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, and the Washington Department of Fish and Wildlife (WDFW)

NMFS Consultation Number: WCR-2021-03137

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	N/A
Puget Sound Chinook salmon (*O. tshawytscha*)	Threatened	No	N/A	No	N/A
Southern Resident killer whales (*Orcinus orca*)	Endangered	No	N/A	No	N/A
Green Sturgeon – Southern Distinct Population Segment (*Acipenser medirostris*)	Threatened	No	N/A	No	N/A
Pacific Eulachon – Southern Distinct Population Segment (*Thaleichthys pacificus*)	Threatened	No	N/A	No	N/A

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: March 3, 2023 (***Date expires: April 30, 2032***)

TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

ACRONYMS

BIA	Bureau of Indian Affairs
CHART	critical habitat analytical review team
DIPs	demographically independent populations
DPS	distinct population segment
EFH	essential fish habitat
ERD	evaluation and recommended determination
ESA	Endangered Species Act
ESU	Evolutionary Significant Unit
FY	fiscal year
HR	harvest rate
HUC	hydrologic unit code
ITS	incidental take statement
MSA	Magnuson-Stevens Act
MSY	maximum sustainable yield
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
PBF	physical or biological features
PCE	primary constituent element
PEPD	proposed evaluation and pending determination
PIT	passive integrated transponder
PSIT	Puget Sound Indian Tribes
PSSTRT	Puget Sound Steelhead Technical Recovery Team
RM	river mile
RMP	resource management plan
SMU	Skagit Management Unit
WDFW	Washington Department of Fish and Wildlife
USFWS	United States Fish and Wildlife Service
USIT	Upper Skagit Indian Tribe
VSP	viable salmonid population

1.0 INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2.0 and 3.0, below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 U.S.C. 1531 et seq.), as amended, and implementing regulations at 50 CFR part 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 part 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within 2 weeks at the NOAA Library Institutional Repository (https://repository.library.noaa.gov/welcome). A complete record of this consultation is on file at the NMFS West Coast Regional Lacey, WA office.

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 (65 Fed. Reg. 42422, July 10, 2000). The ESA 4(d) Rule provides 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 the 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 DPS 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 on Puget Sound steelhead for the 2009 fishery year were evaluated in NMFS' biological opinion for the 2008 Pacific Salmon Treaty Agreement (NMFS 2008c). 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 2010c; 2010b).

A four-year RMP, covering the effects of Puget Sound salmon and steelhead fisheries, for fishery years 2011 through 2014, was submitted by the WDFW and Puget Sound Indian Tribes (PSIT) (together, referred to as the co-managers) and approved in 2011 (PSIT and WDFW 2010a; 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.

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, 2017, 2018, 2019, 2020, 2021, and 2022 fishery cycles (May 1, 2014 through May 14, 2023) that considered actions based on the management framework from the previously approved RMP, including similar actions by the BIA and USFWS (NMFS 2014b; 2015b; 2016c; 2017; 2018b; 2019a; 2020a; 2021b; 2022b). In each of these biological opinions, NMFS concluded that the proposed fisheries were not likely to jeopardize the continued existence of ESA-listed Puget Sound Chinook salmon, Southern Resident killer whales, Puget Sound steelhead, Puget Sound/Georgia Basin bocaccio, Puget Sound/Georgia Basin yelloweye rockfish, or the Central America of Mexico DPS of humpback whales. NMFS has reviewed and provided comments and guidance on a draft, non-annual Puget Sound RMP, submitted in December 2017 for consideration under Limit 6 of the ESA 4(d) Rule, and has continued to work with the Puget Sound co-managers on further development of the plan.

Specific to the Skagit River steelhead, on November 18, 2016, the Sauk-Suiattle Tribe, the Swinomish Indian Tribe, the Upper Skagit Indian Tribe, and the Washington Department of Fish and Wildlife (WDFW) (co-managers) submitted a Skagit River Steelhead Fishery Resource

Management Plan (2016 RMP)(Sauk-Suiattle Indian Tribe et al. 2016), and requested that NMFS make a determination as to whether the 2016 RMP meets the requirements of Limit 6 of the 4(d) Rule. The 2016 RMP proposed to utilize a Skagit River-specific steelhead management framework to manage impacts to natural-origin Skagit River steelhead, which are part of the ESA-listed DPS. The request relies on, as its basis, the information and commitments submitted by co-managers and proposed in the 2016 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. In 2018, NMFS completed a consultation under Section 7 of the ESA (NMFS 2018c). In that biological opinion, NMFS concluded that the proposed fisheries were not likely to jeopardize the continued existence of ESA-listed Puget Sound steelhead.

On December 8, 2021, the Sauk-Suiattle Tribe, the Swinomish Indian Tribe, the Upper Skagit Indian Tribe, and the Washington Department of Fish and Wildlife (WDFW) (co-managers) submitted a Skagit River Steelhead Fishery Resource Management Plan (2021 RMP) (Sauk-Suiattle Indian Tribe et al. 2021). The 2021 RMP proposes a continuation of a Skagit River-specific steelhead management framework to manage impacts to natural-origin Skagit River steelhead for a duration of 10 years. After thorough review of the 2021 Skagit RMP, NMFS responded to the applicants, on December 14, 2021 with confirmation that the plan was sufficient to begin the formal ESA 4(d) Rule review process (Jording 2021). NMFS' 4(d) Rule determination as to whether the 2021 RMP meets the required Limit 6 criteria is the proposed federal action, described below.

Consistent with requirements of the 4(d) Rule, NMFS assessed the RMP and prepared a Proposed Evaluation and Pending Determination (PEPD) as to whether the 2021 RMP addressed the criteria in under Limit 6 of the ESA 4(d) Rule for listed salmon and steelhead. The PEPD also analyzed whether implementation of the 2021 RMP would appreciably reduce the likelihood of survival and recovery of the ESA-listed Puget Sound Steelhead DPS. The PEPD was posted on the NMFS website and a notice of availability was posted in the Federal Register on December 23, 2022(87 FR 78944). The public comment period expired on January 23, 2023. 28 comments were received on the PEPD and NMFS prepared an Evaluation and Recommended Determination.

This opinion is based on information provided in the 2021 RMP, discussions with co-managers, 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.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 FR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on

November 16, 2022. As a result, the 2019 regulations are once again in effect, and we are applying the 2019 regulations here. For purposes of this consultation, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3 Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). The Federal action agency is NMFS.

The proposed action, a determination by NMFS that the 2021 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. A supportive 4(d), Limit 6 determination for the 2021 RMP would enable the Skagit co-managers to implement limited fisheries, directed at ESA-listed natural-origin Skagit River steelhead, in the Skagit Terminal Area, for a period of ten years (through April 30, 2032). The 2021 RMP would be implemented and enforced within the parameters set forth in *United States* v. *Washington.*

The 2021 RMP maintains management for the Skagit Management Unit (SMU) established in the 2016 RMP, for harvest management purposes only, comprised of four Demographically Independent Populations (DIPs) 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 into the SMU for the purposes of harvest management (Myers et al. 2015).

Under the 2021 RMP, the SMU would be independently managed, for harvest purposes (i.e., separate harvest limits), from the other populations in the Puget Sound Steelhead DPS. The 2021 RMP would apply an abundance-based, stepped harvest regime ranging from 4 percent at run sizes forecast to be below 4,000 fish to 25 percent when the terminal run size[2] of steelhead in the Skagit Basin is forecasted to exceed 8,000 fish (Table 1). These harvest rate limits would include all steelhead mortality from both incidental mortality in Skagit terminal area (see section 2.3, Action Area) salmon fisheries as well as from the directed steelhead fisheries proposed in the 2021 RMP.

---

[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. 2021).

[2] Skagit River steelhead terminal run size is the total adult steelhead annually estimated to return to the Skagit Terminal Area from marine waters.

Table 1. Stepped fishing regime proposed for managing steelhead fisheries in the Skagit River (Sauk-Suiattle Indian Tribe et al. 2021).

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 2021 RMP proposes that treaty tribal directed commercial, subsistence, and ceremonial fisheries for steelhead are operated by the Swinomish, Sauk-Suiattle, and Upper Skagit Tribes in the Skagit Terminal Area and utilize net and hook and line gear. Under this plan, tribal net fisheries directed at the steelhead would typically operate between December 1st and April 15th, but time and area regulations will vary depending on the pre-season estimate of steelhead run size as well as other species that may be potentially affected by a fishery (Sauk-Suiattle Indian Tribe et al. 2021).

A directed steelhead recreational fishery may be conducted during the period beginning no earlier than February 1st and extending no later than April 30th, annually. Time and area restrictions would vary depending on the forecasted return of wild winter steelhead (see Table 1) and potential incidentally impacted species. Recreational steelhead fishing occurs primarily in freshwater and the retention of marked (adipose fin clipped) hatchery steelhead is allowed. Retention of unclipped Skagit steelhead may be allowed depending upon the preseason abundance projection and given the harvest rates proposed in this RMP. Since the retention of unclipped steelhead is currently prohibited state-wide, this would require a rule change approved by the Washington Fish and Wildlife Commission (Sauk-Suiattle Indian Tribe et al. 2021). Retention of incidentally caught hatchery steelhead (summer and winter) during recreational fisheries may be permitted unless specifically prohibited. There is no implied intent within this plan for recreational fisheries directed at wild summer steelhead. However, wild summer steelhead may be incidentally encountered during fisheries for trout and salmon. Angling is restricted in some streams to protect migrating juvenile and adult salmonids (Sauk-Suiattle Indian Tribe et al. 2021).

The 2021 RMP also proposes to develop and utilize an in-season update (ISU) fishery during the ten-year management period based on the long-standing tangle-net test fishery. These updates would further inform annual harvest management by making appropriate adjustments, in season, to the allowable impact rate consistent with Table 1 during the fishing season (Sauk-Suiattle Indian Tribe et al. 2022).

The 2021 RMP proposes several additional conservation actions to be continued or implemented to conserve or build the population structure and diversity of the Skagit River steelhead. 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 (Sauk-Suiattle Indian Tribe et al. 2021).

Additionally, the 2021 RMP also proposes continued annual monitoring measures for the Skagit River steelhead populations throughout the duration of the RMP in order to better inform the status of each population individually. These monitoring measures would include annual accounting of recreational encounters, all landed catch, estimates of non-landed mortalities, and estimation of spawning abundance to provide the basic information needed to monitor population abundance trends and assess management performance against the harvest objectives (harvest rate ceilings and abundance thresholds) (Sauk-Suiattle Indian Tribe et al. 2021). These actions are described in more detail in the RMP and NMFS' Evaluation and Recommended Determination (ERD), and incorporated here by reference (Sauk-Suiattle Indian Tribe et al. 2021; NMFS 2023).

The 2021 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.

This opinion analyzes the effects of the 2021 RMP on the Puget Sound Steelhead DPS. The 4(d) Rule determination covers the 10-year term of the 2021 RMP.

Other Puget Sound treaty and non-treaty salmon fisheries occur in the Action Area (Section 2.3), including fisheries for Chinook, coho, sockeye, and chum salmon, which may incidentally impact Skagit River steelhead. These incidental impacts will be included in calculation of the overall, annual impact rates described in the Skagit RMP.

We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not.

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, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species or to 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 provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes reasonable and prudent measures

(RPMs) and terms and conditions to minimize such impacts.

NMFS determined the proposed action is not likely to adversely affect the Puget Sound Chinook Salmon ESU, the Southern Resident Killer Whale DPS, Southern DPS Green Sturgeon, or Southern DPS Eulachon or their designated critical habitats. These findings are documented in the "Not Likely to Adversely Affect" Determinations section (Section 2.12).

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 "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably 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 also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation of critical habitat for Puget Sound Steelhead DPS use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced 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.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis and, in this opinion, we use the terms "effects" and "consequences" interchangeably.

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

- *Evaluate the rangewide status of the species and critical habitat expected 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 through viable salmonid populations (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 PBFs which were identified when the critical habitat was designated.

- *Evaluate the environmental baseline of the species and critical habitat.* The environmental baseline (Section 2.4) 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.

- *Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.* In Section 2.5, 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.

- *Evaluate cumulative effects.* Cumulative effects (Section 2.6), 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.

- *Integration and synthesis.* In section 2.7, we add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly 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; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.

- *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 to the action in Section 2.9. The reasonable and prudent alternative 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 Puget Sound Steelhead DPS, which is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. 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 function of the PBFs that are essential for the conservation of the species.

2.2.1 Status of Listed Species

Climate Change

One factor affecting the overall status of Puget Sound salmonids and aquatic habitat is climate change. Below, we describe climate change and other ecosystem effects on Puget Sound steelhead.

Changes in climate and ocean conditions happen on several different time scales and have had a profound influence on distributions and abundances of marine and anadromous fishes. Salmon and steelhead throughout Washington are also likely affected by climate change in both freshwater and marine habitats. 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). These changes will shrink the extent of the snowmelt-dominated habitat available to salmonids and may restrict our ability to conserve diverse salmon and steelhead life histories, making 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).

As trends progress toward warmer oceans and streams, more extreme winter flood events, summer low flows, loss of snowpack in the mountains, and ocean acidification, salmon face increasing challenges (Ford 2022). Higher ambient air temperatures will likely cause water temperatures to rise (ISAB 2007). Salmonids require cold water for spawning and incubation. As climate change progresses and stream temperatures warm, thermal refugia will be essential to persistence of many salmonid populations. Thermal refugia are important for providing salmonids with patches of suitable habitat while allowing them to undertake migrations through or to make foraging forays into areas with greater than optimal temperatures. To avoid waters above summer maximum temperatures, juvenile rearing may be increasingly found only in the confluence of colder tributaries or other areas of cold water refugia (Mantua et al. 2009). Summer steelhead populations within the Puget Sound DPS may be more vulnerable to climate change since there are few summer run populations that belong to the DPS as compared to winter run populations, they exhibit relatively small abundances, and they occupy limited upper river tributary habitat. In an assessment of exposure to climate change, Crozier et al. (2019) found that steelhead vulnerability to climate change is high due to high exposure and sensitivity, but also ranked Puget Sound steelhead as having a high adaptive capacity, which would help mitigate the negative effects of climate change (Crozier et al. 2019; Ford 2022).

