, or 25%, based on the run size] and obtain a number of harvest [total mortality] fish.
3. Subtract the number of harvested fish from number of returning mature fish to obtain a number of spawners.
4. Use the spawner recruit parameters to compute the next random number of recruits and multiply this by a random variable in order to incorporate environmental and demographic stochasticity.
5. Complete for 25 cycles.
6. Repeat for N=1500 simulations.

This process was completed using both the Ricker and Beverton-Holt recruitment functions, developed from the 1978-2007 spawner-recruit data, in Step 4. The results of these simulations were distributions of total run-sizes (pre-harvest) and spawner abundances (post-harvest) that represent the range of expected values, given the current estimated spawner-recruit relationships. These ranges were then compared to the thresholds for critical, viable, and rebuilding abundances established by the co-managers or the PSSTRT (see discussion above) to how the proposed harvest regime would affect the frequency of meeting or exceeding the abundance reference points (Table 14). Additional analysis produced distributions of the full range and frequency of both total estimated run-sizes (pre-harvest) and total estimated spawners (post harvest) under simulations of: No Fishery, constant 4.2% incidental take rate (to simulate the recent and current harvest estimates), the proposed RMP abundance-stepped harvest rates. The results of these simulations are discussed in the next section (2.5.2, Effects of the Proposed Action).

In assessing the adequacy and thoroughness of the co-manager analysis, NMFS considered both the direct application of the methods to the data sets, as presented in the RMP, as well as the efficacy of these methods, as utilized, to adequately address uncertainties around the underlying assumptions within the RMP's general approach. Our assessment was informed by a review of the pertinent research related to these uncertainties, including information provided in response to the public review of NMFS preliminary evaluation and pending determination for the Skagit RMP (PEPD; 82 FR 57729) in December of 2017. In particular, submissions from the Wild Fish Conservancy (WFC et al. 2018), Trout Unlimited (TU 2018), and McMillan (2018) provided several additional and informative sources evaluating some the underlying assumptions of the spawner-recruit relationship and their potential effects on the evaluation of the Skagit RMP assessment.

It is important to keep in mind that the abundance-based, stepped harvest regime proposed in the Skagit RMP was not directly developed from the estimated spawner-recruit relationship, as described above, which resulted in an F_{MSY} (estimated sustainable harvest rate) of 0.41 (41%), which is significantly higher than the rate proposed in the RMP (Sauk-Suiattle Indian Tribe et al. 2018). However, because the co-manager's simulations evaluating the impacts of proposed RMP harvest regime were based on the estimated spawner-recruit relationship, it's important to explore several of the uncertainties relate to the general spawner-recruit relationship developed and used in the RMP analysis. In particular, due to the RMP's analysis of recruitment at the adult life-stage and in a single, aggregated management unit, there may be underlying aspects of the productivity and compacity relationships, at lower scales, which could be masked by this approach.

At the broadest level, the primary concern with the recruitment relationship developed by the co-managers is one of stationarity, or the consistency of the underlying relationship—in this case the productivity (recruits/spawner)—over the timescale in the series. Non-stationarity in this relationship could introduce uncertainty regarding the reliability of the calculated productivity parameter (alpha) in the recruitment function(s), as described above. As described in Section 2.2.1 (figure 14), there has been variation in the productivity of the Skagit River steelhead over the historical timeframe used in constructing the spawner-recruit functions. Although the variation evident in the 24-year dataset could simply be expected process error around a stable spawner-recruit relationship, it could also be evidence of non-stationarity. Both Trout Unlimited (TU 2018, and McMillan 2018) and WFC et al. (2018) pointed to evidence of non-stationarity in the recruits per spawner relationship over the time series, with the WFC letter suggesting "clear evidence", citing an internal analysis (Gayeski 2018), of non-stationarity in the historical Skagit River steelhead spawner-recruit relationship. They concluded analytically that there is a clear change point at 1990, with the mean alpha parameter (productivity) under the Ricker model after 1990 being about half of that from before 1990. Gayeski (2018) went on to develop an alternative Ricker function, for the Skagit River, utilizing an expanded (relative to the base spawner-recruit data used in the Skagit RMP) post-1990 data set to represent the more recent (reduced) productivity regime. However, the resulting mean alpha parameter produced from this work, based on the more recent time period, is close to that used in the RMP (α=4.85; sd 2.86 and α=2.56; sd 1.95), suggesting that although there may be a good argument for non-stationarity in the historical time series, the discernable impact on the RMP assessment, is likely minimal and would fall within the margin of error between the estimates.

At a finer level, the concern is that density-dependence within the Skagit River may be incompletely characterized by the RMP analysis. This potential concern was raised by the Trout Unlimited response letter (TU 2018) during the PEPD public review. They cited the use of adult-recruitment used in the RMP analysis and the aggregation of the spawners and recruits, basin-wide, as concerns that the resulting capacity parameters may be estimating lower system capacity than is likely available. In interpreting traditional Ricker or Beverton-Holt spawner-recruit relationships, the assumption is that the inflection point reflects the onset of density dependent effects in the population, and that association is typically interpreted to mean the population is close to reaching the capacity of the available habitat. Recent research suggests, however, that the presence of density dependence at the watershed level does not necessarily mean that a given population is at capacity. Signals of density dependence can occur even at very low population levels where there is abundant, un- or under-utilized habitat. For example, in the Snake River basin Walters et al. (2013) found strong density dependence at the juvenile stage when formerly large populations declined to very low levels, despite no concurrent changes in habitat. Similarly, Atlas et al. (2015) documented density dependence in a highly depleted population of steelhead in British Columbia, despite the availability of ample high-quality habitat. Additionally, standard application of stock-recruit models assume density dependence is occurring at the watershed scale. Walters et al (2013) and Atlas et al. (2015) suggest density dependence is occurring at smaller, more localized scales. If density dependence is occurring at smaller scales then stock-recruit curves, based on capacity generated from the basin-scale, may underestimate carrying capacity and thus result in management plans and recovery goals that may not fully use the available habitat for an entire river basin. Incorporation of spatial effects, temporal lag effects (e.g., Finstad et al. 2013), and juvenile dispersal distances (Einum et al. 2008), may improve model predictions. Based on the spawner-recruit analysis in the RMP the Skagit River steelhead MSY harvest rate would be 41% (Ricker model; Sauk-Suiattle Indian Tribe 2018). The rates that are proposed in the RMP—from 4%-25%, depending on run-size—are sufficiently low to provide escapements that can continually test the capacity of the system to produce larger, total runs.

An additional assessment provided in the Skagit RMP takes a conservative approach to the co-manager's analysis of effect to the abundance of the Skagit steelhead. It incorporates a range of assumed survival reductions—15%-35%, in 5% increments—into the iterative modelling process described above. These assumed levels of reduced survival are applied to the resulting recruits generated by each of the recruitment functions (Ricker and Beverton-holt). This additional assessment looked to evaluate the RMP harvest regime's effect on abundance under assumptions of reduced productivity. These additional, more conservative assumptions of the productivity of the Skagit steelhead can be used to evaluate the uncertainties related to a potential overestimate of the current spawner-recruit relationship in the base parameters developed in the RMP.

Additionally, the RMP assessment is based on the available information and limitations of it. These limitations include the historical management and collection of the information at the basin-wide scale and, as a result, the RMP addresses the effects of the proposed harvest regime at the proposed aggregate Skagit River steelhead management unit level (SMU, see Section 1.3 Proposed Federal Action). This somewhat limits the ability to assess, quantitatively, the likely effects to the individual Skagit River DIPs, as well as the effects to several important diversity elements (VSP), discussed earlier in Section 2.2.1, Status of the Species. The RMP does, however, propose several measures to be continued or implemented to address the absence of certainty related to the potential effects of the proposed action on the population-structure and diversity of the Skagit River steelhead (Sauk-Suiattle Indian Tribe et al. 2016, Section 8.4-Additional Conservation Actions for Populations and Diversity). These include: Fishery management objectives that are protective of Kelts; Fishery management objectives that are protective of the summer run-timing component of the Skagit populations; Fishery management objectives that are protective of the early run-timed Skagit Steelhead; and Fishery management objectives that are protective of the Nookachamps winter steelhead DIP.

2.5.1.2 Effects to Species

Based on the simulations performed in the Skagit RMP and supplemental analyses, the proposed Skagit RMP harvest rates would result in changes to the expected total run sizes, which represent the pre-harvested total adults, and changes to the expected numbers of spawning steelhead in the Skagit River. The expected differences are represented in the following 4 figures (Figures 25-28), the first two of which represent the resulting changes based on simulations using the Ricker recruitment model, and last two of which represent the results from simulations using the Beverton-Holt recruitment model, as described in Section 2.5.5.1, above. These results are also summarized in tables 16 and 17. For comparing the potential effects of the proposed RMP harvest regime, both a “No Fishing” simulation and a “constant 4.2% HR (Harvest Rate)” simulation are presented (Sauk-Suiattle Indian Tribe et al. 2018). The No Fishing simulation assumes no harvest at all, direct or indirect. The 4.2% harvest rate simulation is meant to represent the current incidental take from the existing Puget Sound salmon and steelhead fisheries (See Section 2.4.1.1). For reference we will utilize the average total run size and average spawning abundance, from the historical time series used in the recruitment analysis (1978-2007)—8,335, average total run size and 7,128, average spawner abundance (Sauk-Suiattle Indian Tribe et al. 2016, Appendix table A-2). Due to the limitations of the abundance bins used in the output results from the simulations, fine-scale differences in the effects to run-size and abundance, such as numbers that fall within the range of the bin, are not possible to assess, e.g. 4,593 is included in the 4,001-6,000 bin. We will, instead, utilize the difference in the estimated proportion of the run sizes and spawner abundance above and below 8,000 as the reference point in our assessment of the differences from the simulated harvest scenarios. This number represents a reasonable reference point, given the available abundance bins, to look at differences relative to the long-term averages described above, i.e., 8,335 average run size and 7,128 average spawner abundance.

Based on the Ricker model simulations (Figure 25), the effect to the total run sizes produced under the proposed Skagit RMP abundance-based harvest regime, relative to the “No Fishing” simulation would be an overall, slight increase in the frequency (+0.8%) of run-sizes below 8,000, with slight reductions at the 0-2,000 and 2,001-4,000 levels of -0.2% and -0.1%, respectively and slight increases at the 4,001-6,000 and 6,001-8,000 levels of +0.8% and +0.4%, respectively (Figure 25, Table 16). The effect to the total run produced under the proposed Skagit RMP stepped harvest rate regime, relative to the “No Fishing” simulation would be an overall, slight decrease in the frequency (-0.8%) of run-sizes above 8,001, with slight increase at the 8,001-10,000 and 10,001-12,000 levels of +0.1% and +0.2%, respectively) and with slight reductions at the 12,001-14,000, 14,001-16,000, and the >16,000 levels of -0.4%, -0.1%, and -0.5%, respectively (Figure 25, Table 16). Relative to the "4.2% HR" simulations, there were some slight differences in the frequency of run sizes, in certain abundance bins, however the differences in the overall frequency of run sizes below 8,000 or above 8,001, relative to the proposed Skagit RMP abundance-based harvest regime were similar to the "No Fishing" scenario (See Table 16).