In marine habitat, scientists are not certain of all the factors impacting steelhead survival, but several ocean basin-scale and regional-scale events are linked with fluctuations in steelhead health and abundance, such as the Oceanic Niño Index (ONI), the Pacific Decadal Oscillation (PDO), and deep-water salinity and temperature (Ford 2022). The NWFSC's Annual Salmon Forecast[3] provides annual summaries of these ocean indicators and more based on large-scale physical, regional-scale physical, and local-scale biological data that occur in the year of ocean entry for salmon smolts (Ford 2022). In general, years that are favorable for salmonid survival are characterized by physical conditions that include cold water along the U.S. West Coast before or after outmigration, no El Niño events at the equator, cold and salty water locally, and an early onset of upwelling. Climate change plays a part in steelhead mortality but more studies are needed to determine the specific causes of this marine survival decline in Puget Sound (Salish Sea Marine Survival Project 2015).

Overall, the marine heat wave from 2014 to 2016 had the most drastic impact on marine ecosystems in 2015, with lingering effects into 2016 and 2017. Conditions had somewhat returned to "normal" in 2018, but another marine heat wave in 2019 again set off a series of marine ecosystem changes across the North Pacific. One reason for lingering effects of ecosystem response is due to biological lags. These lags result from species impacts at larval or juvenile stages, which are typically most sensitive to extreme temperatures or changes in food supply. It is only once these species grow to adult size or recruit into fisheries that the impact of

---

[3] https://www.fisheries.noaa.gov/west-coast/science-data/ocean-ecosystem-indicators-pacific-salmon-marine-survival-northern

the heat wave is apparent (Ford 2022). Any rebound in VSP parameters for Puget Sound steelhead are likely to be constrained under these conditions (NWFSC 2015; Ford 2022).

A primarily positive or slightly negative pattern in the PDO was in place from 2014 through 2019, though since 2019 the pattern has been primarily negative[4]. The NWFSC's most recent 2022 summary of ocean ecosystem indicators[5] reported 2022 was a mix of good and bad ocean conditions for juvenile salmon in the Northern California Current. The PDO turned negative (cool phase) in January 2020 and has remained negative through 2022 with some of the lowest (coldest) values in the 25-year time series occurring in 2021 and 2022. The ONI also signaled cold ocean conditions. The ONI turned negative in May 2020 and has remained negative throughout 2022 with La Niña conditions (values less than or equal to -0.5 °C) for the last 15 consecutive three-month periods (August 2021 to October 2022). The National Weather Service Climate Prediction Center predicted ONI to remain negative throughout the winter and transition to ENSO-neutral conditions in February-April 2023. Despite the lackluster upwelling, the northern copepod biomass anomalies and copepod species richness showed signs of cool conditions in the spring and early summer. Still, the anomalies of northern copepods turned weakly negative by mid-summer, resulting in average biomass anomalies for the May–September period. Weakly positive temperature anomalies occurred in June 2022, following weak upwelling conditions. Strongly positive temperature anomalies followed in July through September. Cool and neutral temperature anomalies returned in September, the remainder of fall was punctuated by strong positive anomalies. The existing regional climate cycles will interact with global climate changes in unknown and unpredictable ways (NWFSC 2023[5]).

2.2.1.1 Status of Puget Sound Steelhead

The Puget Sound Steelhead DPS was listed as a threatened species under the ESA on May 11, 2007 (72 FR 26722). Subsequent status assessments of the DPS after the ESA-listing decision have found that the risk of extinction has not changed substantially (Ford et al. 2011; NMFS 2016a; Ford 2022) (81 FR 33468, May 26, 2016). On October 4, 2019 NMFS published a Federal Register notice (84 FR 53117), announcing NMFS' intent to initiate a new 5-year status review for 28 listed species of Pacific salmon and steelhead and requesting updated information from the public to inform the most recent five-year status review. On March 24, 2020, NMFS extended the public comment period, from the original March 27, 2020, through May 26, 2020 (85 FR 16619). The NWFSC completed a recent biological viability assessment (Ford et al. 2022) as part of the five-year review. the NMFS' West Coast Region is currently preparing the final five-year status review document for all Puget Sound listed salmon and steelhead, with anticipated completion in 2023.

At the time of listing, the PSSBRT 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

---

[4] https://www.ncei.noaa.gov/access/monitoring/pdo/.

[5] https://www.fisheries.noaa.gov/west-coast/science-data/2022-summary-ocean-ecosystem-indicators

releases of out-of-DPS hatchery fish from Skamania-derived summer run and Chambers Creek-derived winter run stocks (Discussed further in Section 2.4.1; Hard et al. 2007; Hard et al. 2015). Loss of diversity and spatial structure were judged to be "moderate" risk factors (Hard et al. 2007). In 2011, the BRT identified degradation and fragmentation of freshwater habitat, with consequential effects on connectivity, as the primary limiting factors and threats facing the Puget Sound Steelhead DPS (Ford et al. 2011). The BRT also determined that most of the steelhead populations within the DPS continued to show downward trends in estimated abundance, with a few sharp declines (Ford et al. 2011). The 2015 status review concurred with the earlier BRT review that harvest and hatchery production of steelhead in Puget Sound were at low levels and not likely to increase substantially in the foreseeable future, thus these risks have been reduced since the time of listing. However, unfavorable environmental trends previously identified (Ford et al. 2011) were expected to continue (Hard et al. 2015).

As part of the recovery planning process, NMFS convened the Puget Sound Steelhead Technical Recovery Team (PSSTRT) in 2011 to identify historic populations and develop viability criteria for the recovery plan. The PSSTRT delineated populations and completed a set of population viability analyses (PVAs) for these Demographically Independent Populations (DIPs) and Major Population Groups (MPGs) within the DPS that are summarized in the final draft viability criteria reports (Puget Sound Steelhead Technical Recovery Team 2011; PSSTRT 2013; NWFSC 2015). This framework and associated analysis provided a technical foundation for the recovery criteria and recovery actions identified in the subsequent Puget Sound Steelhead Recovery Plan (NMFS 2019e) at the watershed scale, and higher across the Puget Sound Steelhead DPS.

The populations within the Puget Sound Steelhead DPS are aggregated into three extant MPGs containing a total of 32 DIPs based on genetic, environmental, and life history characteristics (PSSTRT 2013; Hard et al. 2015; Ford 2022). Populations 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 1 illustrates the DPS, the MPGs, and the DIPs for Puget Sound steelhead.

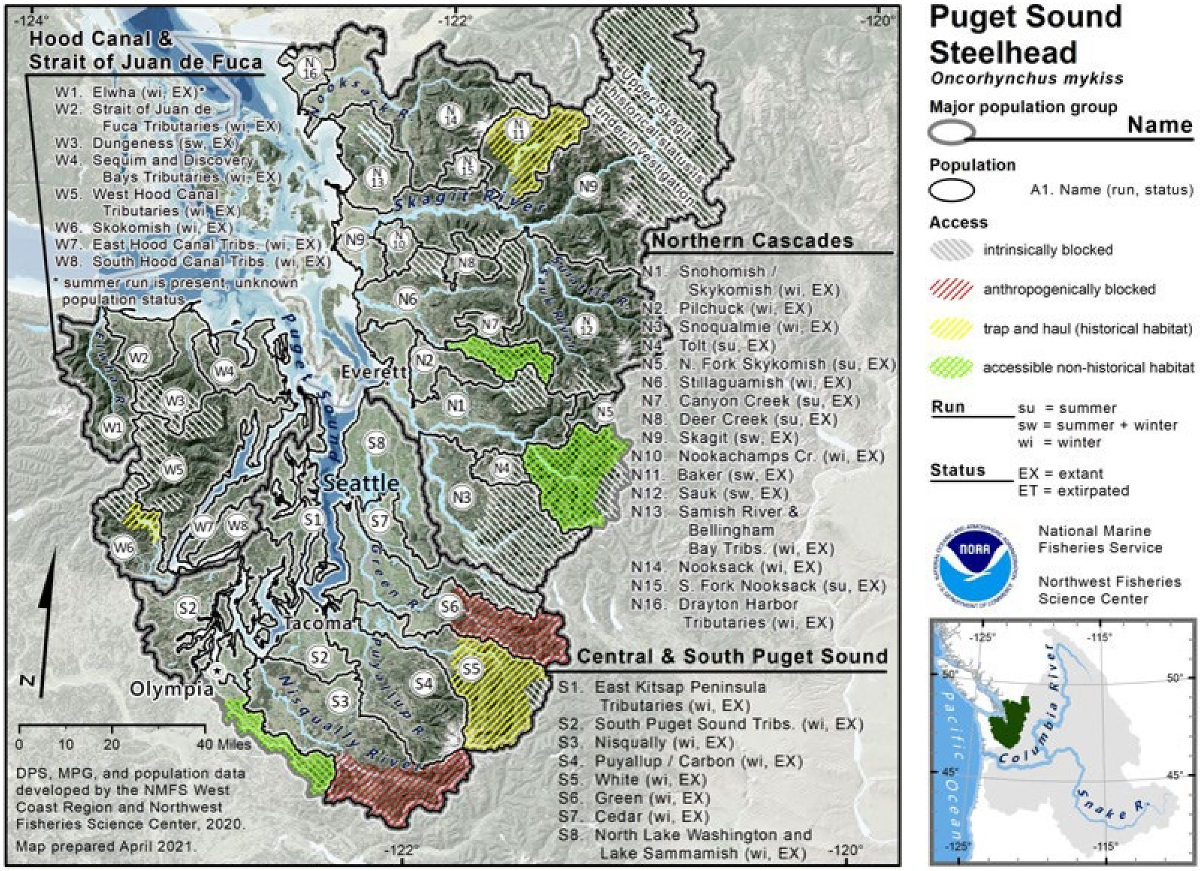


Figure 1. Map of the Puget Sound Steelhead DPS's spawning and rearing areas, identifying 32 demographically independent populations (DIPs) within 3 major population groups (MPGs). The three steelhead MPGs are the Northern Cascades MPG, Central & South Puget Sound MPG, and Hood Canal & Strait of Juan de Fuca MPG. Areas where dams block anadromous access to historical habitat is marked in red cross-hatching; and areas where historical habitat is accessible via trap and haul programs is marked in yellow cross-hatching. Areas where the laddering of falls has provided access to non-historical habitat is marked in green cross-hatching. Finally, historically inaccessible portions of watersheds are marked in grey and white cross-hatching (Ford 2022).

NMFS adopted a recovery plan for Puget Sound steelhead on December 20, 2019 (https://www.fisheries.noaa.gov/resource/document/esa-recovery-plan-puget-sound-steelhead-distinct-population-segment-oncorhynchus). The Puget Sound Steelhead Recovery Plan (Plan) (NMFS 2019e) provides guidance to recover the species to the point that it can be naturally self-sustaining over the long term. To achieve full recovery, steelhead populations in Puget Sound need to be robust enough to withstand natural environmental variation and some catastrophic events, and they should be resilient enough to support harvest and habitat loss due to human population growth. The Plan aims to improve steelhead viability by addressing the pressures that contribute to the current condition: habitat loss/degradation, water withdrawals, declining water quality, fish passage barriers, dam operations, harvest, hatcheries, climate change effects, and reduced early marine survival. NMFS is using the recovery plan to organize and coordinate recovery of the species in partnership with state, local, tribal, and federal resource managers, and the many watershed restoration partners in the Puget Sound. Consultations, including this one, will incorporate information from the Plan (NMFS 2019e).

In the Plan, NMFS and the PSSTRT modified the 2013 and 2015 PSSTRT viability criteria to produce the viability criteria for the Puget Sound Steelhead DPS, as described below:

- All three MPGs (North Cascades, Central-South Puget Sound, and Hood Canal-Strait of Juan de Fuca) (Figure 1) must be viable (Hard et al. 2015). The three MPGs differ substantially in key biological and habitat characteristics that contribute in distinct ways to the overall viability, diversity, and spatial structure of the DPS.
- There must be sufficient data available for NMFS to determine that each MPG is viable.

The Plan (NMFS 2019e) also established MPG-level viability criteria. The following are specific criteria are required for MPG viability:

- At least 50 percent of steelhead populations in the MPG achieve viability.
- Natural production of steelhead from tributaries to Puget Sound that are not identified in any of the 32 identified populations provides sufficient ecological diversity and productivity to support DPS-wide recovery.
- In addition to the minimum number of viable DIPs (50 percent) required above, all DIPs in the MPG must achieve an average MPG-level viability that is equivalent to or greater than the geometric mean (averaged over all the DIPs in the MPG) viability score of at least 2.2 using the 1–3 scale for individual DIPs described under the DIP viability discussion in the PSSTRT Viability Criteria document (Hard et al. 2015). This criterion is intended to ensure that MPG viability is not measured (and achieved) solely by the strongest DIPs, but also by other populations that are sufficiently healthy to achieve MPG-wide resilience. The Plan allows for an alternative evaluation method to that in Hard et al. (2015) may be developed and used to assess MPG viability.

The Plan (NMFS 2019e) also identified specific DIPs in each of the three MPGs which must attain viability. These DIPs, by MPG, are described as follows:
For the **North Cascades MPG,** eight of the sixteen DIPs must be viable. The eight DIPs described below must be viable to meet this criterion:

- Of the eleven DIPs with winter or winter/summer runs, five must be viable:
- Nooksack River Winter-Run;
- Stillaguamish River Winter-Run;
- One from the Skagit River (either the Skagit River Summer-Run and Winter-Run or the Sauk River Summer-Run and Winter-Run);
- One from the Snohomish River watershed (Pilchuck, Snoqualmie, or Snohomish/Skykomish River Winter-Run); and
- One other winter or summer/winter run from the MPG at large.