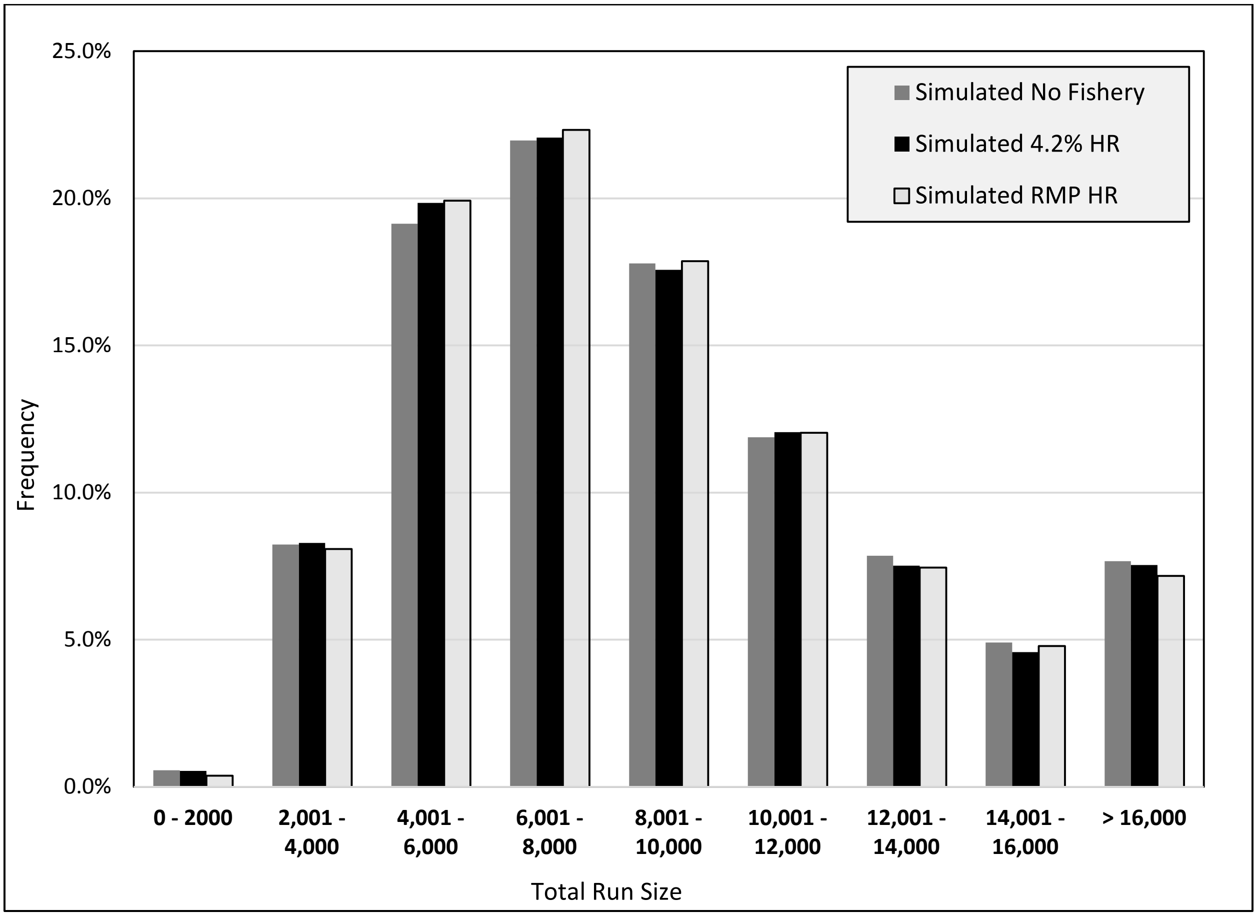


Figure 25. Skagit River steelhead total run size projections from Ricker model simulations of three harvest scenarios, based on the Skagit RMP Ricker recruitment function. Simulated scenarios are: No Fishing (charcoal bars); 4.2% Harvest Rate (HR) (black bars); and the proposed Skagit RMP stepped HR regime (light gray bars). Source data- Sauk-Suiattle Indian Tribe et al. (2018).

Based on the Ricker model simulations (Figure 26), the effect to Skagit steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime, relative to the "No Fishing" simulation would be an overall increase in the frequency (+22.1%) of spawner abundances below 8,000, with increases at the 2,001-4,000, 4,001-6,000, and 6,001-8,000 levels of +3.9%, +8.6%, and +9.6%, respectively (Figure 26, Table 16). The effect to Skagit steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime, relative to the “No Fishing” simulation would be an overall decrease in the frequency(-22.1%) of spawner abundances above 8,001, with decreases in the frequency, between -3.0% and -5.3%, of all spawner abundance bins (Figure 26, Table 16). Relative to the “4.2% HR” simulations, the effect to Skagit steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime would be an overall increase in the frequency (+18.1%) of spawner abundances below 8,000, with a slight decrease in the frequency (-0.1%) at the 0-2,000 abundance level and increases at the 2,001-4,000, 4,001-6,000, and 6,001-8,000 levels of +2.5%, +6.6%, and +9.2%, respectively (Figure 26, Table 16). The effect to Skagit steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime, relative to the “4.2% HR” simulation would be an overall decrease in the frequency (-18.1%) of spawner abundances above 8,001, with decreases in the frequency, between -2.1% and -4.5%, of all spawner abundance bins (Figure 26, Table 16).

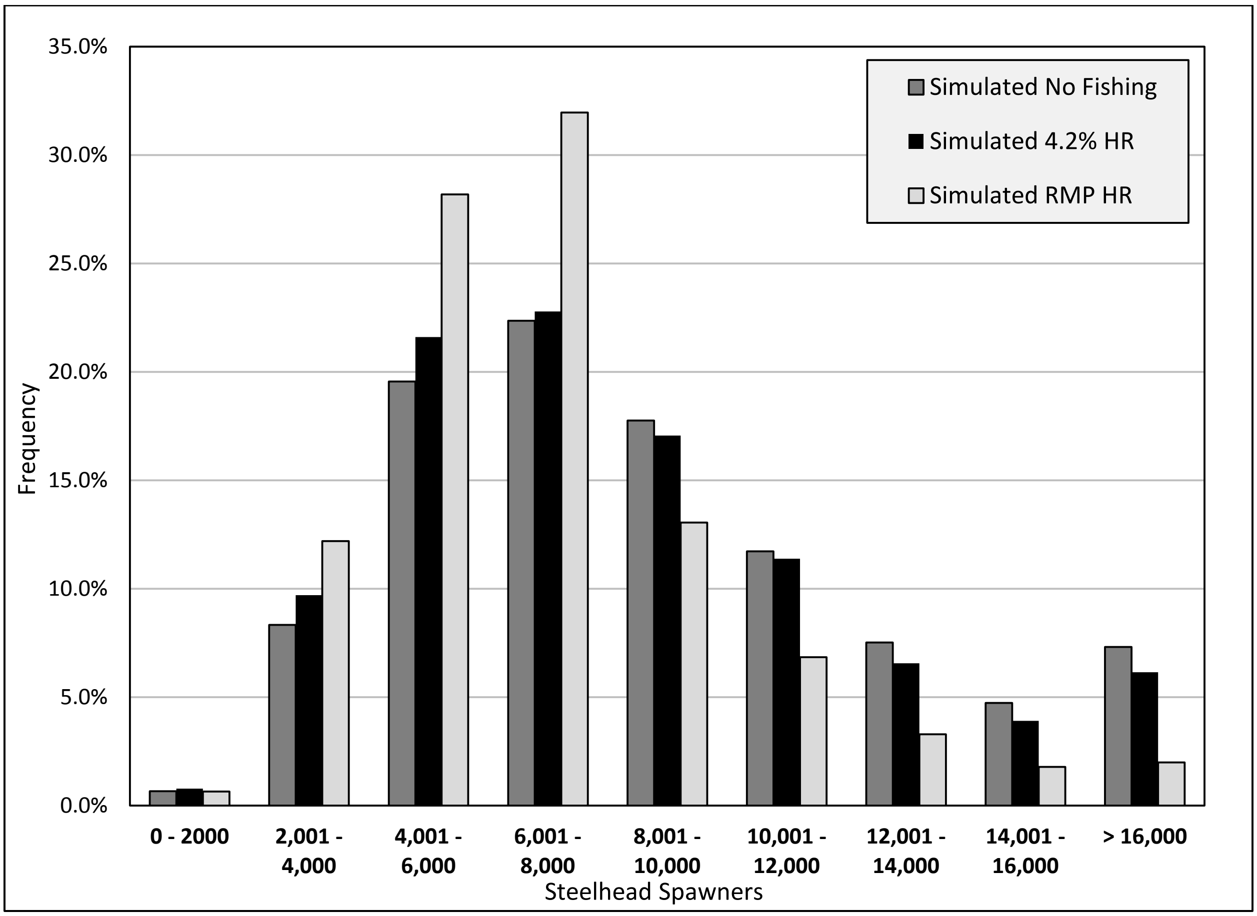


Figure 26. Skagit River steelhead spawner abundance projections from Ricker model simulations of three harvest scenarios, based on the Skagit RMP Ricker recruitment function. Simulated scenarios are: No Fishing (charcoal bars); 4.2% Harvest Rate (HR) (black bars); and the proposed Skagit RMP stepped HR regime (light gray bars). Source data- Sauk-Suiattle Indian Tribe et al. (2018).

Table 16. Percentage (frequency) of total run sizes and spawner abundances projected from the Skagit RMP Ricker model simulations.

Ricker- Total Run Size Simulations					
Run Size ranges (bins)	**Simulated No Fishing**	**Simulated 4.2% HR**	**Simulated Skagit RMP HR**	**difference between Skagit RMP and No Fishing**	**Difference between Skagit RMP and 4.2% HR**
0 - 2000	0.6%	0.5%	0.4%	-0.2%	-0.2%
2,001 - 4,000	8.2%	8.3%	8.1%	-0.1%	-0.2%
4,001 - 6,000	19.1%	19.8%	19.9%	0.8%	0.1%
6,001 - 8,000	22.0%	22.1%	22.3%	0.4%	0.3%
% Projected Run Size ≤8,000	**49.9%**	**50.7%**	**50.7%**	**0.8%**	**0.0%**
8,001 - 10,000	17.8%	17.6%	17.9%	0.1%	0.3%
10,001 - 12,000	11.9%	12.1%	12.0%	0.2%	0.0%
12,001 - 14,000	7.9%	7.5%	7.4%	-0.4%	-0.1%
14,001 - 16,000	4.9%	4.6%	4.8%	-0.1%	0.2%
> 16,000	7.7%	7.5%	7.2%	-0.5%	-0.4%
% Projected Run Size >8,001	**50.1%**	**49.3%**	**49.3%**	**-0.8%**	**0.0%**
Ricker- Spawner abundance Simulations					
Spawner Abundance ranges (bins)	**Simulated No Fishing**	**Simulated 4.2% HR**	**Simulated Skagit RMP HR**	**difference between Skagit RMP and No Fishing**	**Difference between Skagit RMP and 4.2% HR**
0 - 2000	0.7%	0.8%	0.7%	0.0%	-0.1%
2,001 - 4,000	8.3%	9.7%	12.2%	3.9%	2.5%
4,001 - 6,000	19.6%	21.6%	28.2%	8.6%	6.6%
6,001 - 8,000	22.4%	22.8%	32.0%	9.6%	9.2%
% Projected Abundance ≤8,000	**50.9%**	**54.9%**	**73.0%**	**22.1%**	**18.1%**
8,001 - 10,000	17.8%	17.1%	13.1%	-4.7%	-4.0%
10,001 - 12,000	11.7%	11.4%	6.9%	-4.9%	-4.5%
12,001 - 14,000	7.5%	6.6%	3.3%	-4.2%	-3.3%
14,001 - 16,000	4.7%	3.9%	1.8%	-3.0%	-2.1%
> 16,000	7.3%	6.1%	2.0%	-5.3%	-4.2%
% Projected Abundance >8,001	**49.1%**	**45.1%**	**27.0%**	**-22.1%**	**-18.1%**

Based on the Beverton-Holt model simulations (Figure 27), the effect to the Skagit River steelhead total run sizes (pre-harvest adult recruits) under the proposed Skagit RMP abundance-based harvest regime relative to the "No Fishing" simulation would be an overall, slight increase in the frequency (+1.4%) of run-sizes below 8,000, with slight increases at the 0-2,000, 2,001-4,000, and 4,001-6,000 levels of +0.1%, +0.5, and +1.0, respectively and a slight decrease in the 6,001-8,000 level of -0.3% (Figure 27, Table 17). The effect to the total run sizes (pre-harvest adult recruits) produced under the proposed Skagit RMP abundance-based harvest regime, relative to the "No Fishing" simulation would be an overall, slight decrease in the frequency (-1.4%) of run-sizes above 8,001, with slight decreases at all run size levels of between -0.1% to -0.4%. (Figure 25, Table 17). Relative to the "4.2% HR" simulations, the effect to Skagit River steelhead total run sizes produced by the proposed Skagit RMP abundance-based harvest regime would be an overall slight increase in the frequency (+1.2%) of spawner abundances below 8,000, with slight increases at the 2,001-4,000, 4,001-6,000, and 6,001-8,000 levels of +0.5%, +0.6%, and +0.1%, respectively (Figure 27, Table 17). The effect to Skagit steelhead run sizes produced by the proposed Skagit RMP abundance-based harvest regime, relative to the "4.2% HR" simulation would be an overall slight decrease in the frequency (-1.2%) of run sizes above 8,001, with slight decreases in the frequency, between -0.1% and 0.4%, of all run size levels above 8,001 (Figure 27, Table 17).