The rationale for this is that there are four major watersheds in this MPG, and one viable population from each will help attain geographic spread and habitat diversity within core extant steelhead habitat (NMFS 2019e). Of the five summer-run DIPs in this MPG, three must be viable, representing each of the three major watersheds containing summer-run populations (Nooksack, Stillaguamish, Snohomish rivers). Therefore, the priority summer-run populations are as follows:

- South Fork Nooksack River Summer-Run;
- One DIP from the Stillaguamish River (Deer Creek Summer-Run or Canyon Creek Summer-Run); and
- One DIP from the Snohomish River (Tolt River Summer-Run or North Fork Skykomish River Summer-Run).

As described, these priority populations in the North Cascades MPG include specific, winter or winter/summer-run populations from the Nooksack, Stillaguamish, Skagit or Sauk, and Snohomish River basins and three summer-run populations from the Nooksack, Stillaguamish, and Snohomish basins. These populations are targeted to achieve viable status to support MPG viability. Having viable populations in these basins assures geographic spread, provides habitat diversity, reduces catastrophic risk, and increases life-history diversity (NMFS 2019e).

For the **Central and South Puget Sound MPG,** four of the eight DIPs must be viable. The four DIPs described below must be viable to meet this criterion:

- Green River Winter-Run;
- Nisqually River Winter-Run;
- Puyallup/Carbon Rivers Winter-Run, or the White River Winter-Run; and
- At least one additional DIP: Cedar River, North Lake Washington/Sammamish Tributaries, South Puget Sound Tributaries, or East Kitsap Peninsula Tributaries.

The rationale for this prioritization is that steelhead inhabiting the Green, Puyallup, and Nisqually River watersheds currently represent the core extant steelhead populations and these watersheds contain important diversity of stream habitats in the MPG.

For the **Hood Canal and Strait of Juan de Fuca MPG,** four of the eight DIPs must be viable. The four DIPs described below must be viable to meet this criterion:

- Elwha River Winter/Summer-Run (see rationale below);
- Skokomish River Winter-Run;
- One from the remaining Hood Canal populations: West Hood Canal Tributaries Winter-Run, East Hood Canal Tributaries Winter-Run, or South Hood Canal Tributaries Winter-Run; and
- One from the remaining Strait of Juan de Fuca populations: Dungeness Winter-Run, Strait of Juan de Fuca Tributaries Winter-Run, or Sequim/Discovery Bay Tributaries Winter-Run.

The rationale for this prioritization is that the Elwha and Skokomish rivers are the two largest single watersheds in the MPG and bracket the geographic extent of the MPG. Furthermore, both Elwha and Skokomish populations have recently exhibited summer-run life histories, although the Dungeness River population was the only summer/winter run in this MPG recognized by the PSTRT in Hard et al. (2015). Two additional populations, one population from the Strait of Juan de Fuca area and one population from the Hood Canal area, are needed for a viable MPG to maximize geographic spread and habitat diversity.

Lastly, the Plan (NMFS 2019e) also identified additional attributes, or characteristics which should be associated with a viable MPG.

- All major diversity and spatial structure conditions are represented, based on the following considerations:
    - Populations are distributed geographically throughout each MPG to reduce risk of catastrophic extirpation; and
    - Diverse habitat types are present within each MPG (one example is lower elevation/gradient watersheds characterized by a rain-dominated hydrograph and higher elevation/gradient watersheds characterized by a snow-influenced hydrograph).

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.

Abundance and Productivity

Puget Sound steelhead abundance estimates are available for seven of the 11 winter-run DIPs and one of the five summer-run DIPs in the Northern Cascades MPG,[6] five of the eight winter-run DIPs in the Central and South Puget Sound MPG,[7] and seven of the eight winter-run DIPs in the Hood Canal and Strait of Juan de Fuca MPG.[8] Little or no data is available on summer-run populations to evaluate extinction risk or abundance trends. Because of their small population size and the complexity of monitoring fish in headwater holding areas, summer steelhead have not been broadly monitored. Data continue to only be available for one summer-run DIP, the Tolt River steelhead population in the Northern Cascades MPG from 2015 to 2019.

Long-term abundance of steelhead in populations for which data are available (Figure 2) has shown a generally declining trend across much of the DPS over the full period of the abundance data available for each DIP; however, the latest biological viability assessment update notes that in the near term, there has been a relative improvement in abundance and productivity (Ford 2022). Since 2015, 14 of the 22 populations indicate small to substantive increases in

---

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

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

[8] 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.

abundance[9], though most steelhead populations remain small. From 2014 to 2019, eight of the 22 steelhead populations had fewer than 250 natural spawners annually, and 12 of the 22 steelhead populations had 500 or fewer natural spawners (Table 2).

The current abundance for Puget Sound steelhead populations, as estimated for the 2015-2019 time period (NMFS 2019e; WDFW 2021; Ford 2022) is based on data for fewer than 40 percent of the DIPs (WDFW 2021). However, these data indicate that the Puget Sound Steelhead DPS is currently at less than 25 percent of recovery goals, as identified for the DIPs which had sufficient data to assess (WDFW 2021). Where recent five-year abundance information is available, 30 percent (6 out of 20) of the populations are at less than 10 percent of their High Productivity Recovery Targets (lower abundance target), 65 percent (13 out of 20) of the populations are between 10 percent and 50 percent of lower abundance recovery targets, and 5 percent (1 out of 20) of populations are at 50 percent and 100 percent of the recovery target (Table 3)(Ford 2022).

---

[9] South Hood Canal, Skokomish River, Westside Hood Canal Tributaries, Elwha River, Samish River/Bellingham Bay Tributaries, Nooksack River, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, Carbon River, and Nisqually River Nooksack River, Samish River/Bellingham Bays Tributaries, Skagit River, Stillaguamish River, Pilchuck River, Cedar River, Green River, Puyallup River, and Nisqually River show increasing trends (Table 2) (Ford 2022).

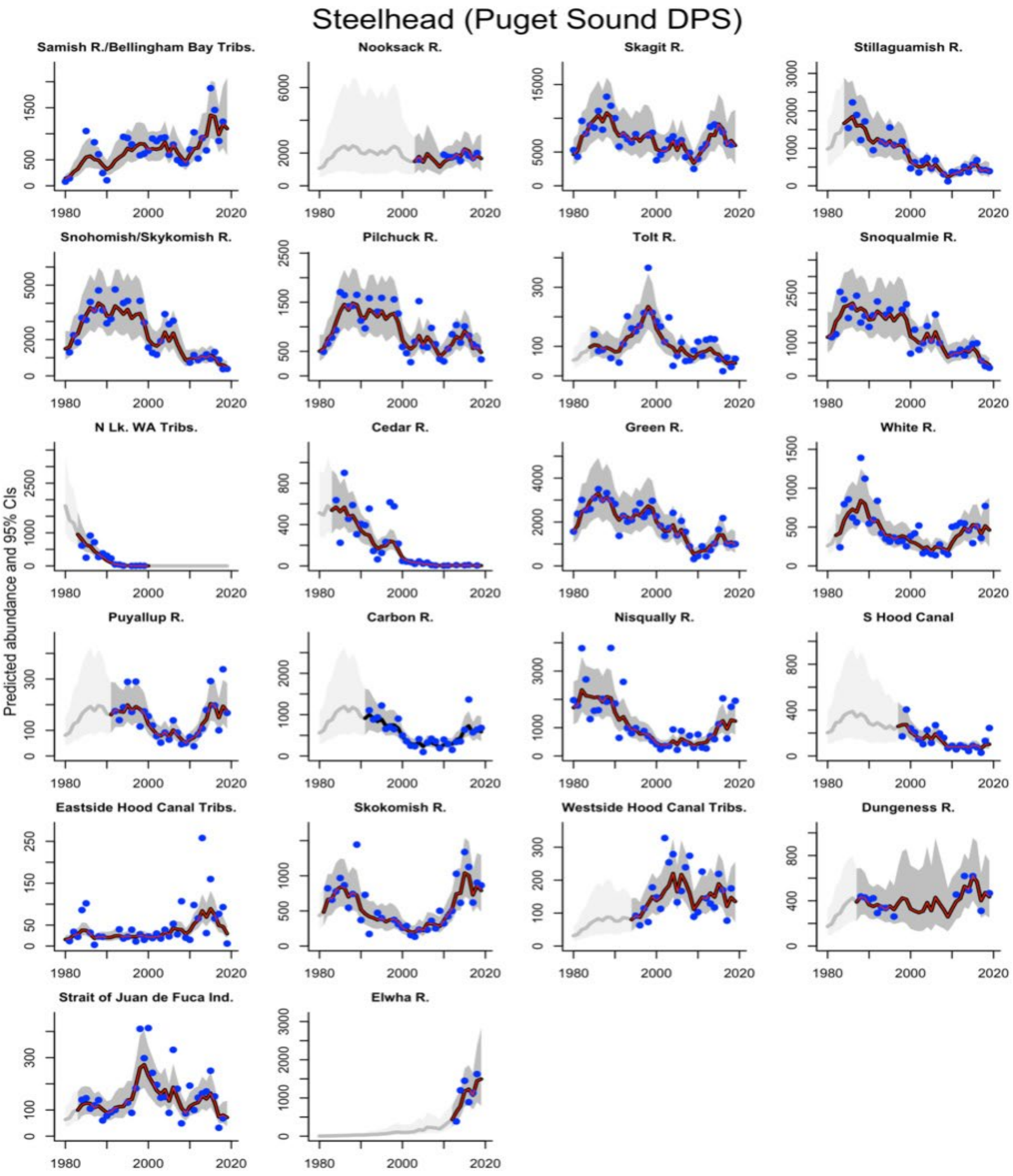


Figure 2. Smoothed trend in estimated total (thick black line, with 95 percent confidence interval in gray) and natural (thin red line) population spawning abundance. In portions of a time series where a population has no annual estimates but smoothed spawning abundance is estimated from correlations with other populations, the smoothed estimate is shown in light gray. Points show the annual raw spawning abundance estimates. For some trends, the smoothed estimate may be influenced by earlier data points not included in the plot. Note: For this DPS, abundance data are for natural-origin spawners (Ford 2022).

Table 2. Five-year geometric mean of raw natural spawner counts for Puget Sound steelhead. This is the raw total spawner count times the fraction natural estimate, if available. In parentheses, the 5-year geometric mean of raw total spawner counts is shown. A single value not in parentheses means that the fraction natural was 1.0 and thus, the total count was the same as the natural-origin count. The geometric mean was computed as the product of counts raised to the power 1 over the number of counts available (2 to 5). A minimum of 2 values was used to compute the geometric mean. Percent change between the most recent two 5-year periods is shown on the far right. Key: HCSJF = Hood Canal & Strait of Juan de Fuca MPG; NC = Northern Cascades MPG; CPSC = Central & South Puget Sound MPG; W = winter; Su = summer (Ford 2022).

Population	MPG	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	Percent Change
South Hood Canal W	HCSJF	-	263	176	145	69	91	32
Eastside Hood Canal Tributaries W	HCSJF	27	21	25	37	60	54	-10
Skokomish River W	HCSJF	385	359	205	320	533	938	76
Westside Hood Canal Tributaries W	HCSJF	-	97	208	167	138	150	9
Dungeness River Su and W	HCSJF	356	-	-	-	517	448	-13
Strait of Juan de Fuca and Independent Tributaries W	HCSJF	89	191	212	118	151	95	-37
Elwha River W	HCSJF	-	-	-	-	680	1,241	82
Samish River/Bellingham Bay Tributaries W	NC	316	717	852	535	748	1,305	74
Nooksack River Su and W	NC	-	-	-	-	1,745	1,906	9
Skagit River Su and W	NC	7,202	7,656	5,419	4,677	6,391	7,181	12
Stillaguamish River W	NC	1,078	1,166	550	327	386	487	26
Snohomish/Skykomish Rivers W	NC	3,629	3,687	1,718	2,942	975	690	-29
Pilchuck River W	NC	1,225	1,465	604	597	626	638	2
Snoqualmie River W	NC	1,831	2,056	1,020	1,250	706	500	-29
Tolt River Su	NC	112	212	119	70	108	40	-63
North Lake Washington Tributaries W	CSPS	60	4	-	-	-	-	-
Cedar River W	CSPS	241	295	37	12	4	6	50
Green River W	CSPS	2,062	2,585	1,885	1,045	662	1,289	95
White River W	CSPS	524	311	301	173	514	415	-12
Puyallup River W	CSPS	167	196	93	72	85	201	136
Carbon River W	CSPS	969	800	335	246	290	735	153

Population	MPG	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019	Percent Change
Nisqually River W	CSPS	1,200	754	409	446	477	1,368	187

Table 3. Recent 5-year (2015–19) geometric mean of raw natural spawner counts for Puget Sound steelhead populations and population groups compared with Puget Sound steelhead recovery plan high and low productivity recovery targets (NMFS 2019e). Asterisks indicate that the abundance is only a partial population estimate. Superscript *1*s ([1]) indicate that these populations have a combined target. Abundance is compared to the high-productivity individual DIP targets. Colors indicate the relative proportion of the recovery target currently obtained: red = <10%, orange = 10% > *x* < 50%, yellow = 50% > *x* < 100%, green = >100% (Ford 2022).