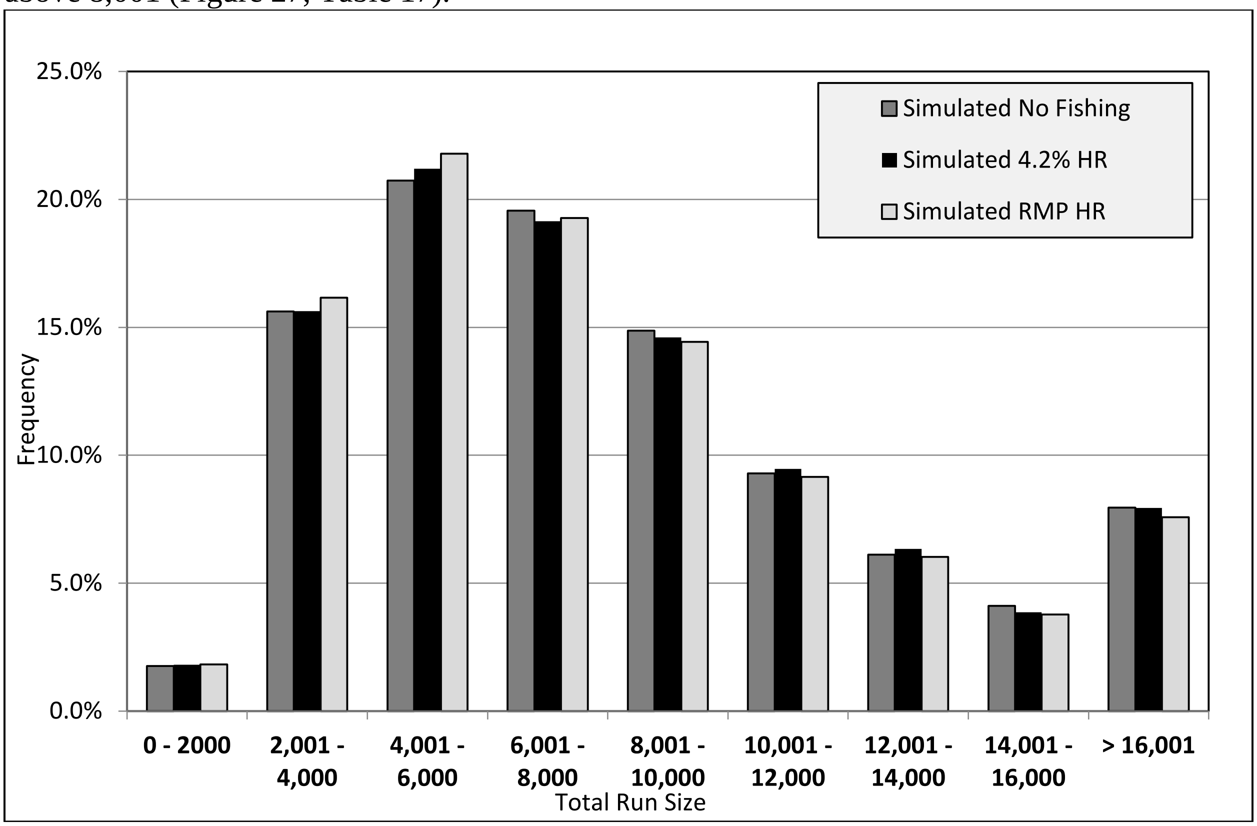


Figure 27. Skagit River steelhead total run size projections from Beverton-Holt model simulations of three harvest scenarios, based on the Skagit RMP Beverton-Holt recruitment function. Simulated scenarios are: No Fishing (charcoal bars); 4.2% Harvest Rate (HR) (black bars); and the proposed Skagit RMP stepped HR regime (light gray bars). Source data- Sauk-Suiattle Indian Tribe et al. (2018).

Based on the Beverton-Holt model simulations (Figure 28), the effect to Skagit River steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime, relative to the “No Fishing” simulation would be an overall increase in the frequency (+19.2%) of spawner abundances below 8,000, with increases in frequency at the 0-2,001, 2,001-4,000, 4,001-6,000, and 6,001-8,000 levels of +0.4%, +5.2%, +10.6%, and +3.0%, respectively (Figure 28, Table 17). The effect to Skagit steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime, relative to the “No Fishing” simulation would be an overall decrease in the frequency (-19.2%) of spawner abundances above 8,001, with decreases in the frequency, between -2.1% and -5.9%, of all spawner abundance bins above 8,001 (Figure 28, Table 17). Relative to the “4.2% HR” simulations, the effect to Skagit River steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime would be an overall increase in the frequency (+15.8%) of spawner abundances below 8,000, with increases in frequency at the 0-2,000, 2,001-4,000, 4,001-6,000, and 6,001-8,000 levels of +0.1%, +3.5%, +9.3%, and +2.9%, respectively (Figure 28, Table 17). The effect to Skagit steelhead spawner abundances produced by the proposed Skagit RMP abundance-based harvest regime, relative to the “4.2% HR” simulation would be an overall decrease in the frequency (-15.8%) of spawner abundances above 8,001, with decreases in the frequency between -1.8% and -4.6%, of all spawner abundance bins above 8,001 (Figure 28, Table 17).

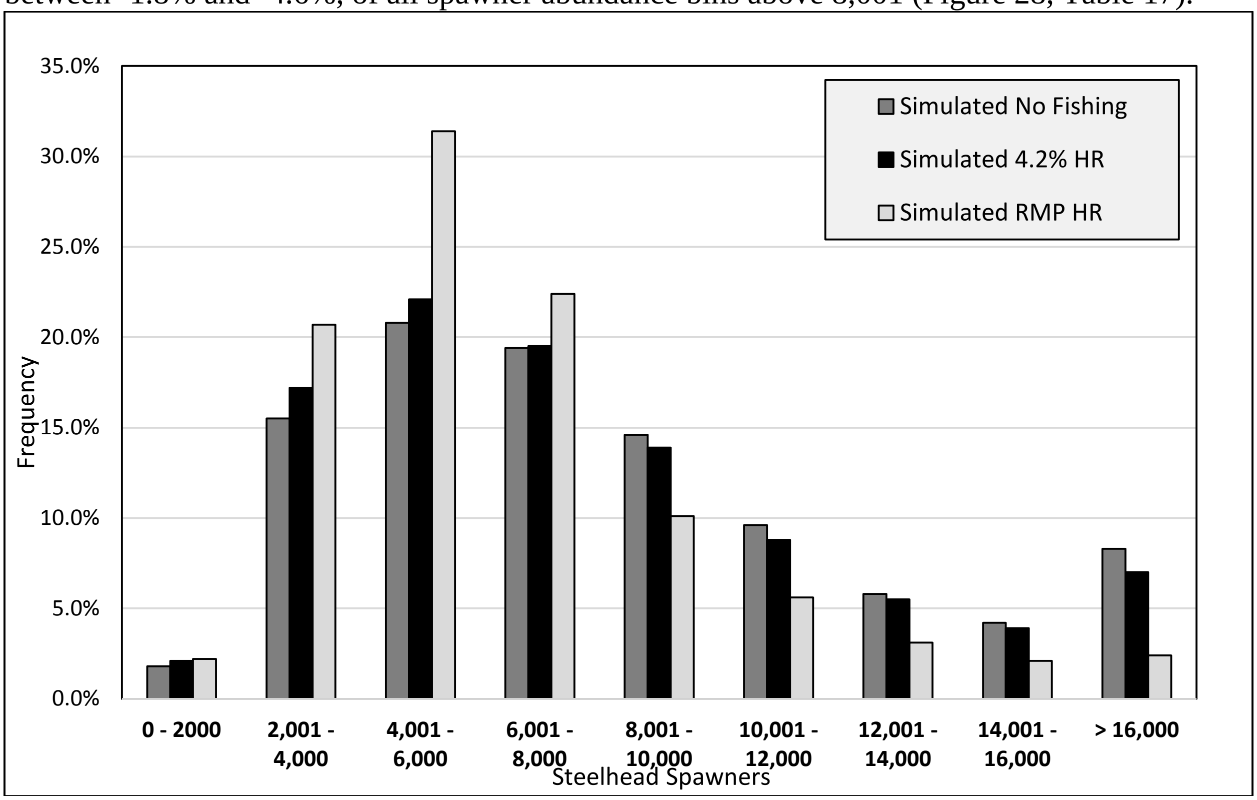


Figure 28. Skagit River steelhead spawner abundance projections from Beverton-Holt model simulations of three harvest scenarios, based on the Skagit RMP Beverton-Holt recruitment function. Simulated scenarios are: No Fishing (charcoal bars); 4.2% Harvest Rate (HR) (black bars); and the proposed Skagit RMP stepped HR regime (light gray bars). Source data- Sauk-Suiattle Indian Tribe et al. (2018).

Table 17. Percentage (frequency) of total run sizes and spawner abundances projected from the Skagit RMP Beverton-Holt model simulations.

Beverton-Holt- Total Run Size Simulations					
Run Size ranges (bins)	**Simulated No Fishing**	**Simulated 4.2% HR**	**Simulated Skagit RMP HR**	**difference between Skagit RMP and No Fishing**	**Difference between Skagit RMP and 4.2% HR**
0 - 2000	1.8%	1.8%	1.8%	0.1%	0.0%
2,001 - 4,000	15.6%	15.6%	16.2%	0.5%	0.5%
4,001 - 6,000	20.7%	21.2%	21.8%	1.0%	0.6%
6,001 - 8,000	19.6%	19.1%	19.3%	-0.3%	0.1%
% Projected Run Size ≤8,000	**57.7%**	**57.8%**	**59.0%**	**1.4%**	**1.2%**
8,001 - 10,000	14.9%	14.6%	14.4%	-0.4%	-0.2%
10,001 - 12,000	9.3%	9.5%	9.2%	-0.1%	-0.3%
12,001 - 14,000	6.1%	6.3%	6.0%	-0.1%	-0.3%
14,001 - 16,000	4.1%	3.9%	3.8%	-0.3%	-0.1%
> 16,000	8.0%	7.9%	7.6%	-0.4%	-0.4%
% Projected Run Size >8,001	**42.3%**	**42.2%**	**41.0%**	**-1.4%**	**-1.2%**
Beverton-Holt- Spawner abundance Simulations					
Spawner Abundance ranges (bins)	**Simulated No Fishing**	**Simulated 4.2% HR**	**Simulated Skagit RMP HR**	**difference between Skagit RMP and No Fishing**	**Difference between Skagit RMP and 4.2% HR**
0 - 2000	1.8%	2.1%	2.2%	0.4%	0.1%
2,001 - 4,000	15.5%	17.2%	20.7%	5.2%	3.5%
4,001 - 6,000	20.8%	22.1%	31.4%	10.6%	9.3%
6,001 - 8,000	19.4%	19.5%	22.4%	3.0%	2.9%
% Projected Abundance ≤8,000	**57.5%**	**60.9%**	**76.7%**	**19.2%**	**15.8%**
8,001 - 10,000	14.6%	13.9%	10.1%	-4.5%	-3.8%
10,001 - 12,000	9.6%	8.8%	5.6%	-4.0%	-3.2%
12,001 - 14,000	5.8%	5.5%	3.1%	-2.7%	-2.4%
14,001 - 16,000	4.2%	3.9%	2.1%	-2.1%	-1.8%
> 16,000	8.3%	7.0%	2.4%	-5.9%	-4.6%
% Projected Abundance >8,001	**42.5%**	**39.1%**	**23.3%**	**-19.2%**	**-15.8%**

The effect of the proposed Skagit RMP harvest regime on the frequency of attaining the critical (C), viable (V), and rebuilding spawner abundance levels, as defined in the RMP, was also analyzed in the RMP. In this case, the analysis only compared the "No Fishing" scenario to the proposed RMP stepped harvest rate. This analysis also shows that the proposed action would change the frequency at which these spawner abundances are attained or exceeded, relative to the "No Fishing" simulation, and shows that the proposed harvest regime would not increase the frequency of spawner abundances that fall at or below the critical value (C) of 500 spawners—in both simulations this frequency remains at 0% of the steelhead runs.

Currently, the Skagit steelhead's ability to attain the PSTRT's preliminary viability abundances (Hard et al. 2015), either at total run size (which in these simulations would be equivalent to the no fishing simulation) or under the proposed Skagit RMP harvest regime, is currently estimated a 0%. As described in Section 2.2.1.1.1 and 2.5.1.1, above, the preliminary viability abundance level is estimated at 44,619 in aggregate, not including the Baker River DIP (Section 2.5.1.1). The frequency at which the Skagit River steelhead abundance can reach this threshold is not affected by the proposed RMP harvest regime, with both the No Fishing and the RMP harvest simulations resulting in a 0% result (Table 18).

Table 18. Percentage (frequency) of simulated spawner abundance levels above R_{MSY} or R_{60} levels, under both Ricker and Beverton-Holt recruitment functions. % in parentheses shows the difference between the RMP harvest regime results and the No Fishing results.

Spawner Reference Point (Threshold)	**Ricker Simulation Results**		**Beverton-Holt Simulation Results**	
	No Fishing	**Proposed RMP Harvest Regime**	**No Fishing**	**Proposed RMP Harvest Regime**
Exceeds Rebuilding MSY (R_{MSY}) (3,912; 2,127)	92%	88% (-4%)	99%	99% (0%)
Exceeds Rebuilding (R_{60}) (5,370; 4,844)	78%	68% (-10%)	82%	75% (-7%)

Source: Sauk-Suiattle Indian Tribe et al. 2016.

The Skagit RMP assessed the effects to spawner abundances under several reduced-survival scenarios (15%-35% reductions), looking to demonstrate the effect of the proposed harvest regime on frequency of falling under the critical (C) threshold or surpassing the R_{MSY} threshold, under both recruitment models. This exercise was used by the co-managers to demonstrate the potential effects to abundance if the population's productivity was actually lower than estimated by the Ricker and Beverton-Holt recruitment analyses. The results of these simulations show that over the full range of survival reductions, there is no change in the frequency (0%) of spawner abundances that fall below the critical threshold of 500 spawners, under either simulation. There are, however, reductions in the frequency of spawner abundances above R_{MSY}, as the incremental survival reduction is increased (Table 19). These reductions range from -3%, at a 15% survival reduction, to -13%, at a 35% survival reduction, under the Ricker simulation and from -1%, at a 15% survival reduction, to -8%, at a 35% survival reduction, under the Beverton-Holt simulation. (Table 19).

Table 19. Percentage (frequency) of simulated spawner abundances that are above R_{MSY} levels, under reduced survival assumptions (Sauk-Suiattle Indian Tribe et al. 2016).

Simulated Survival Reduction	Ricker	Beverton-Holt
	% > R_{MSY}	**% > R_{MSY}**
0%	88%	99%
15%	85%	98%
20%	83%	97%
25%	81%	96%
30%	79%	94%
35%	75%	91%

These results, on the potential effect to total run sizes of steelhead returning to Skagit River indicate, on balance, that the proposed Skagit RMP stepped harvest rates would have a minimal effect on the run sizes recruiting the Skagit, relative to the “No Fishing” scenario. When compared to the “No Fishing” scenario, the Ricker simulations of the Skagit RMP’s stepped harvest rate indicate a small increase of roughly +1% in the frequency of run sizes up to 8,000, with the 4,001-6,000-level increasing the most. The Ricker simulations also indicate a commensurate, overall decrease (roughly -1.0%) in the frequency of run sizes greater than 8,001, with the 12,001-14,000 and >16,000 decreasing the most. There are however small increases in the 8,001-10,000 and 10,001-12,000 levels (Table 16). The Beverton-Holt simulations of run size effects of the Skagit RMP’s stepped harvest rate, compared to the “No Fishing” scenario, also show a small relative increase (+1.4%) in the frequency of run sizes up to 8,000, with the frequency increase largest in the 4,001-6,000 level. Additionally, there is a small commensurate decrease (-1.4%) in frequency of run sizes above 8,001, with the largest decrease in the 8,001-10,000 and >16,000 levels (Table 16). The small projected change in the frequency of all run sizes +1.4% to -1.4%)is likely a result of the underlying spawner-recruit relationships and an indication that the proposed RMP harvest regime would result in spawner abundances in the range that produces higher recruits per spawner.

These results also indicate that the proposed RMP harvest regime would not result in very low spawner abundances, such as the critical threshold of 500, developed in the RMP or the total QET spawner abundance level developed by the PSSTRT for the four Skagit DIPs (323 fish; Hard et al. 2015). Compared to the “No Fishing” scenario, the frequency of spawner abundances up to 8,000, under the Skagit RMP’s stepped harvest rate, would increase by roughly +22% and +19%, under the Ricker and Beverton-Holt models, respectively, with the majority of the increases in the 4,000-6,000 and 6,001-8,000 spawner levels (Tables 16 and 17). The frequency of spawner abundances over the 8,000 spawner levels would decrease by roughly -22% and -19% under the Ricker and Beverton-Holt models, respectively, with the majority of the decreases spread more evenly across the 8,001->16,000 spawner levels (Tables 16 and 17). Compared to the simulated “No Fishing” spawner abundances, with roughly 49% and 43% of the resulting abundances above the 8,001 level, under the Ricker and Beverton-Holt, respectively, the RMP harvest regime would result in decreases to 27% and roughly 23% of the spawner abundances above to 8,001 level. The majority of these decreases come at the 8,001-10,000, the 10,001-12,000, and the >16,000 spawner levels (Tables 16 and 17).

The effect of the Skagit RMP harvest regime on the Skagit River steelhead spawner abundance will likely result in a redistribution of spawner abundances from the higher levels (>8,000) to lower levels, mostly increasing the frequency of spawning levels between 4,000-8,000. It should be noted that, based on the No Fishing simulations, that these levels of spawning (4,000-8,000) are the most frequent levels expected in the Skagit River (Figures 26 and 28). The proposed Skagit RMP harvest regime would still allow for the full range of higher spawning abundance (>8,001) seen in the No Fishing simulations, albeit at a lower frequency. This lower frequency would still allow the Skagit River steelhead population to test the Skagit basin compacity over time and take advantage of any positive changes in the system habitat.

As described earlier in this section 2.5.1.1, Assessment Approach, the Skagit RMP analysis is conducted at the aggregated population (DIP) level. Additionally, as described earlier in this document (Section 2.2.1, Status of the Listed Species), the historical and recent steelhead information, available within the Skagit River basin, is at the basin-wide scale, which aggregates the recently identified DIPs. Therefore, our assessment of the effects of the Skagit RMP’s stepped harvest regime on the abundance of the individual Skagit DIPs is limited. We have assumed that the effects to the aggregated whole are representative of the likely effects at the DIP level.

Overall, the RMP’s stepped harvest regime would lead to a reduction in the frequency of large spawning abundances (>8,001) that may reduce the Skagit River DIPs’ ability to expand, in size, as rapidly as under the current level of incidental take (4.2% HR) or under a No Fishery regime (Tables 16 and 17). However, the shift in the frequency of spawner abundances, into the 4,000-8,000 ranges still produces comparatively large run sizes and frequencies of high spawner abundances: >8,000 to >16,000. Overall, the effect of the RMP stepped harvest regime, on the current Skagit steelhead DIPs’ viability status (Moderate; Hard et al. 2015) from changes in their abundance and productivity would be low. The overall Skagit steelhead run would continue to be the most abundant and productive run of steelhead in the Puget Sound, with expected spawner abundances across the range of abundance seen over that last 40 years.

The Skagit RMP proposes conservation management components (Section 1.3) that would focus on the protection and/or expansion of several key elements of Skagit River steelhead diversity, including: protection of the early run timed winter steelhead; protection of kelts; protection of the summer run steelhead, and protection of the Nookachamps winter steelhead DIP.

As indicated in Section 2.2.1 and 2.4.1, the early-timed portion of the winter steelhead run has been reduced, in significant proportion, from its historical role, primarily due to the disproportionately high harvest rates implemented to harvest the returning hatchery fish (NMFS 2016c). These historical impacts affected not only the early-run component of the Skagit and Sauk populations but also potential affect the entirety of the Nookachamps population (Section 2.4.1.2). As mentioned earlier in this opinion, the Skagit River early-winter hatchery steelhead program, which had operated for over half a century was discontinued in 2013—fish from these releases no longer return to the Skagit and the fisheries that targeted them at high rate of harvest are also no longer present in the system. Conservation actions proposed in the Skagit RMP include the recreational fishery opening no earlier than February 1st, annually, and being restricted to the middle and upper portions of the fishing area (Figure 1), and the tribal fishery focusing harvest pressure away from the early run component. Both aspects of the fishery plan will protect the Nookachamps DIP.

In addition to the early timed winter steelhead, the Skagit RMP proposes conservation actions to minimize impacts to the Skagit summer run components. These measures include the delayed opening of the recreational fishery until February 1st, which will reduce the interaction of fishers with holding summer steelhead in the upper reaches of the fishing areas, and by not conducting any tribal fisheries directed specifically at summer steelhead. The protection of steelhead kelts is also a focus of the Skagit RMP conservation actions. These include the timing and location of the recreational fishery as well as conducting the tribal fisheries, directed at other species, e.g., spring Chinook and sockeye salmon, to minimize the impact to steelhead kelts.

Overall, these additional measures, focusing on important diversity elements, when combined with the stepped harvest regime, will allow for the conservation or expansion of the attributes contributing to the diversity parameters for VSP. In particular, the early run component of all of the DIPs and the Nookachamps DIP, in particular, will likely see benefits from the low overall levels of fishing pressure, compared to the high levels seen for more than half a century. When combined with the conservative harvest rates in the RMP, the effect of the fishery on the viability of the individual Skagit steelhead DIP viability status (Moderate; Hard et al. 2015) from changes in their diversity or spatial structure would be low.

Given that the Proposed Action would isolate the effects to the Skagit River steelhead DIPs and that the effect to the Skagit River steelhead DIPs' viability is would be low and allow the Skagit DIPs to maintain their current moderate status, thereby maintaining their potential for contribution to MPG-level viability (Table 3). NMFS concludes that the effects of the Proposed Action on the viability of the Northern Cascade MPG would be low and the effects to the viability and recovery of the Puget Sound steelhead DPS would also be low.

2.5.2 Effects of the Proposed Action on Puget Sound Steelhead Designated Critical Habitat

Critical habitat has been designated in areas throughout the Skagit River basin (78 Fed. Reg. 2726) (Figure 8). Fishing activities will take place over relatively short time periods in any particular area. The PBFs most likely to be affected by the Proposed Action are (1) water quality, and forage to support spawning, rearing, individual growth, and maturation; and, (2) the type and amount of structure that supports juvenile growth and mobility.

Most of the harvest related activities in the Skagit River terminal area (Section 2.3) occur from boats or along river banks. The gear used in the proposed fishing activities under the Skagit RMP would include hook-and-line and nets. If hooks, lines, or nets come in contact with the substrate or other habitat features, their capture efficiency is dramatically reduced. As a result, fishermen endeavor to keep gear from being in contact or entangled with substrate and habitat features because of the resultant interference with fishing and potential loss of gear. Derelict fishing gear can affect habitat in a number of ways including barring passage, harming eelgrass beds or other estuarine benthic habitats, or occupying space that would otherwise be available to salmonids. Any impact to water quality from vessels in transit, or while fishing, would be short term and transitory in nature. These effects on water quality are, therefore, likely to be minor and restricted to materials spilled from fishing boats or left on banks. Construction activities related to salmon fisheries are limited to maintenance and repair of existing facilities (such as boat launches) and are not expected to result in any additional impacts on riparian habitats. By removing adults that would otherwise return to spawning areas, harvest could affect water quality and forage for juveniles by decreasing the return of marine derived nutrients to spawning and rearing areas, although this has not been identified as a limiting factor for the DPS. The Proposed Action will result in spawner abundances across a similar range to what has been estimated in the recent historical timeframe (40 years). Overall, there will be minimal disturbance to vegetation, and negligible effects to spawning or rearing habitat, water quantity and water quality from the Proposed Action.

2.6 Cumulative Effects

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

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the Action Area. However, it is difficult if not impossible to distinguish between the Action Area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the Action Area are described in the environmental baseline (Section 2.4).

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 2011) 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 2013), the National Flood 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 (SSPS 2007). Puget Sound steelhead recovery planning is underway and is expected to be finalized in 2019. Although state, tribal and local governments have developed plans and initiatives to benefit ESA listed salmonids, 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 steelhead populations and steelhead critical habitat PBFs, 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.