		Abundance		
			Target	
MPG	Population	2015–19	High productivity	Low productivity
HCSJF	South Hood Canal	91	2,100	7,100
HCSJF	Eastside Hood Canal Tributaries	93	1,800	6,200
HCSJF	Skokomish River	958	2,200	7,300
HCSJF	Westside Hood Canal Tributaries	150	2,500	8,400
HCSJF	Dungeness River	408	1,200	4,100
HCSJF	Strait of Juan de Fuca Independent Tributaries	95	1,000	3,300
HCSJF	Elwha River	1,241	2,619	2,619
HCSJF	Sequim and Discovery Bay Tributaries	n/a	500	1,700
NC	Samish River/Bellingham Bay Tributaries	1,305*	1,800	6,100
NC	Nooksack River	1,906	6,500	21,700
NC	Skagit River	7,181[1]	15,000	15,000
NC	Stillaguamish River	487	7,000	23,400
NC	Snohomish/Skykomish Rivers	690	6,100	20,600
NC	Pilchuck River	638	2,500	8,200
NC	Snoqualmie River	500	3,400	11,400
NC	Tolt River (SU)	40	300	1,200
NC	Drayton Harbor Tributaries	n/a	1,100	3,700
NC	South Fork Nooksack River (SU)	n/a	400	1,300
NC	Sauk River	[1]	15,000	15,000
NC	Nookachamps River	[1]	15,000	15,000
NC	Baker River	[1]	15,000	15,000
NC	Canyon Creek (SU)	n/a	100	400
NC	Deer Creek (SU)	n/a	700	2,300
NC	North Fork Skykomish River (SU)	n/a	200	500

CSPS	North Lake Washington Tributaries	n/a	4,800	16,000
CSPS	Cedar River	n/a	1,200	4,000
CSPS	Green River	1,282	5,600	18,700
CSPS	White River	130	3,600	12,000
CSPS	Puyallup/Carbon Rivers	136	4,500	15,100
CSPS	Nisqually River	1,368	6,100	20,500
CSPS	East Kitsap Tributaries	n/a	2,600	8,700
CSPS	South Sound Tributaries	n/a	6,300	21,200

Steelhead productivity has been variable for most populations since the mid-1980s (Figure 3). Since around 2000, productivity has fluctuated around replacement for Puget Sound steelhead populations, but the majority have predominantly been below replacement (NWFSC 2015; Ford 2022). Some steelhead populations have shown signs that productivity has been above replacement in the most recent years for which data are available (2015-2019) (Figure 3). Steelhead populations with recent productivity estimates generally above replacement include the Samish River, Nooksack River, Skagit River, Green River, White River, Puyallup River, Nisqually River, the South, East, and West Hood Canal Tributaries, the Skokomish River, and the Elwha River (Figure 3)(NWFSC 2015; Ford 2022).

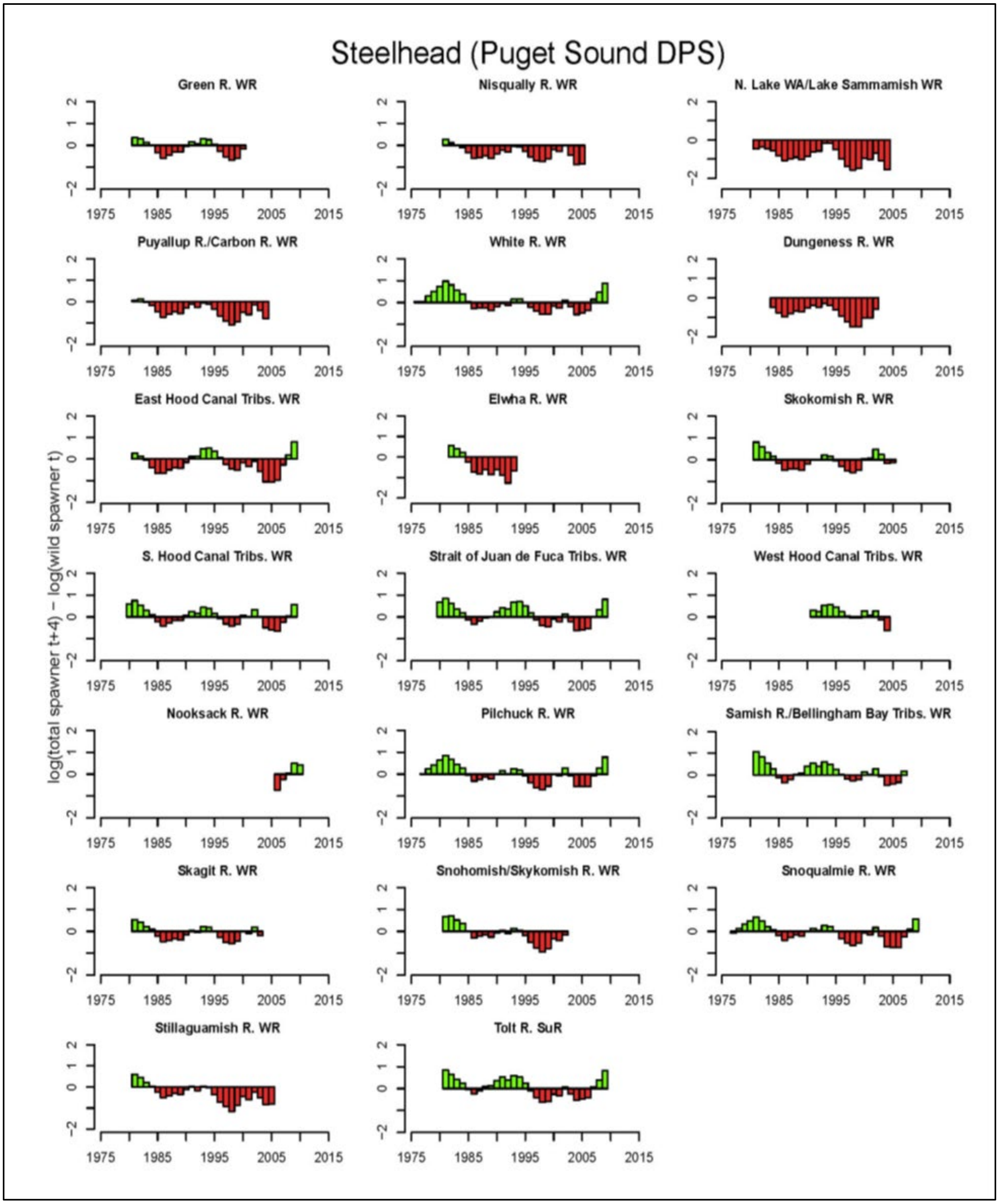


Figure 3. Trends in population productivity of Puget Sound steelhead, by run-year (Ford 2022).

Spatial Structure and Diversity

Spatial structure and diversity consider a population's identifying characteristics—such as utilization of habitat, distribution of spawning aggregations, genetic and phenotypic traits, life-history characteristics such as growth rate, frequency and phenology of reproduction (seasonal run and spawn timing), and age structure. Spatial structure and diversity buffer a population against short-term environmental fluctuations and long-term climatic change (Ford 2022). For spatial structure, the factors the TRT considered for influence on viability included fraction of suitable rearing and spawning habitat occupied by steelhead throughout the DPS (Ford 2022).

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. 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). In October of 2016, NMFS proposed revisions to inclusion of the hatchery programs as part of Pacific salmon ESUs and steelhead DPSs listed under the ESA (81 FR 72759). NMFS issued its final rule in December of 2020 (85 FR 81822). This final rule includes steelhead from five artificial propagation programs in the Puget Sound Steelhead DPS: The Green River Natural Program; White River Winter Steelhead Supplementation Program; Hood Canal Steelhead Supplementation Program; the Lower Elwha Fish Hatchery Wild Steelhead Recovery Program; and the Fish Restoration Facility Program (85 FR 81822, December 17, 2020).

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 available intrinsic potential rearing and spawning habitat that is occupied compared to what is needed for viability.[10] 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. The PSSTRT concluded that low population viability was widespread throughout the DPS and populations showed evidence of diminished spatial structure and diversity. 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 (Puget Sound Steelhead Technical Recovery Team 2011). 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,

---

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

and freshwater habitat fragmentation or loss (NWFSC 2015). The Puget Sound Steelhead Technical Recovery Team (PSSTRT) concluded that the Puget Sound DPS was at very low viability, considering the status of all three of its constituent MPGs, and many of its 32 DIPs (Hard et al. 2015). For spatial structure there were a number of events that occurred in Puget Sound during the last review period (since 2015) that are anticipated to improve status populations within several of the MPGs within the DPS. These will be discussed further in the Environmental Baseline, Section 2.4.

Since the PSSTRT completed its review, there have been a number of genetic studies related to Puget Sound steelhead population structure and hatchery-origin steelhead introgression. Additional analyses of Puget Sound steelhead population demographics, distribution, and habitat are provided in the 2019 Recovery Plan (Ford 2022). Since publication of the NWFSC report in 2015, reductions in hatchery programs founded from non-listed and out-of-DPS stocks (i.e., Skamania) have occurred. The magnitude of these changes will be discussed in detail in section 2.4.1. In addition, the fraction of out-of-DPS hatchery steelhead spawning naturally are low for many rivers (NWFSC 2015; NMFS 2016g; 2016f). The fraction of natural-origin steelhead spawners was 0.9 or greater for the 2005-2009 and 2010-2014 time periods for all populations where data was available. For 17 of 22 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). However, the fraction of natural-origin steelhead spawners could not be estimated for a substantial number of DIPs during the 2010-2014 period, or for the most recent 2015-2019 timeframe (Ford 2022). In some river systems, such as the Green River, Snohomish/Skykomish Rivers, and the Stillaguamish Rivers the estimated levels of hatchery-origin spawners were higher than some guidelines recommend (e.g., no more than 5 percent hatchery-origin spawners on spawning grounds for isolated hatchery programs (HSRG 2009) over the 2005- 2009 and 2010-2014 timeframes. The 2022 NWFSC Biological Viability Assessment (Ford 2022) states that a third of the 32 Puget Sound steelhead populations continue to lack monitoring of abundance data, and in most cases it is likely that abundances are very low. Steelhead hatchery programs are discussed in further detail in the Environmental Baseline, Section 2.4.

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. Summer-run fish produced in isolated hatchery programs were historically derived from the Skamania River summer stock in the lower Columbia River Basin (i.e., from outside the DPS). The production and release of hatchery fish of both run types (winter and summer) may continue to pose risk to diversity in natural-origin steelhead in the DPS, as described in Hard et al. (2007) and Hard et al. (2015). However, the 2022 NWFSC Biological Viability Assessment (Ford 2022) states that risks to natural-origin Puget Sound steelhead that may be attributable to hatchery-related effects has decreased since the 2015 status review due to reductions in production of non-listed stocks, and the replacement with localized stocks. The three summer steelhead programs continuing to propagate Skamania derived stocks from outside of Puget Sound should be phased out completely by 2031 (NMFS 2019b; Ford 2022). Lastly, annual reporting from the operators and current science suggest that risks remain at the same low to negligible levels as evaluated in 2016 and 2019 (NMFS 2016a; 2019b; 2019e).

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).

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).

Overall, the status of the Puget Sound Steelhead DPS, based on the best available data on spatial structure, diversity, abundance, and productivity has improved since the last status review in 2015 (Ford 2022). Recent increases in abundance observed for the majority (15 out of 21) of steelhead DIPs where data are available from 2015-2019 have been modest, and are generally within the range of variability observed in the time series for which data is available. The production of hatchery fish founded from non-listed stocks of both run types (Chambers (EWS) winter and Skamania (ESS) summer) continues to pose risk to diversity to natural-origin steelhead in the DPS (Hard et al. 2007; Hard et al. 2015; NMFS 2019e; Ford 2022). However, hatchery production has declined in recent years across the DPS, especially for non-listed stocks, and the fraction of hatchery spawners are low for many rivers. In addition, discontinuation of the release of Skamania hatchery-origin summer-run steelhead from the three programs currently operating is planned for the near future (Ford 2022).

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. Limiting factors are defined as impaired physical, biological, or chemical features (e.g., inadequate spawning habitat, high water temperature, insufficient prey resources) and associated ecological processes and interactions experienced by the fish that result in reductions in VSP parameters (abundance, productivity, spatial structure, and diversity). This analysis, combined with Ford (2022) and the Puget Sound Steelhead Recovery Plan (NMFS 2019e), identified the following factors, as well as ten primary pressures associated with the listing decision for Puget Sound steelhead, and subsequent affirmations of the listing, as those limiting steelhead recovery:

- 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. This includes agriculture, residential, commercial and industrial development (including impervious surface runoff), timber management activities, water withdrawals and altered flows.

- Fish passage barriers at road crossings and dams.
- Reduced spatial structure for steelhead in the DPS.
- Reduced habitat quality through changes in river hydrology and temperature profile, which are expected to increase with continuing climate change.
- Reduced 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 considered a significant limiting factor for Puget Sound steelhead due to low harvest rates.
- Threats to genetic diversity and ecological interactions posed by use of two hatchery steelhead stocks (Chambers Creek and Skamania) inconsistent with wild stock recovery throughout the DPS. However, the risk to the species' persistence that may be attributable to hatchery-related effects has declined since the last status review, based on hatchery risk reduction measures that have been implemented. Improvements in hatchery operations associated with ongoing ESA review and determination processes are expected to further reduce hatchery-related risks. Further, hatchery releases of steelhead founded from non-native or out of DPS stocks have declined, and are expected to decrease further or cease as a term of recent 4(d) authorizations.
- Declining diversity in the Puget Sound DPS, including the uncertain, but likely weak, status of summer-run fish in the DPS.
- High rates of juvenile mortality in estuarine and marine waters of Puget Sound, attributed to marine mammal predation, parasite prevalence, and contaminant loads.
- Concerns regarding existing regulatory mechanisms and land-use management plans, lack of reporting and enforcement for some regulatory programs, certain Federal, state, and local land and water use decisions continue to occur 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 allow direct and indirect species take and/or adverse habitat effects.

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 ESA-listed steelhead, the action area includes all of the Skagit River Basin (Figure 4) accessible to steelhead as well as Marine Area 8-1 of Puget Sound (Skagit Bay, Figure 5). This action area includes the areas where fishing under the proposed action could take place, and where the effects of that fishing on listed fish species considered in this opinion would occur.