Habitat restoration efforts are supported by Federal, state, and local agencies; tribes; environmental organizations; and communities. Projects supported by these entities focus on improving general habitat and ecosystem function or species-specific conservation objectives that, in some cases, are identified through ESA recovery plans. The larger, more region-wide, restoration and conservation efforts are presented below. These actions have helped restore habitat, improve fish passage, and reduce pollution. While these efforts are reasonably likely to occur, funding levels may vary on an annual basis. However, we anticipate that projects to restore and protect habitat, restore access and recolonize the former range of salmon and steelhead, and improve fish passage at hydropower sites will result in a net benefit for salmon and steelhead compared to the current conditions. Some examples of major non-federal funding entities are detailed below.

The Governor’s Salmon Recovery Office arose from Washington’s Salmon Recovery Act, and includes the Salmon Recovery Funding Board (SRFB). SRFB has helped finance more than

900 salmon recovery projects focused on habitat protection and restoration. SRFB administers two grant programs (general salmon recovery grants and Puget Sound Acquisition and Restoration grants). Municipalities, tribal governments, state agency non-profit organizations, regional fisheries enhancement groups, and private landowners may apply for these grants.

Numerous environmental organizations, communities, and tribes have contributed to salmon habitat restoration and conservation efforts in the Puget Sound region. These projects are often funded by in-kind matches with funding provided by NOAA's Cooperative Research Program, Pacific Coastal Salmon Recovery Fund, Pacific states' salmon recovery funds, and other sources. The projects vary, ranging from small- to large-scale efforts that include habitat conservation, creation, enhancement, restoration, and protection. These projects may also be initiated and developed under recovery plans prepared for threatened and endangered species. Project examples include donating conservation easements, excavating new tidal channels, removing invasive species, stabilizing streambanks, installing or upgrading culverts, removing barriers to fish migration, planting riverbanks, conserving water, restoring wetlands, and managing grazing to protect high-quality aquatic habitat, among others.

The Pacific Coastal Salmon Recovery Fund was established by Congress to help protect and recover salmon and steelhead populations and their habitats (NMFS 2001). The states of Washington, Oregon, California, Idaho, and Alaska, and the Pacific Coastal and Columbia River tribes, receive PCSRF appropriations from NMFS each year. This fund supplements existing state, tribal and local programs to foster development of Federal-state-tribal-local partnerships in salmon and steelhead recovery. The PCSRF has made substantial progress in achieving program goals, as indicated in annual reports to Congress, workshops, and independent reviews. NMFS considers the projects completed by the states and tribes as cumulative effects.

NMFS has completed ESA consultation on the activities of the NOAA Restoration Center in the Pacific Northwest (NMFS 2004a). These include participation in the Damage Assessment, Remediation, and Restoration Program (DARP); Cooperative Research Program (CRP); and the Restoration Research Program. The CRP is a financial and technical assistance program which helps communities to implement habitat restoration projects. Projects are selected for funding based on their ecological benefits, technical merit, level of community involvement, and cost effectiveness. National and regional partners and local organizations contribute matching funds, technical assistance, land, volunteer support or other in-kind services to help citizens carry out restoration which NMFS considers as cumulative effects.

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

Puget Sound steelhead are likely to be adversely affected by climate change (see Section 2.4.1.5). A decrease in winter snow pack is expected to reduce spring and summer flows and increase water temperatures throughout the region. Warmer temperatures may also increase the probability of higher sediment loads in tributaries due to more rain-on-snow events on the upper slopes of various mountain ranges throughout the Skagit River basin releasing sediment that is no longer protected by winter snow pack. Reduced summer flows and higher water temperatures are expected to reduce the habitat quality and habitat quantity needed for juvenile steelhead rearing and for adult holding, making those areas in the upper Skagit River basin more essential for the persistence and recovery of the ESA-listed populations. Habitat quantity and quality may be degraded as annual flows are reduced and water temperatures increase as a result of climate change. These climate change effects on the quantity and quality of habitat in the Action Area are expected over the next 50 years to reduce the spatial distribution of steelhead populations in the Puget Sound because some sections of individual tributaries may become too warm for rearing reducing steelhead productivity unless the natural-origin populations can adapt to these changes. These effects are assumed in the status of the Puget Sound steelhead DPS (Section 2.2.1). The Proposed Action addresses this by enacting incrementally increasing rates of harvest, based on annual steelhead abundance to conserve the productivity, abundance of Skagit River steelhead populations, and by enacting conservation actions within the proposed Skagit River fisheries to conserve population diversity. Salmonid species resilience to future environmental conditions depends both on characteristics of individual populations and on the level and rate of change. The life history types that will be successful in the future are neither static nor predictable, therefore maintaining or promoting the existing diversity that is found in the natural population is the wisest strategy for continued existence of steelhead populations in the Puget Sound.

NMFS anticipates that human development activities will continue to have adverse effects on listed species in the Action Area. On the other hand, NMFS is also certain that available scientific information will continue to grow and tribal, public, and private support for salmon recovery will remain high and this will fuel the upward trend in habitat Mitchell Act funding restoration and protection actions as well as hatchery, harvest, and hydropower reforms that are likely to result in improvements in fish survival.

2.7 Integration and Synthesis

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

2.7.1 Puget Sound Steelhead

NMFS describes its approach to the analysis of the Proposed Action in broad terms in section 2.1, and in more detail as NMFS focused on the effects of the action in Section 2.5.1. The approach incorporates information discussed in the Status (Section 2.2.1.1), Environmental Baseline (Section 2.4.1), and Cumulative Effects (Section 2.6) sections. In the effects analysis, NMFS first analyzed the effects of the Proposed Action on the Skagit River steelhead DIPs, using quantitative analyses where possible and more qualitative considerations where necessary. NMFS then assessed the effects of the proposed action on the Northern Cascade MPG. Risk to the survival and recovery of the Puget Sound steelhead DPS was then determined by assessing how effects to the Northern Cascades MPG would affect the viability of the Puget Sound steelhead DPS as a whole.

We described the Status of the Puget Sound DPS in terms of the Viable Salmonid Population (VSP) attributes: Abundance and Productivity, and Diversity and Spatial Structure. The current status was described as depressed and not currently viable (Hard et al. 2015). The status of the Skagit River steelhead populations were also described, at the DIP level, where possible, otherwise at the combined population level, in terms of VSP attributes. The viability of the Skagit River steelhead populations is currently assessed at Moderate with low risk of extinction in the next 100 years (Hard et al. 2015). The status of the Puget Sound steelhead designated critical habitat was described, as was the designated critical habitat within the Action Area. We described the effects that climate change has had on the Puget Sound region as a whole, as well as to the Skagit River basin.

The environmental baseline for listed steelhead in Puget Sound and their critical habitat includes the ongoing effects of past and current development activities and hatchery management practices. 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. Historic levels of harvest and extensive propagation of out-of-basin stocks (e.g., Chambers Creek and Skamania hatchery stocks) throughout the Puget Sound steelhead DPS, and increased predation by marine mammals and birds are also sources of concern. Development activities and the ongoing effects of existing structures are expected to continue to have adverse effects similar to those in the baseline. Hatchery production has been modified to some extent to reduce the impacts to ESA-listed steelhead but is expected to continue at lower levels with lesser impacts. NMFS expects that both Federal and State steelhead recovery and management efforts will provide new tools, data and technical analyses, refine Puget Sound steelhead population structure and viability, and better define the role of individual populations in the DPS. The Puget Sound Steelhead recovery plan aid in identifying measures necessary to protect and restore degraded habitats, manage hatcheries and fisheries consistent with recovery, and prioritize research on data gaps regarding population parameters. The final recovery plan is anticipated to be completed by the end of 2019.

The NMFS assessed the effects of the Proposed Action on the Skagit River steelhead DIPs, the Northern Cascades MPG, and the Puget Sound steelhead DPS were then assessed and described. The proposed Skagit RMP would have a low-moderate effect on the abundance and productivity of Skagit River steelhead and a low impact on the diversity of the Skagit River steelhead DIPs. Overall the proposed Skagit RMP would have a low effect on the viability of the Skagit River steelhead DIPs and would likely maintain their current moderate status. Therefore, the proposed Skagit RMP would, through its low effects to the viability of Skagit DIPs, have a low effect on the viability of the Northern Cascades MPG, and, in turn, a low effect on the viability of the Puget Sound steelhead DPS, maintaining its currently low DPS-wide viability status. NMFS also described the potential effects to the designated critical habitat, within the Action Area as likely low and of the short and transient nature.

As described in the previous sections, NMFS also considers its trust responsibility to the tribes in evaluating the Proposed Action and recognizes the importance of providing 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.

NMFS then described the cumulative effects that could be expected to occur in the Action Area. Cumulative Effects are those effects of future state or private activities, not involving Federal activities, which are reasonably certain to occur within the Action Area. Some types of human activities that contribute to cumulative effects are expected to have adverse impacts on populations and PBFs, 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, these 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.

2.8 Conclusion

2.8.1 Puget Sound Steelhead

After reviewing and analyzing the current status of the listed species and the 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 steelhead DPS or destroy or adversely modify designated critical habitat for the Puget Sound steelhead DPS.

2.9 Incidental Take Statement

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

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.

The Proposed Action is NMFS's determination that the Skagit RMP meets the criteria of the 4(d) Rule, Limit 6. If NMFS determines the Skagit RMP does meet the 4(d) criteria, then harvest of steelhead pursuant to the RMP would not be subject to the take prohibitions of section 9 of the ESA. Our biological opinion concludes that the Skagit RMP is not likely to jeopardize the continued existence of listed species or to destroy or adversely modify their critical habitat. If NMFS approves the RMP, no prohibited take of listed species would occur under the proposed action. Also, take from the Puget Sound steelhead DPS would be directed, not incidental. For these reasons, no exemption from the ESA's take prohibitions is appropriate.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a Proposed Action on listed species or critical habitat or regarding the development of information (50 CFR 402.02). NMFS believes the following conservation recommendations are consistent with these obligations, and therefore should be implemented by NMFS, in cooperation with the Skagit Tribes and the WDFW.

(1) During the term of the Skagit RMP, develop a strategy to assess the ability of the RMP to conserve the specified populations or diversity components (Sauk-Suiattle Indian Tribe et al. 2016, Section 8.4), including: protection of steelhead Kelts; protection of the Skagit summer-run timing component; protection of the Early-timed winter steelhead; and protection of the Nookachamps Creek DIP.

(2) During the term of the Skagit RMP, develop a plan to assess the existing Skagit River steelhead gaps identified in the Skagit RMP (Section 11, Data Gaps) related to: population structure and diversity, including DIP differentiation—spatial, temporal, life-history and genetic; the need to re-evaluate the current spawning ground estimation methodology; the need to better understand the role and importance of the resident *O. mykiss* to the abundance and productivity of the Skagit steelhead population; and other approaches to quantify productivity and population trends, including the use of habitat-based modeling of production potential and quantifying smolt production in management, e.g. improving forecasting capability, quantifying recruitment and developing escapement goals.

2.11 Re-initiation of Consultation

This concludes formal consultation for the impacts of the Skagit River Steelhead Fishery Resource Management Plan. The plan is proposed for implementation over a five-year period, through April 30, 2022.

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

2.12 "Not likely to Adversely Affect" Determinations

NMFS anticipates the Proposed Action is not likely to adversely affect Chinook salmon, Southern Resident killer whales, Southern green sturgeon, or Southern eulachon which occur in the Action Area or adversely affect their critical habitat

Puget Sound Chinook Salmon

The occurrence of Chinook salmon in the timeframe proposed for the Skagit RMP steelhead fisheries—December 1- April 30—and in the location of the fisheries makes it extremely unlikely that Chinook would be encountered in fisheries carried out under the Skagit RMP. Due to late start of the proposed fishery in the Skagit RMP, well after the fall Chinook run has ended, and the early end of the proposed fisheries, prior to the spring Chinook salmon run beginning, the effects of the proposed action on Chinook salmon are discountable. Additionally, the proposed action will not affect the designated critical habitat of the Puget Sound Chinook salmon ESU.

Southern-Resident Killer Whale

The Proposed Action would take place in the Skagit terminal area, which includes Puget Sound marine area 8.1. There are no expected direct interactions with SRKW by fishing activities under the Proposed Action, because they would be small in scale and mostly focused on the nearshore areas close to the mouth of the Skagit River. While there is evidence that SRKW utilize steelhead as winter prey (Hanson et al. 2010; Ford et al. 2016), the likely effects of the Proposed Action on the concentrations of SRKW prey base in Marine Area would be insignificant. Additionally, as described above in Puget Sound Chinook Salmon, the proposed action will also not affect the SRKW's primary prey species, Chinook salmon. Thus, the Proposed Action is not likely to adversely affect Southern-Resident killer whales or its designated critical habitat.

Green Sturgeon

Individuals of the southern DPS of green sturgeon are unlikely to be caught in Skagit terminal area steelhead fisheries. Sturgeon are primarily a bottom-oriented, benthic feeding species. These fisheries target steelhead in the Skagit terminal marine area (8-1) or in the lower portion of the Skagit mainstem, where the fish are actively migrating higher in the water column. Or, use hook-and-line gear to target steelhead in the mid- and upper-Skagit basin, where green sturgeon would not typically be present. Any contact of these gears with the bottom, either in the freshwater or terminal marine area, would be rare and inadvertent. NMFS is not aware of any records or reports of green sturgeon being caught any Puget Sound salmon fisheries (NMFS 2017a). Given the nature and location of the steelhead fisheries, NMFS would not expect green sturgeon to be caught or otherwise affected by the proposed fisheries or there to be any effect on the physical or biological factors (PBFs) of green sturgeon critical habitat, making the effects discountable..

Eulachon

The Proposed Action is not likely to adversely affect eulachon or its designated critical habitat. The ESA-listed southern DPS of Eulachon is primarily a marine, pelagic species that spawn in the lower reaches of coastal rivers and whose primary prey is zooplankton (Drake et al. 2010). 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 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) and hook and line gear designed to catch the much larger salmon species. The gear is deployed to target pelagic feeding salmon near the surface and in mid-water areas. Encounters of eulachon in salmon fisheries would be extremely unlikely given the general differences in spatial distribution and gear characteristics. NMFS is not aware of any record of eulachon caught in either commercial or recreational Puget Sound 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.

3.0 MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

"Essential fish habitat" (EFH) is defined in section 3 of the Magnuson-Stevens Act (MSA) as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." NMFS interprets EFH to include aquatic areas and their associated physical, chemical and biological properties used by fish that are necessary to support a sustainable fishery and the contribution of the managed species to a healthy ecosystem.

The MSA and its implementing regulations at 50 CFR 600.920 require a Federal agency to consult with NMFS before it authorizes, funds or carries out any action that may adversely affect EFH. The purpose of consultation is to develop a conservation recommendation(s) that addresses all reasonably foreseeable adverse effects on EFH. Further, the action agency must provide a detailed, written response to NMFS within 30 days after receiving an EFH conservation recommendation. The response must include measures proposed by the agency to avoid, minimize, mitigate, or offset the impact of the activity on EFH. If the response is inconsistent with NMFS' conservation recommendation the agency must explain its reasons for not following the recommendations.

The objective of this consultation is to determine whether NMFS' ESA 4(d) Rule determination regarding the submitted RMP for activities within the Puget Sound, is likely to adversely affect EFH. If the Proposed Action is likely to adversely affect EFH, a conservation recommendation(s) will be provided.

3.1 Essential Fish Habitat Affected by the Project

Pursuant to the MSA, the Pacific Fishery Management Council (PFMC) has designated EFH for three species of federally-managed Pacific salmon: Chinook salmon (*O. tshawytscha*); coho salmon (*O. kisutch*); and Puget Sound pink salmon (*O. gorbuscha*) (PFMC 2014). The PFMC does not manage the fisheries for chum salmon (*O. keta*) or steelhead (*O. mykiss*). Therefore, EFH has not been designated for these species.

For this EFH consultation, the Proposed Action and Action Area are described in detail in the ESA consultation above. The action is NMFS' ESA 4(d) Rule determination regarding the submitted Skagit River Steelhead Fishery RMP. The Action Area is the Skagit Terminal Area, as described in Section 2.3 of the above biological opinion, including the Skagit River subbasin and Marine Area 8.1, in Puget Sound, and is part of the EFH for Chinook and coho salmon. A more detailed description and identification of EFH for salmon is found in Appendix A to Amendment 14 to the Pacific Coast Salmon Plan (PFMC 1999). Assessment of the impacts on these species' EFH from the above Proposed Action is based on this information.

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 manmade barriers, and longstanding, naturally-impassable barriers (i.e., natural waterfalls in existence for several hundred years). In particular, freshwater EFH for Chinook and coho salmon consists of four major components, (1) spawning and incubation; (2) juvenile rearing; (3) juvenile migration corridors; and (4) adult migration corridors and adult holding habitat.

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 exclusive economic zone, 200 miles offshore. In particular, marine EFH Chinook and coho salmon consists of three components, (1) estuarine rearing; (2) ocean rearing; and (3) juvenile and adult migration.

3.2 Adverse Effects on Essential Fish Habitat

Based on information submitted by the co-managers and evaluated in NMFS' analysis in the ESA consultation above, NMFS believes that the effects of this action on EFH are likely to be within the range of effects considered in the ESA portion of this consultation. Impacts to coho EFH will be similar to those impacts identified for Chinook salmon EFH and considered in this opinion.

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 2014). 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.

Fishing Activities

Most of the harvest related activities in Puget Sound occur from boats or along river banks, with most of the fishing activity in the marine and nearshore areas. The gear fishermen use include hook-and-line, drift and set gillnets, beach seines, and to a limited extent, purse seines. The types of salmon fishing gear that are used in Puget Sound salmon fisheries in general actively avoid contact with the substrate because of the resultant interference with fishing and potential loss of gear. 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 Skagit terminal area steelhead 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) it is likely that fewer nets will become derelict compared to several years and decades ago. Puget sound-wide, in 2014, an estimated 13 nets became derelict, and 12 of them where recovered (James 2015), in 2013 an estimated 15 nets became derelict, 12 of which were recovered (Beattie 2013), and in 2012 eight nets were lost, and six were recovered (Beattie and Adicks 2012). From June 2012 to February 2016 a total of 77 newly lost nets were reported, and only 6 of these were reported by commercial fishermen (Drinkwin 2016).The Proposed Action will result in comparatively small-scale fisheries within the Skagit River basin. These fisheries would not likely result in an increase in lost or derelict gear.

Harvest of Prey Species

Prey species can be considered a component of EFH (PFMC 2014). 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 does not include harvest of prey species and 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 would operate under the Proposed Action range in size from small crafts, such as drift boats and small jet sleds used in the recreational fishery to larger drift gill net boats used in the treaty commercial and Ceremonial and Subsistence fisheries. Section 4.2.2.29 of Appendix A to Amendment 18 of the Pacific Coast Salmon Plan (PFMC 2014) 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 (Marine Area 8.1). Also these activities would occur to some degree through implementation of fisheries or activities other than the Puget Sound salmon fisheries, i.e., recreational boating and marine species fisheries.

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 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. Removal of Chinook and coho salmon carcasses would not occur under the Proposed Action.

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 recommendations for salmon EFH because the proposed action will not have an adverse effect on salmon EFH.

3.4 Statutory Response Requirements

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

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

3.5 Supplemental Consultation

NMFS 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)).

4.0 DATA QUALITY ACT DOCUMENTATION AND PRE-DESSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this consultation are the applicants and action agencies listed on the first page. Other interested users could include the agencies, applicants, and the American public. Individual copies of this opinion were provided to the NMFS 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 adhere 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, if applicable*] contain more background on information sources and quality.

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

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

5.0 References

Atlas, W.I., T.W. Buehrens, D.J.F. McCubbing, R. Bilson, and J.W. Moore. 2015. Implications of spatial contraction for density dependence and conservation in a depressed population of anadromous fish. Canadian Journal of Fisheries and Aquatic Sciences. 72 (11): 1682-1693.

Battin, J., M. W. Wiley, M. H. Ruckelhaus, R. N. Palmer, E. Korb, K. K. Bartz, and H. Imaki. 2007. Projected impacts of climate change on salmon habitat restoration. Proceedings of the National Academy of Science. 104(16): 6720-6725.

Beattie, W. 2013. Letter describing derelict fishing nets in the Puget Sound area. On file with NMFS West Coast Region Sand Point Office.

Beattie, W. 2014. Conservation Planning Coordinator, NWIFC, Olympia, Washington. April 16, 2014. Personal communication via email with Amilee Wilson, NMFS, regarding native steelhead incidental encounters in Puget Sound treaty marine salmon and steelhead fisheries.

Beattie, W. and K. Adicks. 2012. Letter describing derelict fishing nets in the Puget Sound area. On file with NMFS West Coast Region, Sand Point Office.

Beechie, T., E. Buhle, M. Ruckelshaus, A. Fullerton, and L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. *Conservation* 130(4): 560-572.

Bishop, S., and A. Morgan (eds.). 1996. Critical habitat issues by basin for natural Chinook salmon stocks in the coastal and Puget Sound areas of Washington State. Northwest Indian Fisheries Commission, Olympia, WA. 105pp.

Booth, D. D. Hartley, and R. Jackson. 2002. Forest cover, impervious-surface area, and the mitigation of stormwater impacts. Journal of the American Water Resources Association. 38 (3).

Burgner, R. L., J. T. Light, L. Margolis, T. Okazaki, A. Tautz, and S. Ito. 1992. Distribution and origins of steelhead trout (*Oncorhynchus mykiss*) in offshore waters of the North Pacific Ocean. Int. North Pac. Fish. Comm. Bull. 51.

Chasco, B., Kaplan, I., Thomas, A., Acevedo-Gutiérrez, A., Noren, D.P., Ford, M.J., Hanson, M.B., Scordino, J., Jeffries, S.J., Pearson, S.F., and others. 2017. Estimates of Chinook salmon consumption in Washington State inland waters by four marine mammal predators from 1970–2015. Can. J. Fish. Aquat. Sci. (ja). Available from http://www.nrcresearchpress.com/doi/abs/10.1139/cjfas-2016-0203.

Cram, J., N. Kendall, T. Buehrens, A. Marshall, T. Seamons, K. Ryding, A. Weiss, B. Leland, and D. Rawding. (In prep.) Evaluating risks and prioritizing actions for Washington State steelhead. Washington Department of Fish and Wildlife, Olympia, Washington.

Dennis, M. 2017. Biologist, National Marine Fisheries Service. Lacey, Washington. April 12, 2017. Personal communication via email with Susan Bishop, Sustainable Fisheries

Division NMFS WCR, regarding estimated take of listed Puget Sound Chinook salmon and steelhead, and Puget Sound rockfish in scientific research.

Dennis, M. 2018. Biologist, National Marine Fisheries Service. Lacey, Washington. February 5, 2018. Personal communication via email with James Dixon, Sustainable Fisheries Division NMFS WCR, regarding estimated take of Skagit River steelhead in scientific research.

DFO (Department of Fish and Oceans). 2010. Population Assessment Pacific Harbour Seal (*Phoca vitulina richardsi).* DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/011.

Donaldson, L.R. 1943. Skagit River Hatchery location survey. Report to the Washington Department of Fisheries. 12 p. + appendices.

Drake, J., R. Emmett, K. Fresh, R. Gustafson, M. Rowse, D. Teel, M. Wilson, P. Adams, E. A. K. Spangler, R. Spangler. 2010. Status Review Update for Eulachon in Washington, Oregon and California. January 20, 2010. 443 p.

Drinkwin, J. 2016. Derelict fishing gear program progress and updates March 21, 2016. Northwest Straits Foundation. Powerpoint presentation on file with NMFS Sand Point Office, 7600 Sand Point Way, NE 98115.

EDPU. 2005. Elwha-Dungeness Watershed Plan, Water Resources Inventory Area 18 (WRIA 18) and Sequim Bay in West WRIA 17. Published by Clallam County. May 2005. Volume 1: Chapters 1-3 and 15 appendices; Volume 2: Appendix 3-E.

Einum, S., Nislow, K.H., Reynolds, J.D. & Sutherland, W.J. 2008. Predicting population responses to restoration of breeding habitat in Atlantic salmon. Journal of Applied Ecology 45: 930 938

Finstad, A.G., L.M. Saettem, S. Einum. 2013. Historical abundance and spatial distributions of spawners determine juvenile habitat accessability in salmon: implications for population dynamics and management targets. Can. J. of Fish. Aquat. Sci. 70:1339-1345.