Within the Skagit River Basin, the action area includes all mainstem and tributary waters utilized by adult and juvenile Skagit River steelhead for migration, emigration, holding, spawning, and rearing. The freshwater portion of the action area includes the Skagit River tributaries including but not limited to the Cascade River; the Sauk River subbasin and tributaries, the Suiattle River, Finney Creek and Nookachamps Creek. The areas above hydro-impoundments on the Upper Skagit and Baker River (Figure 4) are not included in the action area.

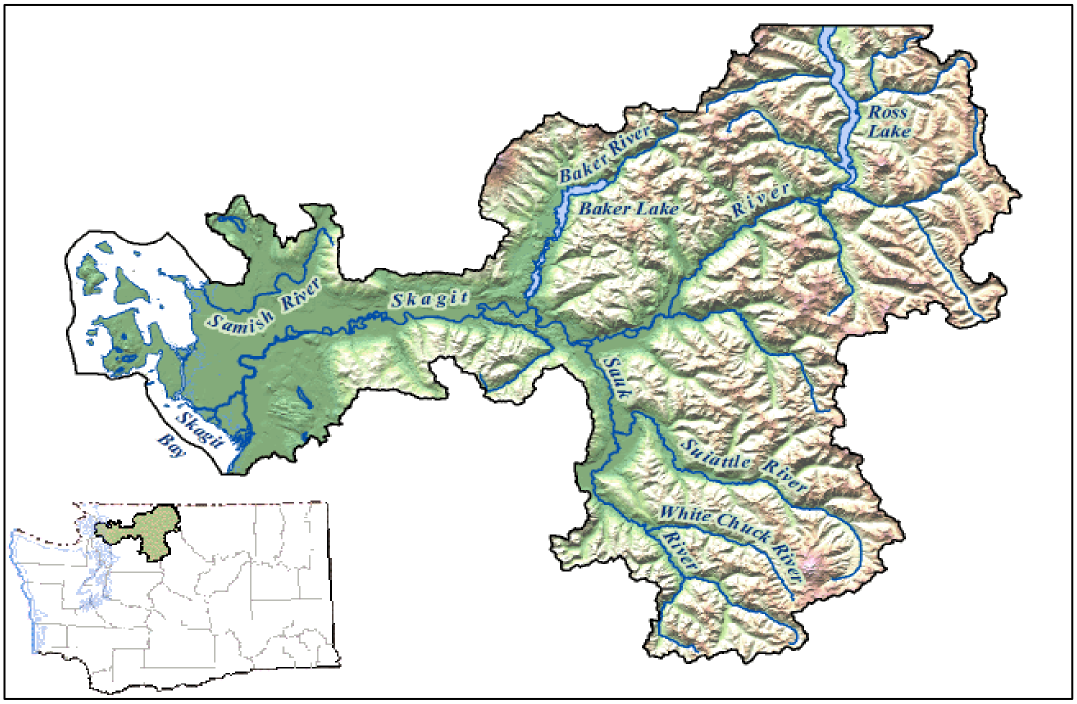


Figure 4. Map of the Skagit Terminal Area.

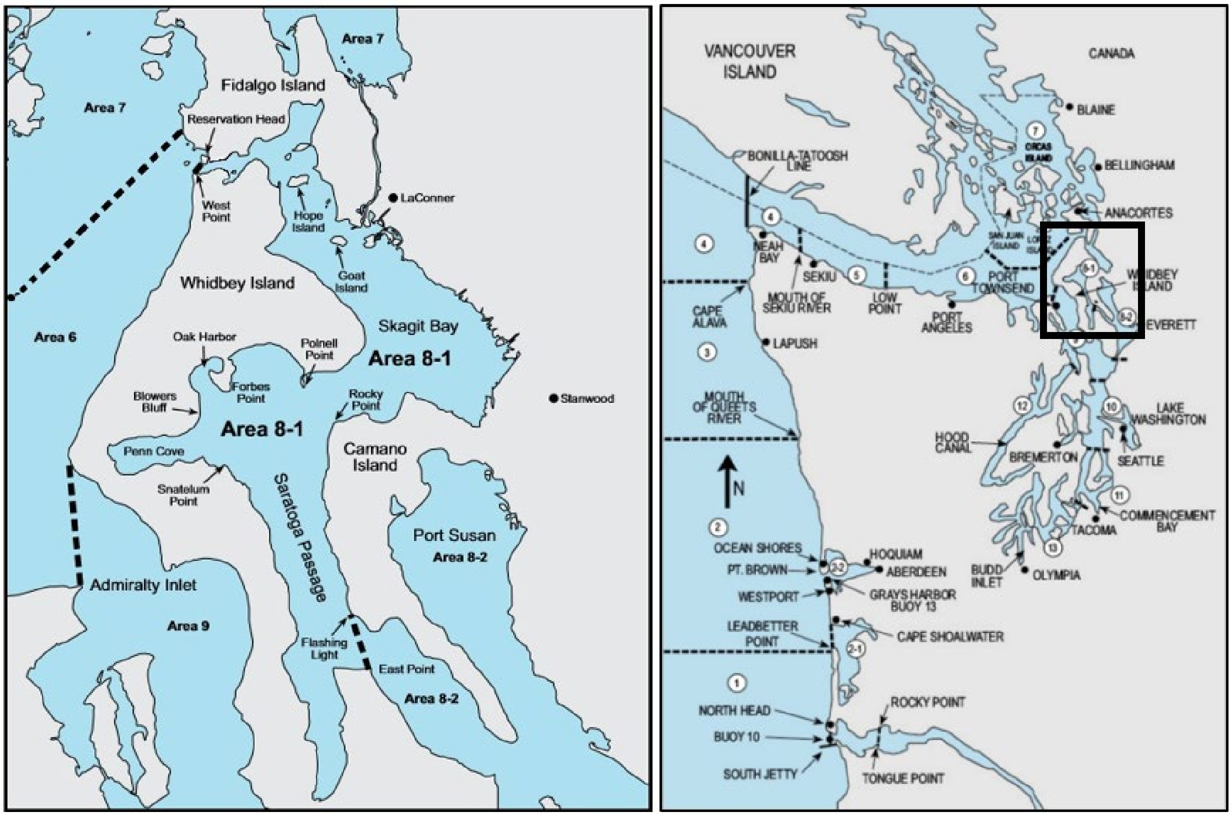


Figure 5. Map of Marine Area 8-1 relative to all the WDFW Washington Marine Areas.

The action area comprising the Skagit River Basin and Skagit Bay is also referred to as the Skagit Terminal Area (Sauk-Suiattle Indian Tribe et al. 2021).

2.4 Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

The environmental baseline includes the effects of many activities that occur within the action area. The status of the species described in Section 2.2 of the opinion is a consequence of those effects.

NMFS recognizes the unique status of treaty Indian fisheries in relation to the environmental baseline. Implementation of treaty Indian fishing rights involves, among other things, application of the various legal principles regarding sharing established in *United States* v. *Washington*. Exploitation rate calculations and harvest levels to which the sharing principles apply 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 *U.S.* v. *Washington*, Secretarial Order 3206, and other applicable laws and policies. The conservation principles of *U.S.* v. *Washington* will guide the 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

additional Federal action would be developed with government-to-government discourse involving both technical and policy representatives of NMFS and affected Indian tribes prior to finalizing a proposed course of action.

2.4.1 Puget Sound Steelhead

In this section we will describe the past and present activities in the action area that have impacted the Puget Sound Steelhead DPS and contributed to its current status

Climate Change and Other Ecosystem Effects

More detailed discussions about the likely effects of large-scale environmental variation on salmonids, including climate change, are found in Section 2.2.1 of this opinion. Climate change has broad and substantial negative implications for salmonids and salmonid habitat in the Pacific Northwest (e.g., Climate Impacts Group 2004; Beechie et al. 2006; Zabel et al. 2006; Battin et al. 2007; ISAB 2007; Mantua et al. 2010; Wade et al. 2013; Tohver et al. 2014; Mauger et al. 2015; Crozier et al. 2019), including the Skagit River system (e.g., Lee and Hamlet 2011; Rybczyk et al. 2016; Austin et al. 2021).

Warmer streams, ocean acidification, lower summer stream flows, and higher winter stream flows are projected to negatively affect salmonids (Blum et al. 2018). Increased stream temperatures are expected to increase metabolic rates in salmon requiring increased food availability (Myrvold and Kennedy 2018), making the persistence of cold water “refugia” within rivers and the diversity among salmon populations critical in helping salmon populations adapt to future climate conditions. Similar types of effects on salmon may occur in the marine ecosystem including warmer water temperatures, loss of coastal habitat due to sea level rise, ocean acidification, and changes in water quality and freshwater inputs (Mauger et al. 2015; Thorne et al. 2018).

Harvest

Harvest of Puget Sound steelhead is limited to terminal tribal net fisheries and recreational fisheries. In response to declining abundance throughout the 1990s, harvest rates were curtailed in 2003, with “wild” harvest rates reduced to below 10 percent (NMFS 2018a). Recreational fisheries are mark-selective for hatchery stocks, but some natural-origin steelhead are encountered, with a proportion of those fish subject to hooking mortality and noncompliance. Hatchery steelhead production for harvest is primarily of Chambers Creek winter-run stock (South Puget Sound) and Skamania Hatchery summer-run stock, both of which have been selected for an earlier run timing than natural stocks to minimize fishery interactions. In tribal net fisheries, most indirect fishery impacts occur in fisheries directed at salmon and hatchery steelhead. Some additional impacts occur in pre-terminal fisheries, but these are negligible and data are insufficient to attribute them to individual populations. Consequently, harvest impacts are reported as terminal harvest rates (Ford 2022).

Harvest rates differ widely among the different rivers, but all have declined since the 1970s and 1980s. Harvest rates on natural steelhead during the earlier period averaged between 10 and 40 percent, with some populations in the central and south parts of Puget Sound, such as the Green and Nisqually River populations, experiencing harvest rates over 60 percent. In recent years, terminal harvest rates have continued to decline, averaging less than 2 percent over the last five years.

On April 11, 2018, NMFS approved a five-year joint tribal and state RMP (2016 RMP) for a tribal harvest and recreational catch and release fishery for natural-origin steelhead in the Skagit River basin under the ESA 4(d) Rule (NMFS 2018c). Similar to the previous 2016 RMP, under the proposed action, harvest rates would be based on overall escapement (spawning abundance) (Ford 2022). The plan also addressed incidental impacts to steelhead in the Skagit River from fisheries targeting other species of salmon. The annual allowable impact rate to Skagit steelhead in the Skagit area fisheries is determined using a sliding scale system based on the terminal run size forecast for the Skagit River (Table 1). NMFS (2018c) concluded that the effects of the Skagit steelhead fishery on the viability and recovery of the Puget Sound Steelhead DPS would be low and that the 2016 RMP met the requirements of the ESA 4(d) Rule.

Fisheries under the 2016 RMP were limited in 2018. Recreational steelhead fishing occurred from April 14, 2018 until April 29, 2018. No tribal directed steelhead fishery occurred in 2018. The 2018 steelhead run forecast was for 5,247, which limited the overall annual fishery impact on steelhead to 10 percent. During the short time the Skagit recreational catch-and-release fishery was open in 2018 an estimated total of 568 wild steelhead were caught and released, resulting in an estimated 57 mortalities (WDFW and PSTIT 2018). When combined with the estimated incidental mortalities from tribal and recreational fisheries targeting other species, the overall estimated steelhead mortalities (i.e., impacts) during the 2017-18 Skagit steelhead management period, including the April 2018 directed recreational steelhead fishery, were 116. The 2017-18 post season run size estimate was 6,199 steelhead (WDFW and PSTIT 2018) which was larger than the pre-season forecast. The 116 estimated mortalities resulted in an overall impact rate of 1.87 percent (Table 4), far lower than either the 20 percent or 10 percent limits that the final run size or the forecasted run size, respectively, would have allowed (Table 4) (NMFS 2022b).

The 2018-2019 Skagit fishery represented the first full season for the steelhead directed fishery. The preseason forecast was 6,567 natural-origin steelhead, which would allow an up to 20 percent terminal impact rate. The co-managers post-season reported total mortality was 326 natural-origin steelhead for the July 1, 2018 through June 30, 2019 management period. The final post-season run size estimate was 4,636, which resulted in a total harvest rate of 7.04 percent (WDFW 2019). This final rate was below both the 20 and 10 percent limits of either the pre-season forecasted rate or the rate that resulted from the lower post-season run estimate, respectively (Table 4)(NMFS 2022b).

Based on the 2019-2020 pre-season steelhead forecast of 3,963 natural-origin steelhead, the co-managers did not implement any steelhead-directed fisheries in the Skagit Basin for the 2019-2020 season, which ended on June 30, 2020 (WDFW et al. 2021a; WDFW et al. 2021b). All incidental impacts on Skagit steelhead in fisheries directed at other species were managed under the 4 percent limit (Table 4)(NMFS 2022b). The final post-season run size estimate was 3,092 and total mortality was estimated to be 72 steelhead. The final mortality rate was estimated at 2.32 percent, substantially under the maximum allowable harvest rate of 4 percent.
The 2020-2021 Skagit Basin pre-season steelhead forecast was 4,297 natural-origin steelhead. The final post-season run size estimate was 3,578, and total mortality was estimated to be 209 steelhead. The final harvest rate was estimated at 5.84 percent (Table 4), substantially under the maximum allowable harvest rate of 10 percent allowed under the pre-season run size estimate of >4,000 (Table 4)(WDFW et al. 2022a).

The most recent 2021-2022 Skagit Basin pre-season steelhead forecast was 3,833 natural-origin steelhead. The final post-season run size estimate was 5,805, and total mortality was estimated to be 198 steelhead. The final mortality rate was estimated at 3.41 percent, under the maximum allowable harvest rate of 4 percent allowed under the pre-season run size estimate of <4,000 (Table 4)(WDFW et al. 2022a).