Ford, M. J., editor. 2011. Status Review Update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113. 307 p.

Ford, M. J., J. Hempelmann, B. Hanson, K. L. Ayres, R. W. Baird, C. K. Emmons, J. I. Lundin, G. S. Schorr, S. K. Wasser, and L. K. Park. 2016. Estimation of a killer whale (*Orcinus orca*) population's diet using sequencing analysis of DNA from feces. PLoS One. 11(1): e0144956.

Fresh, K. L. 1997. The role of competition and predation in the decline of Pacific salmon and steelhead *in* Pacific salmon and their ecosystems, status and future options. D.J. Stouder, D.A. Bisson, and R.J. Naiman, editors. Chapman and Hall, New York. 245-275.

Gayeski, N. 2018. Ilustration of the development of a management strategy evaluation for harvest of ESA-listed wild Skagit River winter-run steelhead. Submitted as Appendix to WFC et al. 2018. 13p.

Gibson, C. 2013. Preventing the loss of gillnets in Puget Sound salmon fisheries. Prepared by the Northwest Straits Commission with the Northwest Indian Fisheries Commission. August 2013. http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/rockfish/puget_sound_derelict_gill_net_prevention_report.pdf.

Hannah, R. W., and S. A. Jones. 2007. Effectiveness of bycatch reduction devices (BRDs) in the ocean shrimp (*Pandalus jordani*) trawl fishery. Fisheries Research 85:217-225.

Hanson, M. B., R. W. Baird, J. K. B. Ford, J. Hempelmann-Halos, D. M. V. Doornik, J. R. Candy, C. K. Emmons, G. S. Schorr, B. Gisborne, K. L. Ayres, S. K. Wasser, K. C. Balcomb, K. Balcomb-Bartok, J. G. Sneva, and M. J. Ford. 2010. Species and stock identification of prey consumed by endangered southern resident killer whales in their summer range. Endangered Species Research. 11 69-82.

Hard, J. J., J. M. Myers, M. J. Ford, R. G. Cope, G. R. Pess, R. S. Waples, G. A. Winans, B. A. Berejikian, F. W. Waknitz, P. B. Adams, P. A. Bisson, D. E. Campton, and R. R. Reisenbichler. 2007. Status review of Puget Sound steelhead (*Oncorhynchus mykiss*). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-81, 137p.

Hard, J. J., J. M. Myers, E. J. Connor, R. A. Hayman, R. G. Kope, G. Lucchetti, A. R. Marshall, G. R. Pess, and B. E. Thompson. 2015. Viability criteria for steelhead within the Puget Sound distinct population segment. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-129.

Hay, D. E., and P. B. McCarter. 2000. Status of the eulachon *Thaleichthys pacificus* in Canada. Department of Fisheries and Oceans Canada, Canadian Stock Assessment Secretariat, Research Document 2000-145. Ottawa, Ontario.

Henry, K. 2014. Kendall Henry, Fish and Wildlife Biologist, Washington Department of Fish and Wildlife, Olympia, Washington. April 17, 2014. Personal communication via email with Amilee Wilson, NMFS, regarding native steelhead incidental encounters in Puget Sound non-treaty commercial salmon fisheries.

Henry, K. 2015. Kendall Henry, Fish and Wildlife Biologist, Washington Department of Fish and Wildlife, Olympia, Washington. March 11, 2015. Personal communication via email with Amilee Wilson, NMFS, regarding native steelhead incidental encounters in Puget Sound non-treaty commercial salmon fisheries.

Henry, K. 2017. Fish and Wildlife Biologist, Washington Department of Fish and Wildlife, Olympia, Washington. March 28, 2017. Personal communication regarding native steelhead incidental encounters in Puget Sound non-treaty commercial salmon fisheries.

HSRG. 2009. Columbia River Hatchery Reform System-Wide Report. Hatchery Scientific Review Group. February 2009. 272 p.

ISAB (Independent Science Advisory Board). 2007. Climate change impacts on Columbia River Basin fish and wildlife. Report ISAB 2007-2. Northwest Power and Conservation Council, Portland, Oregon. 146p http://www.nwcouncil.org/library/isab/isab2007-2.htm

James, C. 2015. Letter to Dan Tonnes, NMFS Protected Resources Division, describing derelict fishing nets in the Puget Sound area. April 23, 2015.

Jeffries, S. J., H. Huber, J. Calambokidis, and J. Laake. 2003. Trends and Status of Harbor Seals in Washington State. Journal of Wildlife Management. 67(1): 208-219.

Jeffries, S. 2011. Trends in other Chinook salmon predators. Presentation to Southern Resident Killer Whale Workshop. September 22, 2011. Power Point presentation.

Jones, R. 2015. 2015 5-Year Review - Listing Status under the Endangered Species Act for Hatchery Programs Associated with 28 Salmon Evolutionarily Significant Units and Steelhead Distinct Population Segments. Memorandum from Rob Jones, SFD NMFS WCR, to Chris Yates, PRD NMFS WCR. September 28, 2015. 54 p.

Jording, J. 2010. Fish and Wildlife Biologist, Washington Department of Fish and Wildlife, Olympia, WA. March 25, 2010. Personal communication with Amilee Wilson, NMFS NWR Sustainable Fisheries Division, regarding steelhead encounters in Puget Sound commercial salmon fisheries.

Joseph J., L. Loomis, S. Schuyler, and J.B. Scott. 2016. Cover letter transmitting the Skagit River Steelhead Resource Management Plan and requesting review under Limit 6 of the ESA 4(d) Rule. Dated November 4, 2016. Transmitted November 11, 2018. 1p.

Kendall, N.W., G.W. Marston, M.M. Klungle. 2017. Declining patterns of Pacific Northwest steelhead trout (*Oncorhynchus mykiss*) adult abundance and smolt survival in the ocean. Can. J. Fish. Aquat. Sci. 74: 1275-1290.

Kinsel, C.W., S.E. Vincent, M.S. Zimmerman, and J.H. Anderson. 2013. Abundance and age structure of Skagit River steelhead smolts: 2012 annual report. Washington Department of Fish and Wildlife Fish Program, Science Division. Prepared for: Upper Skagit Indian Tribe (EPA Puget Sound Partnership Implementation Agreement #11EPAPSP442).

Kinsel, C., J. Anderson, and M. LeMoine. 2016. Skagit River tributary steelhead trapping annual report. Washington Department of Fish and Wildlife, Science Division. EPA Puget Sound Partnership Implementation Agreements PA-01J016-3 & PA-00J912-01).

Kraig, E. 2017. Eric Kraig, Fish and Wildlife Biologist, Washington Department of Fish and Wildlife, Olympia, WA. April 2017. Personal communication with Bob Leland WDFW, regarding steelhead encounters in Puget Sound recreational salmon fisheries.

Leland, R. 2010. Robert Leland, Fish and Wildlife Biologist, Washington Department of Fish and Wildlife, Olympia, WA. April 1, 2010. Personal communication with Amilee

Wilson, NMFS NWR Salmon Management Division, regarding steelhead encounters in Puget Sound recreational salmon fisheries.

Little, A. C. 1898. Ninth annual report of the state fish commissioner. Washington Dept. Fish and Game, Olympia.

LLTK (Long Live The Kings). 2015. Why focus on the Salish Sea? Salish Sea Marine Survival Project. Long Live The Kings and Pacific Salmon Fund: http://marinesurvivalproject.com/the-project/why/. Accessed March 5, 2015.

Mantua, N., Nathan, I. Tohver, and A. Hamlet. 2009. Impacts of climate change on key aspects of freshwater salmon habitat in Washington State. *In*: Washington Climate Change Impacts Assessment: Evaluating Washington’s future in a changing climate. Climate Impacts Group, University of Washington, Seattle, Washington. Available at: http://cses.washington.edu/db/pdf/wacciach6salmon649.pdf

May, C.L., J.R. Koseff, L.V. Lucas, J.E. Cloern and D.H. Schoellhamer. 2003. Effects of spatial and temporal variability of turbidity on phytoplankton blooms, Marine Ecology Progress Series 254 (2003), pp. 111–128.

McClure, B. 2017. Responses to NOAA Fisheries' Questions as of June 28 and July 5, 2017 compiled by staff from the Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, Skagit River System Cooperative, and Washington Department of Fish and Wildlife submitted by Bob McClure (Upper Skagit Indian Tribe). July 11, 2017. 4p.

McCullough, D. 1999 . A Review and Synthesis of Effects of Alterations to the Water Temperature Regime on Freshwater Life Stages of Salmonids, with Special Reference to Chinook Salmon. Columbia Intertribal Fisheries Commission, Portland, OR. Prepared for the U.S. Environmental Protection Agency Region 10. Published as EPA 910-R-99-010.

McElhany, P., M. H. Ruckelshaus, M. J. Ford, T. C. Wainwright. 2000. Viable salmonid populations and the recovery of evolutionarily significant units. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42, 156p.

McGregor, I. A. 1986. Freshwater biology of Thompson River steelhead (*Salmo gairdneri*) as determined by radio telemetry. Master’s thesis. Univ. Victoria, BC.

McMillan, J. R., S. L. Katz, and G. R. Pess. 2007. Observational evidence of spatial and temporal structure in sympatric anadromous (winter steelhead) and resident rainbow trout mating system on the Olympic Peninsula, Washington. Trans. Am. Fish. Soc. 136:736–748.

McMillian, J.R. 2018. Stock Recruit evaluation Skagit_v1.doc. Sent to James Dixon, NMFS. February 8, 2018. 4p.

Moore, M., B. Berejikian, F. Goetz, T. Quinn, S. Hodgson, E. Connor, and A. Berger. 2014. Early marine survival of steelhead smolts in Puget Sound. Salish Sea Ecosystem Conference. May 1, 2014; Paper 199: http://cedar.wwu.edu/ssec/2014ssec/Day2/199. Accessed March 5, 2015.

Moscrip, A.L. and D.R. Montgomery. 1997. Urbanization Flood, Frequency and Salmon Abundance in Puget Lowland Streams. Journal of the American Water Resources Association 33 (1997) (6), pp. 1289–1297.

Mote, P. W. and E. P. Salathé. 2009. Future climate in the Pacific Northwest. In: *Washington Climate Change Impacts Assessment: Evaluating Washington's future in a changing climate*. Climate Impacts Group, University of Washington, Seattle, Washington. Available at: http://www.cses.washington.edu/db/pdf/wacciach1scenarios642.pdf.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California, U.S. Dept. Commer., NOAA Tech Memo. NMFS-NWFSC-35, 443p.

Myers, J.M., J.J. Hard, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Identifying historical populations of steelhead within the Puget Sound distinct population segment. U.S. Dept. Commer., NOAA Tech. Memo. NMFSNWFSC-128. doi:10.7289/V5/TM-NWFSC-128.

National Marine Fisheries Service (NMFS). 2001. Pacific Coastal Salmon Recovery Fund FY 2000 Program Report. Report to Congress.

NMFS. 2005. Chart Assessment for the Puget Sound Chinook Salmon ESU. Appendix A of the Final Assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead. Appendix A. NMFS Northwest Protected Resources Division 1201 NE Lloyd Blvd., Suite 1100, Portland, Oregon 97232-1274. August 2005. 55 p.

NMFS. 2006. Endangered Species Act Section 7 Consultation-Biological Opinion and Section 10 Statement of Findings and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Washington State Forest Practices Habitat Conservation Plan. NMFS, Northwest Region. June 5, 2006. 335 p.

NMFS. 2008a. Endangered Species Act - Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Consultation on Treaty Indian and Non-Indian Fisheries in the Columbia River Basin subject to the 2008-2017 *U.S. v. Oregon* Management Agreement. NMFS, Portland, Oregon. F/NWR/2008/02406. May 5, 2008. 685p.

NMFS. 2008b. Endangered Species Act – Section 7 Consultation Biological Opinion And Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on EPA's Proposed Approval of Revised Washington Water Quality Standards for Designated Uses, Temperature, Dissolved Oxygen, and Other Revisions. National Marine Fisheries Service Northwest Region. February 5, 2008. 133 p.

NMFS. 2008c. Endangered Species Act – Section 7 Consultation Final Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Implementation of the National Flood Insurance Program in the State of

Washington Phase One Document – Puget Sound Region. NMFS, Northwest Region. September 22, 2008. 226 p.

NMFS. 2008d. Endangered Species Act- Section 7 Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Consultation on the Approval of Revised Regimes under the Pacific Salmon Treaty and the Deferral of Management to Alaska of Certain Fisheries Included in those Regimes. NMFS, Northwest Region. December 22, 2008. 422 p.

NMFS. 2010a. Biological Opinion on the Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries and Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service in Puget Sound from May 1-July 31, 2010 on the Puget Sound Chinook Salmon Evolutionarily Significant Unit and the Puget Sound Steelhead Distinct Population Segment (DPS) and Conference Opinion on the Same Actions for the Puget Sound/Georgia Basin Rockfish DPS' Listed Under the Endangered Species Act and Magnuson-Stevens Act Essential Fish Habitat Consultation. National Marine Fisheries Service, Northwest Region. May 5. 74 pp.

NMFS. 2010b. Endangered Species Act Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consultation on the Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in Puget Sound from August 1, 2010 through April 30, 2011. National Marine Fisheries Service, Northwest Region. July 28. 95 pp.

NMFS. 2011. Evaluation of and Recommended Determination on a Resource Management Plan (RMP), Pursuant to the Salmon and Steelhead 4(d) Rule-Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component. May 27, 2011. 260 p.

NMFS. 2012a. Designation of critical habitat for Lower Columbia River coho salmon and Puget Sound steelhead draft biological report. NMFS, Northwest Region. Portland, Oregon. November 2012. 26 p.

NMFS. 2012b. Designation of critical habitat for Lower Columbia River coho salmon and Puget Sound steelhead draft section 4(b)(2) report. NMFS, Northwest Region. Portland, Oregon. November 2012. 99 p.

NMFS. 2013. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation - Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities. NMFS Consultation Number: 2012/00293. NMFS Northwest Region. January 2, 2013.

NMFS. 2014a. Endangered Species Act Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation – Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2014. NMFS, West Coast Region. F/WCR-2014-578. May 1, 2014. 156 p.

NMFS. 2014b. Draft environmental impact statement on two joint state and tribal resource management plans for Puget Sound salmon and steelhead hatchery programs. West Coast Region, Sustainable Fisheries Division. Lacey, WA

NMFS. 2015. Endangered Species Act Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation – Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2015. NMFS, West Coast Region. F/WCR-2015-2433. May 7, 2015. 174 p.

NMFS. 2016a. Endangered Species Act Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat (EFH) Consultation – Impacts of the Role of the BIA with Respect to the Management, Enforcement, and Monitoring of Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2016. NMFS, West Coast Region. F/WCR-2016-4914. June 24, 2016. 196 p.

NMFS. 2016b. Endangered and Threatened Species; Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead. 81 FR 9251. 9251-9325 pages. Available 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.

NMFS. 2016c. Endangered Species Act - Section 7 Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation for Three Hatchery and Genetic Management Plans for Early Winter Steelhead in the Dungeness, Nooksack, and Stillaguamish River basins under Limit 6 of the Endangered Species Act Section 4(d) Rule. NMFS Consultation Number: WCR-2015-2024.

NMFS. 2016d. Endangered Species Act - Section 7 Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation for National Marine Fisheries Service (NMFS) Evaluation of Ten Hatchery and Genetic Management Plans for Salmon and Steelhead in Hood Canal under Limit 6 of the Endangered Species Act Section 4(d) Rule. NMFS Consultation Number: WCR-2014-1688.

NMFS 2016e. Final environmental impact statement to analyze the impacts of NOAA's National Marine Fisheries Service proposed 4(d) determination under limit 6 for five early winter steelhead hatchery programs in Puget Sound. Sustainable Fisheries Division. Lacey, WA. 192 pages, plus appendices.

NMFS. 2017a. Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2017-2018 Puget Sound Chinook Harvest Plan, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2017. NMFS, West Coast Region. F/WCR-2017-6766. May 3, 2017. 191 p.

NMFS. 2017b. ESA Section 7(a)(2) letter of sufficiency regarding the Skagit River steelhead Resource Management Plan. From Peter Dygert, NMFS to Lorraine Loomis, Jason Joseph, Scott Schuyler, and James Scott. June 21, 2017. 2p.

NMFS 2017c. 2016 5-Year Review: Summary & Evaluation of Puget Sound Chinook Salmon Hood Canal Summer-run Chum Salmon Puget Sound Steelhead. NMFS, West Coast Region. April 6, 2017. 88 p.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest.

NWIFC (Northwest Indian Fisheries Commission). 2011. 1:24,000 (24K) Steelhead Distribution. GIS data layer. Available from NMFS, 1201 NE Lloyd Blvd., Suite 500, Portland, OR 97232.Overland, J., Rodionov, S., Minobe, S., and Bond, N. 2008. North Pacific regime shifts: definitions, issues and recent transitions. Prog. Oceanogr. **77**: 92–102. doi:10.1016/j.pocean.2008.03.016.

Pautzke, C. F., and R. C. Meigs. 1941. Studies on the life history of the Puget Sound steelhead trout (*Salmon gairdnerii* [sic]). Trans. Am. Fish. Soc. 70:209–220.

Pearcy, W., and N. Mantua. 1999. Changing ocean conditions and their effects on steelhead. University of Washington. Seattle, Washington. 13 p.

Peterson, W.W.T., and Schwing, F. 2003. A new climate regime in northeast Pacific ecosystems. Geophys. Res. Lett. **30**: 1–4. doi:10.1029/2003GL017528.

Pflug, D., E. Connor, B. Hayman, T. Kassler, K. Warheit, B. McMillan, and E. Beamer. 2013. Ecological, genetic, and productivity consequences of interactions between hatchery and natural origin steelhead of the Skagit Watershed. Report prepared for the Skagit River System Cooperative. Funding No. NMFS-FHQ-2008-2001011. (Available from the Skagit River System Cooperative, P.O. Box 368, La Conner, WA 98257.)

Pitcher, K. W., P. F. Olesiuk, R. F. Brown, M. S. Lowry, S. J. Jeffries, J. L. Sease, W. L. Perryman, C. E. Stinchcomb, and L. F. Lowry. 2007. Abundance and distribution of the eastern North Pacific Steller sea lion (*Eumetopias jubatus*) population. Fish. Bull. 107:102-115.

PFMC.1999. Appendix A. Identification and Description of Essential Fish Habitat, Adverse Impacts, and Recommended Conservation Measures for Salmon. Amendment 14 to the Pacific Coast Salmon Plan. August 1999.

PFMC. 2014. Pacific Coast Salmon Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as Amended through Amendment 18, PFMC. Portland, OR. 91 p. Available at: http://www.pcouncil.org/salmon/fishery-management-plan/current-management-plan/.

PSIT and WDFW. 2010. Draft Puget Sound Steelhead Harvest Management Plan. Available from Washington Department of Fish and Wildlife, Olympia, WA. January 7, 2010. 224p.

PSSTRT. 2013. Viability Criteria for Puget Sound Steelhead. Final Review Draft. 373 p.

Ravenel, W. de C. 1901. Report on the propagation and distribution of food-fishes. Report of the commissioner for the year ending June 30, 1900, p. 25–118. U.S. Commission of Fish and Fisheries, Washington, DC.

Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, Skagit River System Cooperative, and WDFW. 2016. Skagit River Steelhead Fishery Resource Management Plan. November 18, 2016.

Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, Skagit River System Cooperative, and WDFW. 2017. Supplemental Skagit RMP information sent to James Dixon, NMFS. July 11, 2017.

Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, Skagit River System Cooperative, and WDFW. 2018. Supplemental Skagit RMP information sent to James Dixon, NMFS. February 2, 2018.

Scott, J.B. and W.T. Gill. 2008. Assessment of Washington State's steelhead populations and programs. Washington Department of Fish and Wildlife. Olympia, Washington. February 2008.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An ecosystem approach to salmonid conservation. TR-4501-96-6057. ManTech Environmental Research Services Corp., Corvallis, Oregon. Available online at: http://www.nwr.noaa.gov/1habcon/habweb/habguide/ManTech/front.htm.

SSPS. 2005. Puget Sound Salmon Recovery Plan. Volumes I, II and III. Plan Adopted by the National Marine Fisheries Service (NMFS) January 19, 2007. Submitted by the Shared Strategy Development Committee. Shared Strategy for Puget Sound. Seattle, Washington. 503p.

SSPS. 2007. Puget Sound Salmon Recovery Plan. S. S. f. P. Sound. January, 2007. 2 Volumes.

TU (Trout Unlimited) 2018. Comment letter submitted to NMFS WCR SFD, for Nick Chambers, Wild Steelhead Initiative Organizer, in response to the Skagit steelhead RMP PEPD. January 8, 2018. 15p.

Turner, R. 2016a. Joint State/Tribal Hatchery and Genetic Management Plans Submitted by the Washington Department of Fish and Wildlife, with the Jamestown S 'Klallam Tribe, Lummi Nation, Nooksack Tribe, Stillaguamish Tribe, and Tulalip Tribes for Dungeness River, Nooksack River, and Stillaguamish River Hatchery Early Winter Steelhead, Under Limit 6 of the Endangered Species Act 4(d) Rule (50 CFR 223.203(6)) (65 FR 42422, July 10, 2000) - DECISION MEMORANDUM. Memo from R. Turner, SFD Assistant Regional Administrator, NMFS WCR to William W. Stelle, Jr., Regional Administrator, NMFS WCR. April 15, 2016.

Turner, R. 2016b. Joint State/Tribal Hatchery and Genetic Management Plans Submitted by the Washington Department of Fish and Wildlife with the Tulalip Tribes for Snohomish River Basin Hatchery Early Winter Steelhead, Under Limit 6 of the Endangered Species Act

4(d) Rule (50 CFR 223.203(6)) (65 FR 42422, July 10, 2000)- DECISION MEMORANDUM. Memo from R. Turner, SFD Assistant Regional Administrator, NMFS WCR to William W. Stelle, Jr., Regional Administrator, NMFS WCR. April 15, 2016

USBF (U.S. Bureau of Fisheries). 1900. Report of the U.S. commissioner of fish and fisheries, Washington, DC.

U.S. v. Oregon. 2009. 2008-2017 *U.S. v. Oregon* Management Agreement (modified January 23, 2009). Portland, Oregon.

U.S. v. Washington. 1974. 384 F. Supp 312 (W.D. Wash.), aff'd, 500F.2nd 676 (9thCr. 1975, cert. denied), 423 U.S. 1086 (1976). Seattle, Washington.

U.S. v. Washington. 1979. State of Washington v. Fishing Vessel Association. 443 U.S. 658 (1979). U.S. Supreme Court. July 2, 1979.

Walters, A.W., T. Copeland, and D.A. Venditti. 2013. The density dilemma: limitations on juvenile production in threatened salmon populations. Ecology of Freshwater Fish. 22: 508-519.

Ward, L., P. Crain, B. Freymond, M. McHenry, D. Morrill, G. Pess, R. Peters, J.A. Shaffer, B. Winter, and B. Wunderlich. 2008. Elwha River Fish Restoration Plan–Developed pursuant to the Elwha River Ecosystem and Fisheries Restoration Act, Public Law 102-495. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-90, 168 p.

Warheit, K. I. 2014. Measuring reproductive interaction between hatchery-origin and wild steelhead (Oncorhynchus mykiss) from northern Puget Sound populations potentially affected by segregated hatchery programs. Unpublished final report. October 10, 2014. Washington Department of Fish and Wildlife, Olympia, Washington. 92p.

Washington Department of Fish and Wildlife (WDFW). 2015. "Fishdist: 1:24,000 (24K) and 1:100,000 (100K) Statewide Salmonid Fish Distribution". GIS data obtained for lower Columbia River coho and Puget Sound steelhead from Washington Department of Fish and Wildlife, 600 Capitol Way N, Olympia WA 98501-1091.

Wilcox, W. A. 1895. Fisheries of the Pacific coast. Report of the commissioner for 1893, p. 139–304. U.S. Bureau of Commercial Fisheries, Washington, DC.

Wilcox, W. A. 1902. Notes of the fisheries of the Pacific coast in 1899. Report of the commissioner for the year ending June 30, 1901, p. 501–574. U.S. Bureau of Commercial Fisheries, Washington, DC.

Withler, I. L. 1966. Variability in life history characteristics of steelhead trout (*Salmo gairdneri*) along the Pacific coast of North America. J. Fish. Res. Board Can. 23(3):365–393. WSCC (Washington State Conservation Commission). 1999.