A summary of the results of the steelhead harvest under the 2016 RMP is shown in Table 4.

Table 4. Summary of Skagit steelhead harvest results under the 2016 RMP (WDFW and PSTIT 2018; WDFW 2019; WDFW et al. 2021b; Ford 2022; NMFS 2022b; WDFW et al. 2022b; 2022a).

Fishery Season	Pre-Season Run-Size Estimate	Allowable Harvest Rate	Total Estimated Mortalities	Post-Season Run-Size Estimate	Post-Season Estimated Total Harvest Rate
2017-2018	5,247	≤10%	116	6,199	1.87%
2018-2019	6,567	≤20%	326	4,636	7.04%
2019-2020	3,963	≤4%	72	3,092	2.32%
2020-2021	4,297	≤10%	209	3,578	5.84%
2021-2022	3,833	≤4%	198	5,805	3.41%

Steelhead are also caught in small numbers in marine areas throughout Puget Sound, including in marine area 8-1(included in the action area) by fisheries targeting salmon species. Puget Sound tribal and non-tribal marine salmon fisheries encounter summer and winter steelhead in fisheries targeting other salmon species. In the years just prior to the Puget Sound Steelhead DPS listing, an annual average of 125 steelhead were landed incidentally in tribal marine fisheries (commercial and ceremonial and subsistence) and 199 were landed in non-tribal recreational and commercial (only 1 in commercial) fisheries, from all Puget Sound marine areas combined during the 2001/2002 to 2006/2007 time period[11]. Since 2007, an annual average of 51 steelhead were landed incidentally in tribal marine fisheries and an annual average of 108 steelhead were landed in non-tribal fisheries from all Puget Sound marine areas, combined, during the 2008/2009 to 2020/2021 time period (WDFW and PSTIT (2016; 2017; 2018; 2019; 2020; 2021; 2022)). These average, annual estimates of steelhead catch in Puget Sound marine areas are a composite catch of ESA-listed and non-listed hatchery-origin and natural-origin winter and summer steelhead (James 2018b; Parker and Susewind 2020; NMFS 2022b).

Available data on escapement (spawning abundance) of summer and summer/winter steelhead populations in Puget Sound are limited. Given these circumstances, NMFS used available data for five Puget Sound winter and summer/winter steelhead populations (Skagit, Snohomish, Green, Puyallup and Nisqually) with the most complete data to calculate a series of reference terminal harvest rates on Puget Sound natural-origin steelhead. The use of terminal harvest rates to calculate impacts to natural-origin steelhead populations closely approximates stock-specific rates as almost all harvest occurs within the terminal areas and the mixed-stock pre-terminal harvest is very low when spread across the DIPs in the DPS (WDFW and PSTIT 2017; 2018; 2019; 2020; 2021). NMFS calculated that the harvest rate across these five natural-origin steelhead reference populations averaged 4.2 percent annually in Puget Sound terminal fisheries during the 2001/2002 to 2006/2007 time period, just prior to listing (NMFS 2010a) (Table 5). Average harvest rates across the four non-Skagit steelhead reference populations have demonstrated a reduction to 0.93 percent in Puget Sound fisheries during the 2007/2008 to

---

[11] NMFS 2010: Unpublished data on Puget Sound steelhead harvest rates from 2001/2002 to 2006/2007

2020/2021 time period, a 78 percent decline (Table 5). These estimates include sources of non-landed mortality such as hooking mortality and net dropout.

Table 5. Tribal and non-tribal terminal harvest rate (HR) percentages on natural-origin steelhead for five reference Puget Sound winter steelhead populations (2001/02 – 2006/07), and four[c] reference Puget Sound winter steelhead populations 2007/08 – 2019/2020) (NMFS 2015b; WDFW and PSIT 2017; WDFW and PSTIT 2018; 2019; 2020; 2021; 2022).

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 five 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	0.90	0.92	0.06	0.20
2016-17	1.70	1.00	0.90	0.10	0.00
2017-18	1.87	1.20	0.50	0.10	0.10
2018-19	7.04[c]	1.10	0.30	0.00	0.05
2019-20	2.32[c]	0.90	0.35	0.08	0.00
2020-21	5.84[c]	1.2%	0.47	0.00	0.00
Avg HRs 2007-21		**1.11**	**1.13**	**0.30**	**1.19**
Total Avg HR		**0.93%** total average harvest rate across four populations from 2007-08 to 2020-21			

[a] Escapement (spawning abundance) methodology for the Nisqually River was adjusted in 2004; previous estimates are not comparable.

[b] Catch estimate not available in 2006-07 for Snohomish River.

[c] Skagit steelhead harvest rate limits were managed under the Skagit Steelhead Harvest RMP beginning in 2018 to April 30, 2022

In Puget Sound marine recreational fisheries, an annual average of 198 (range 102 – 263) hatchery summer and winter steelhead were landed from all Puget Sound marine areas combined during the 2000/2001 to 2006/2007 time period (Leland 2010) (Table 5). Since ESA listing in 2007, an annual average of 107 (range 15 – 213) hatchery summer and winter steelhead have been landed in marine recreational fisheries, from all Puget Sound marine areas combined during the 2007/2008 to 2020/2021 time period (WDFW and PSTIT 2022) (Table 5). The catch of steelhead in Puget Sound marine recreational fisheries has therefore declined by 46 percent in the years since listing. Washington State prohibits the retention of natural-origin steelhead (those without a clipped adipose fin) in both marine and freshwater recreational fisheries. There is some mortality associated with the catch-and-release of unmarked steelhead in the marine recreational fishery. The mortality rate associated with catch-and-release is estimated at 10 percent (PSIT and WDFW 2010b) (i.e., 10 percent of the fish caught and released die), making the overall additional total mortality from the marine recreational fisheries low.

In summary, during the 2000/01 to 2006/07 seasons, just prior to the ESA listing of Puget Sound steelhead, an average total of 324 steelhead were caught in marine tribal commercial, ceremonial and subsistence (C&S), and non-tribal marine commercial and recreational fisheries. Since listing (2007/08 to 2020/21), an average total of 159 steelhead have been caught in marine tribal and non-tribal commercial, ceremonial and subsistence, and recreational fisheries (Table 6). The steelhead caught in these marine area fisheries include ESA-listed natural-origin and hatchery steelhead, unlisted hatchery steelhead, non-listed steelhead, and hatchery and natural-origin fish from Canada. Overall, the average tribal and non-tribal catch in marine area fisheries has declined by 51 percent compared with the earlier, pre-listing period.

Table 6. Average annual (seasonal) marine area catch of steelhead from 2000/01 to 2006/07 and 2007/08 to 2020/21 time periods.

Time Period	Marine Catch			
	Tribal Commercial and C&S	Non-Tribal Commercial	Non-Tribal Recreational	Total
2000/01 – 2006/07	125	1	198	324
2007/08 – 2020/21	51	1	107	159

The NWFSC’s last two status reviews concurred that consistently low natural-origin steelhead harvest rates since ESA-listing are not likely to substantially affect steelhead spawner abundance in the DPS (NWFSC 2015; Ford 2022). The 2019 Puget Sound Steelhead Recovery Plan also concurred with this assessment (NMFS 2019e).

Hatcheries

There are currently 13 hatchery programs in Puget Sound that propagate steelhead. Five of these programs produce hatchery-origin steelhead that are similar to the natural-origin steelhead populations in the watersheds where those programs release fish. These programs are designed to conserve and rebuild ESA-listed populations and allow for natural spawning of hatchery-origin fish. They use broodstock founded from, and integrated with, the natural population for steelhead conservation purposes. These five programs have been approved by NMFS under Limit 6 of the

ESA 4(d) Rule for salmon and steelhead. Fish produced through these five programs are also included in the listed Puget Sound Steelhead DPS (79 FR 20802, April 14, 2014). In the Central/Southern Cascade MPG, one program operates to rebuild the native White River winter-run steelhead population. One additional rebuilding program is operated to conserve steelhead populations that are part of the Hood Canal and Strait of Juan de Fuca MPG. A newer, conservation program operated out of the North Fork Skokomish Hatchery by Tacoma Power and Utilities is currently supporting the recovery of native Skokomish River winter steelhead. The fourth program, the Elwha River Native Steelhead program, preserves and assists in the rebuilding of native Elwha River winter-run steelhead. The fifth program is a newly developed summer steelhead hatchery program, in the South Fork Skykomish River. This program is transitioning to the use of a localized, within-basin natural-origin broodstock and is intended to maintain a locally-adapted population comprised of hatchery broodstock and naturally spawning fish from within the Puget Sound DPS (Ford 2022).

The remaining eight steelhead hatchery programs produce fish for harvest. In 2016, five early winter steelhead hatchery programs producing non-listed fish and operating within the Dungeness, Nooksack, Stillaguamish, Snohomish, and Skykomish River Basins received approval by NMFS under ESA 4(d) Rule, limit 6 for effects on ESA-listed steelhead and Chinook salmon (NMFS 2016g; 2016f). In evaluating and approving the Early Winter Steelhead (EWS) programs, founded with Chambers Creek stock, for effects on listed fish (NMFS 2016e; 2016h), and based on analyses of genetic data provided by WDFW (Warheit 2014a), NMFS determined that gene flow levels for the five EWS programs were very low and unlikely to pose substantial genetic diversity reduction risks to natural-origin winter-run steelhead populations. One important element to consider for the evaluation of effects of fisheries targeting EWS hatchery returns is that EWS 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 EWS act to reduce gene flow and associated genetic risks to natural-origin steelhead. Hatchery EWS steelhead releases in the Skagit basin were discontinued after 2018. 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 6).

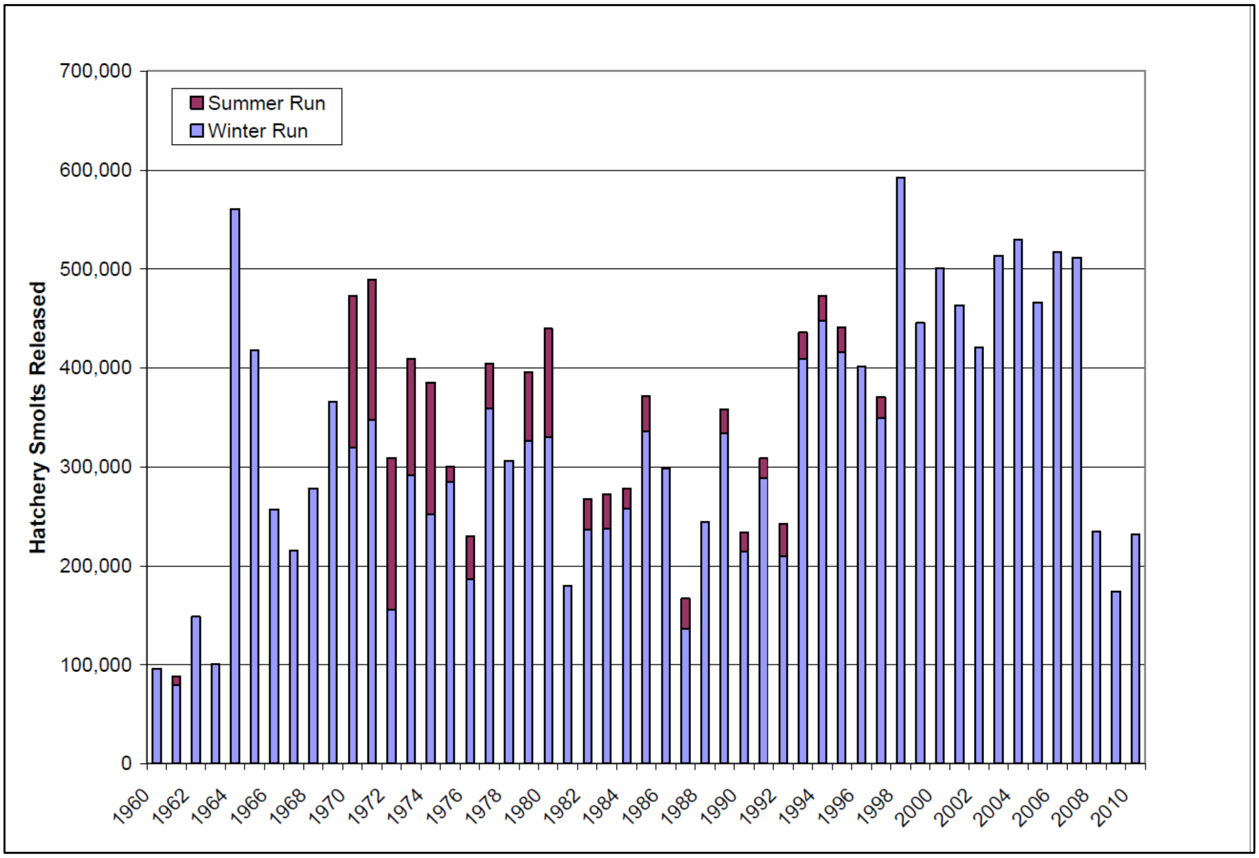


Figure 6. Mean annual release numbers for winter run and summer run hatchery smolts in the Skagit Terminal Area, 1960-2010 (Pflug et al. 2013).

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 EWS occur (Crawford 1979).

Lastly, there are three harvest augmentation programs currently propagating early summer-run steelhead (ESS), which were derived from Columbia River, Skamania stock, in the Green (Soos Creek), Skykomish (Reiter Ponds) and Stillaguamish (Whitehorse Ponds) River Basins and which are not part of the Puget Sound DPS. WDFW has started phasing out these Skamania-origin (Columbia River) programs, the only programs that propagate stock from outside of Puget Sound. The last releases occurred in 2020 for the Whitehorse Ponds program (Stillaguamish River), and in 2022 for the Reiter Ponds program (Skykomish River). The Soos Creek Hatchery summer steelhead program (Green River), which has ESA coverage, will be transitioned to a within-Puget Sound stock by 2031 (NMFS 2019b).

The EWS and ESS stocks historically reared and released as smolts through the eight non-listed programs were 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 early-run hatchery programs may pose genetic risks to natural-origin steelhead (NMFS 2016h; Ford 2022). However, these risks have been assessed through the 4(d) Rule approval process, and were determined to be minimal. Based on analyses of genetic data provided by WDFW (Warheit 2014a), NMFS determined that gene flow levels for the five EWS programs were very low and unlikely to pose substantial genetic diversity reduction risks to natural-origin winter-run steelhead populations (NMFS 2016e; 2016h). Genetic assessment for the summer Green River program was complete in 2019, and risk from gene flow was determined to be low (NMFS 2019c). Genetic assessment for the Skykomish summer program is currently on-going (Ford 2022), and risk is expected to be low based on the assessment within the recently drafted biological opinion for the Skykomish Summer Steelhead Hatchery Program and the Sunset Falls Trap and Haul Program (NMFS 2021a).

Program changes have played an important role in this determination. Between 2007 and 2014 Puget Sound steelhead annual hatchery releases averaged about 2,500,000 annually (NMFS 2014a). Reductions since 2014 from this average total have largely been in response to the need to reduce risks to natural Puget Sound steelhead after the 2007 listing and subsequent risk analyses (NMFS 2014a; Warheit 2014b). Reductions were focused on unlisted steelhead programs in response to the risk of introgression between native steelhead populations and hatchery-origin steelhead. In addition, Chambers Creek (EWS) releases were discontinued in the Elwha and Skagit River basins during the last five year period (Ford 2022). Currently, hatchery programs propagating unlisted steelhead in Puget Sound total 1,076,000 annually (this total includes 350,000 summer steelhead and 531,000 winter steelhead) in the Puget Sound DPS (NWFSC 2020), which have been approved under Limit 6 of the 4(d) Rule. There have also been recent changes associated with several integrated rebuilding programs, including increased production goals for the Green River Native Winter Steelhead and White River Winter Steelhead Supplementation programs; and addition of the North Fork Skokomish Winter Steelhead program, which first released fish in 2017 (NWFSC 2020). Once the non-listed programs have sunset, as required by 4(d) authorization (NMFS 2019c; 2021a), and the integrated programs rebuilding listed populations have achieved their intended release goals, in 2031, Puget Sound steelhead hatchery releases will total 1.3 million. This release level represents a 52 percent total reduction in hatchery releases since listing, and a transition away from programs releasing non-listed and out of DPS stocks.

Habitat

Puget Sound

Human activities have degraded extensive areas of salmon and steelhead spawning and rearing habitat in Puget Sound (Ford 2022). Most damaging to the long-term viability of salmon has been the modification of the fundamental natural processes, which allowed habitat to form and recover from disturbances such as floods, landslides, and droughts. Among the physical and chemical processes basic to habitat formation and salmon persistence are floods and droughts,

sediment transport, heat and light, nutrient cycling, water chemistry, woody debris recruitment and floodplain structure (SSPS 2005).
Land use activities have limited access to historical spawning grounds and altered downstream flow and thermal conditions. Watershed development and associated urbanization throughout the Puget Sound, Hood Canal, and Strait of Juan de Fuca regions have resulted in direct loss of riparian vegetation and soils, significantly altered hydrologic and erosion rates and processes by creating impermeable surfaces (roads, buildings, parking lots, sidewalks etc.), 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; NWIFC 2016; 2020; Ford 2022). Hardening of nearshore bank areas with riprap or other material has altered marine shorelines, changing sediment transport patterns and reducing important juvenile habitat (SSPS 2005; NWIFC 2016; 2020). 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 (Elwha-Dungeness Planning Unit 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). There are substantial habitat blockages by dams in the Skagit and Skokomish River basins, in the Elwha basin until 2014 (prior to the implementation of the Elwha Dam Removal Plan), and minor blockages (including impassable culverts) throughout the region. In general, habitat has been degraded from its pristine condition, and this trend is likely to continue with further population growth and resultant urbanization in the Puget Sound region (Ford 2022).

Habitat utilization by Chinook salmon and steelhead in the Puget Sound area has been historically limited by large dams and other manmade barriers in a number of drainages, including the Nooksack, Skagit, White, Nisqually, Skokomish, and Elwha River Basins (Appendix B in NMFS (2015a)). 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). However, over the past several years modifications have occurred to existing barriers, which have reduced the number of basins with limited anadromous access to historical habitat. The completion of the Elwha and Glines Canyon dam removals occurred in 2014, though the response of fish populations to this action is still being evaluated (Ford 2022). It is clear, however, that Chinook salmon and steelhead are accessing much of this newly available habitat (Pess et al. 2020). Passage operations have begun on the North Fork Skokomish River to reintroduce steelhead above Cushman Dam, and although juvenile collection efficiency is still relatively low, further improvements are anticipated. Similarly, improvements in the adult fish collection facility at Mud Mountain Dam (White River Basin) are near completion, with the expectation that improvements in adult survival will facilitate better utilization of habitat above the dam (NMFS 2014c).

The recent removals of the diversion dam on the Middle Fork Nooksack Dam (July 2020) and the Pilchuck River Diversion Dam (late 2020) will provide access to important headwater salmonid spawning and rearing habitats. Similarly, the proposed modification of Howard Hanson Dam for upstream fish passage and downstream juvenile collection in the longer term (NMFS 2019d) will allow winter steelhead to return to historical headwater habitat in the Green River (NWFSC 2020). It has been hypothesized that summer-run steelhead may have residualized above Howard Hanson Dam (Myers et al. 2015), and restoring access could restore such a run. However, the effects of these two projects on abundance will not be evident for some time. Four of the top six steelhead populations identified by Cram et al. (2018) as having habitat blocked by major dams are in the process of having passage restored or improved (Ford 2022).

In addition, projects focusing on smaller scale improvements in habitat quality and accessibility are ongoing. As of 2019 approximately 8,000 culverts that block steelhead habitat have been identified in Puget Sound (NMFS 2019f), with plans to address these blockages being extended over many years. Smaller scale improvements in habitat, restoration of riparian habitat and reconnecting side- or off-channel habitats, will allow better access to habitat types and niche diversification. While there have been some significant improvements in restoring access, it is recognized that land development, loss of riparian and forest habitat, loss of wetlands, demands on water allocation all continue to degrade the quantity and quality of available fish habitat (NWFSC 2020; Ford 2022).

Many upper tributaries to rivers 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 (2015a)). Urbanization has caused direct loss of riparian vegetation and soils, significantly altered hydrologic and erosional rates and processes (e.g., by creating impermeable surfaces such as roads, buildings, parking lots, sidewalks etc.) (NMFS 2019f), and polluted waterways with stormwater and point-source discharges (Appendix B in NMFS (2015a)). Forestry practices, urban development, and agriculture have resulted in the loss of wetland and riparian habitat, creating dramatic changes in the hydrology of many streams, increases in flood frequency 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 also been reduced in Puget Sound through the construction of dikes, hardening of banks with riprap, and channelization of the mainstem (NMFS 2015a). 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 2015a). In addition to being a factor that contributed to the present decline of Puget Sound Chinook salmon and steelhead populations, the continued destruction and modification of habitat is the principal factor limiting the viability of the Puget Sound Chinook salmon and steelhead into the foreseeable future (72 FR 26722, May 11, 2007). Due to 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 (2015a)).

NMFS has completed several ESA consultations on large-scale projects affecting listed species and their critical habitat in Puget Sound. Among these are the Washington State Forest Practices Habitat Conservation Plan (NMFS 2006), consultations on Washington State Water Quality Standards (NMFS 2008a), the National Flood Insurance Program (NMFS 2008b), the Elwha River Fish Restoration Plan (Ward et al. 2008), the Washington State Department of Transportation Preservation, Improvement, and Maintenance Activities (NMFS 2013), and the Salish Sea Nearshore permitting activities with the Corps (NMFS 2020b). These documents considered the effects of the proposed actions that would occur up to the next 50 years on the ESA-listed salmon and steelhead 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 in the opinions on these actions. The environmental baselines in these documents consider the effects from timber, agriculture and irrigation practices, urbanization, hatcheries, tributary habitat, estuary, and large-scale environmental variation. These biological opinions and HCPs, in addition to the watershed specific information in the Puget Sound Salmon Recovery Plan mentioned above, provide a comprehensive overview of baseline habitat conditions in Puget Sound and are incorporated here.

On November 9, 2020, NMFS issued a biological opinion for 39 habitat modifying projects in the nearshore marine areas of Puget Sound, permitted by the Army Corp of Engineers under the Clean Water Act and the Rivers and Harbors Act (NMFS 2020b). This biological opinion concluded that the proposed action would not jeopardize the continued existence of, nor adversely modify the critical habitat of Puget Sound steelhead, Hood Canal Summer Run (HCSR) chum salmon, PS/GB yellow rockfish, or PS/GB bocaccio. The opinion concluded that the proposed action would jeopardize the continued existence of, and adversely modify critical habitat for, PS Chinook salmon and SRKWs. The biological opinion provided an RPA to the proposed action. The RPA utilized a Habitat Equivalency Analysis methodology and the Nearshore Habitat Values Model to establish a credit/debit target of no-net-loss of nearshore habitat quality. The RPA was designed to achieve, at a minimum, a reduction of these debits to zero. The RPA provides a range of options for achieving this goal and avoiding jeopardy of PS Chinook salmon. The expected improvements to Chinook salmon abundance resulting from implementation of the RPA are expected to improve the amount of prey available for SRKWs. As a result, the RPA avoids jeopardy and adverse modification for SRKWs.

Skagit River

Critical habitat is designated for Puget Sound steelhead throughout the Skagit River Basin. However, areas can be excluded from designation if they: (1) are covered by an existing Habitat Conservation Plan (HCP), (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 7).

Table 7. Habitat areas within the Skagit River basin excluded from critical habitat designation for the Puget Sound Steelhead DPS. 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 due to 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 percent 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 73 percent 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.

2.4.2. Skagit River Steelhead Status

The Skagit River contains four extant steelhead DIPs, as identified in Myers et al. (2015)(Figure 7). 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).

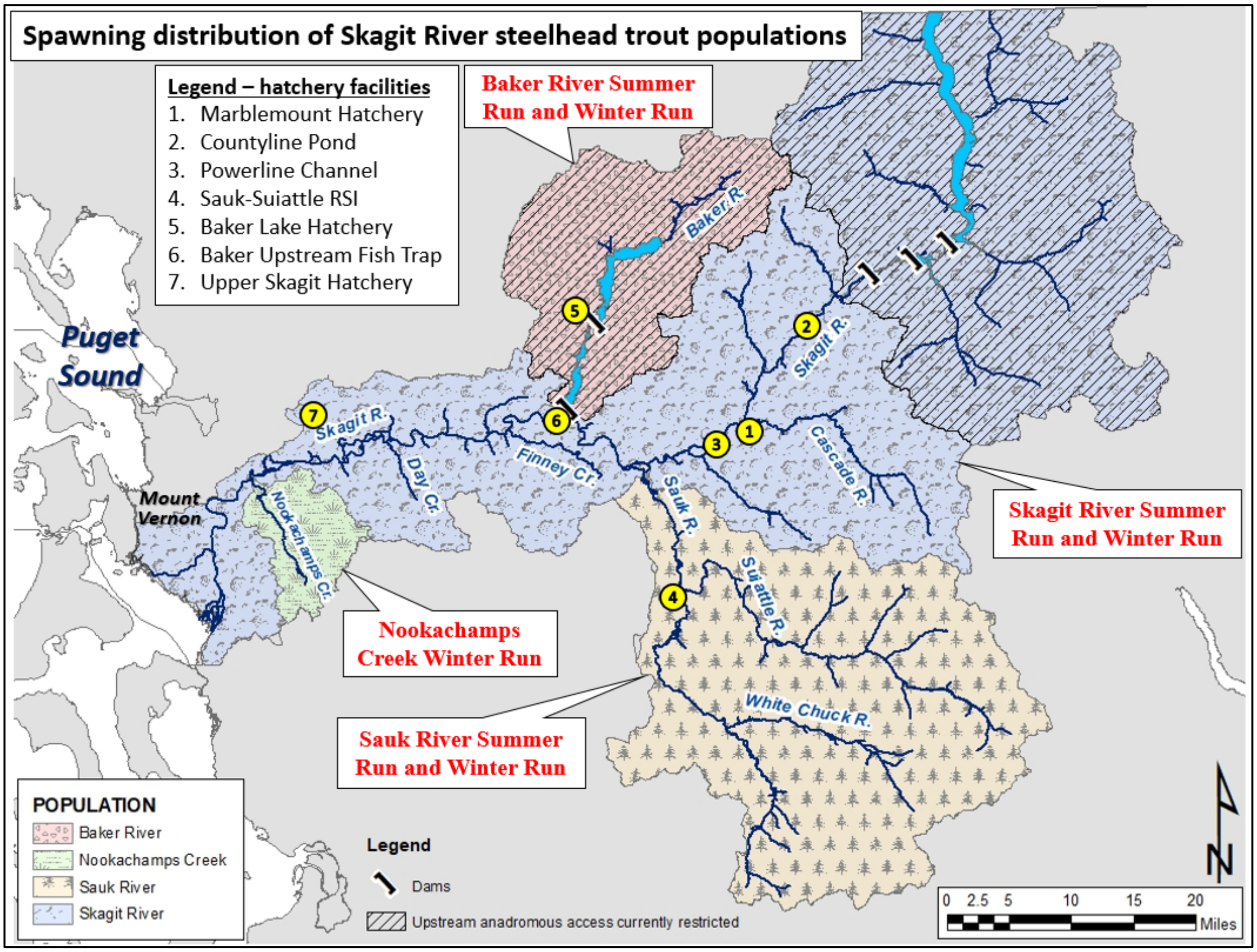


Figure 7. Spawning distribution of the four Skagit River steelhead demographically independent populations (red text). Hatchery facilities in Skagit basin are for reference only – no hatchery steelhead are released in the Skagit River (NMFS 2022a).

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. Similar to the Puget Sound Steelhead DPS section above, this section describes the status of Skagit River steelhead, relative to the VSP attributes; abundance, productivity, spatial structure and diversity.

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. As shown in Table 2 and Figure 8, the Skagit River steelhead annual mean spawner abundance has fluctuated between 7,656 (1995-1999) and 4,677 (2005-2009) (Hard et al. 2015), with more recent abundance geomean reported to be 7,181 annual spawners (2015-2019) (Ford 2022). Based on the average annual spawning abundance estimates available on the WDFW SCoRE website (WDFW 2022), from 1978 to 2022, the geomean of spawning abundance of Skagit steelhead is 6,282 and has ranged from 2,502 to 13,194 (Figure 5). There is an observable, small negative trend in abundance over this time period (R^2=0.113; P=0.03) (see Figure 8).

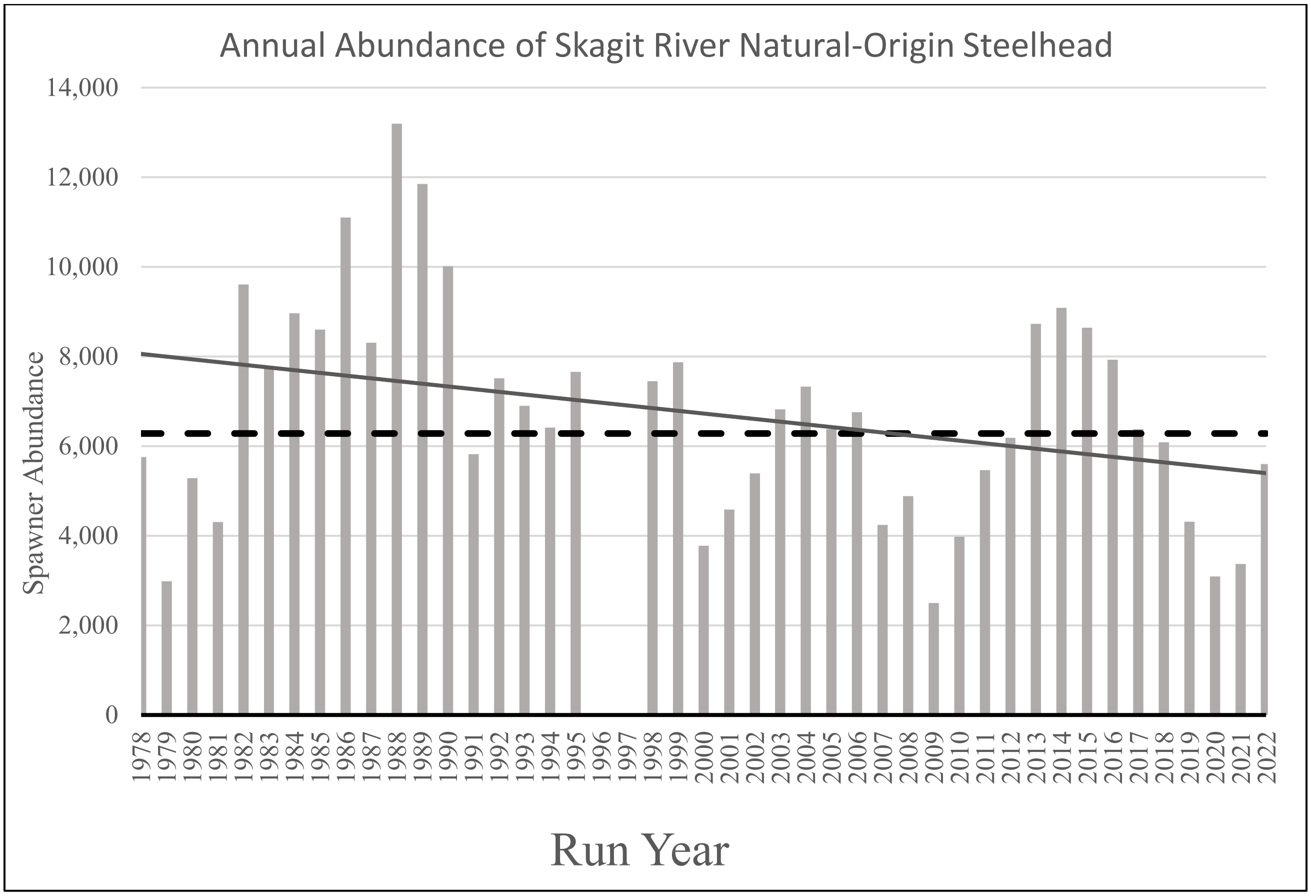


Figure 8. Annual Skagit River natural-origin steelhead spawner abundance (gray vertical bars) for 1978-2022 run years. 1978-2022 geomean of spawning abundance (6,282) shown with black dashed horizontal line. Trendline shown with solid dark grey line. Source data from: (Sauk-Suiattle Indian Tribe et al. 2021; WDFW and PSTIT 2021; WDFW 2022; WDFW and PSTIT 2022; WDFW et al. 2022a).

The Puget Sound Steelhead Recovery Team was established by NMFS and convened in March 2014 to develop a recovery plan for the Puget Sound Steelhead DPS. This recovery plan was finalized in December 2019 (NMFS 2019e). Recovery targets for abundance were calculated at the DIP level with adjustments for both low and high productivity. Because abundance information is unavailable for approximately one third of the DIPs, the Skagit River, Sauk River, Nookachamps River, and Baker River populations have a combined target of 15,000 under both high and low productivity (NMFS 2019e; Ford 2022).

Population productivity of the Skagit River populations, defined as the total number of adult recruits produced per total number of spawners, has varied considerable over the period of record (Figure 9). However, growth rates across a series of timespans show a generally stable population over the period from the late 1970s through until 2013 (Table 8). Long term variability in the productivity of the Skagit River has been shown to be correlated with annual variability in hydrologic and marine conditions (Scheuerell et al. 2020; Sauk-Suiattle Indian Tribe et al. 2021).

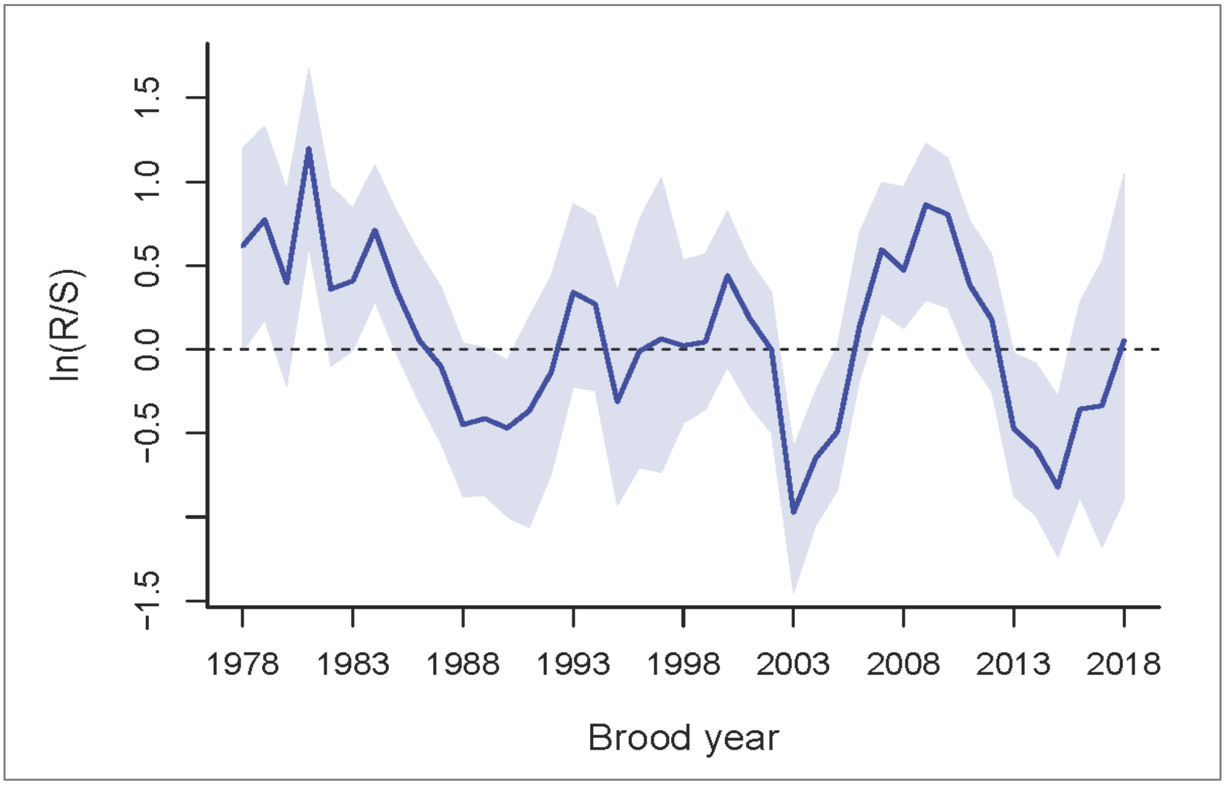


Figure 9. Estimated annual lifetime productivity of the Skagit SMU in units of log normal total adult recruits produced per spawner. The blue line represents the median estimate and the shaded area is the 95% credible interval (Sauk-Suiattle Indian Tribe et al. 2021).

Table 8. Estimates of population growth rate (λ) and 95% CI for the Skagit River natural-origin steelhead across different year ranges, over the 1977-2013 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 et al. 2018)
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	2004-2013	1.018	0.588-1.987	(Cram et al. 2018)

Skagit River Steelhead Spatial Structure and Diversity

Specific to the Skagit River, the co-managers identified the limited spatial structure information for each individual DIP while developing the 2021 RMP, and are working to gather DIP level information into the future (Sauk-Suiattle Indian Tribe et al. 2021).

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. 2021).

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) 22.0 to 94.0 and Skagit River tributaries (Hansen, Sorenson, Day, Jones, Cumberland, Alder, O'Toole, Rocky, and Diobsud Creeks). The surveys also include the Sauk River mainstem to RM 41.0, the South Fork Sauk River to RM 2.0, and Sauk River tributaries (White, Dan, Murphy, and Falls Creeks (Sauk-Suiattle Indian Tribe et al. 2021).

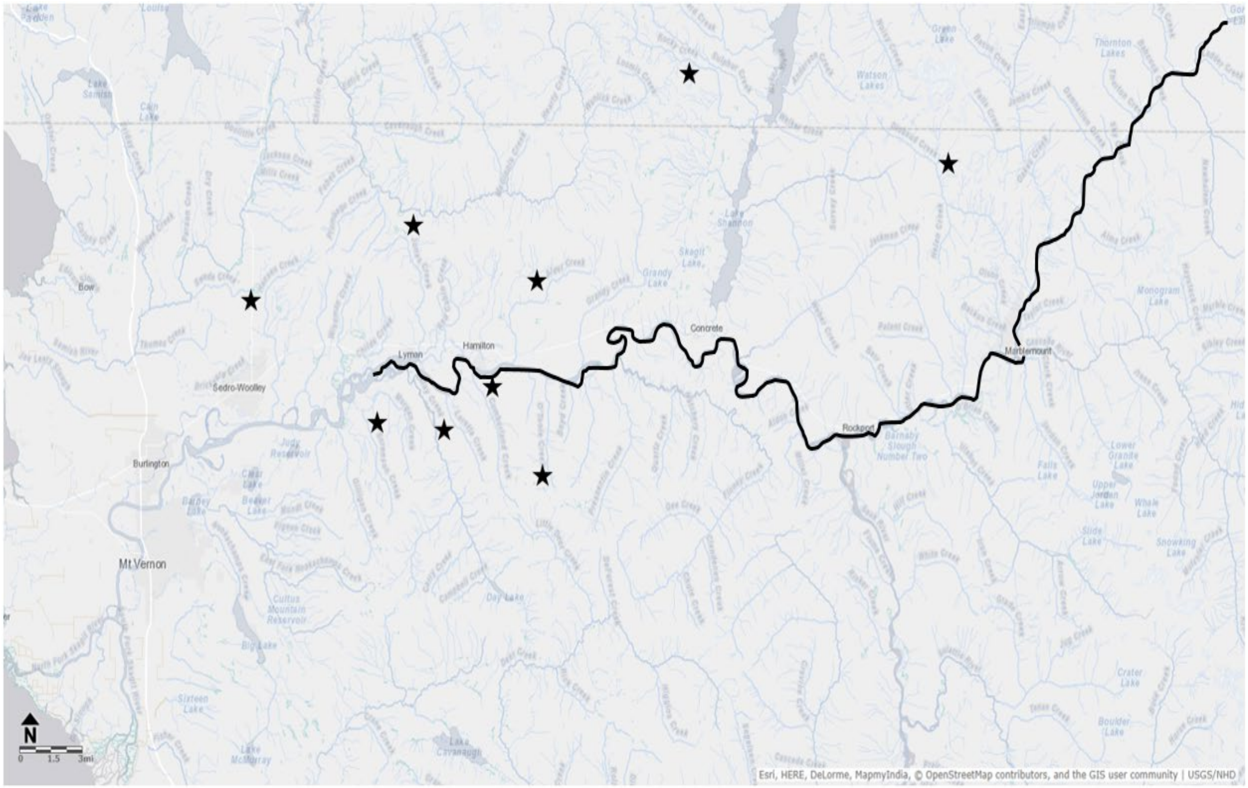
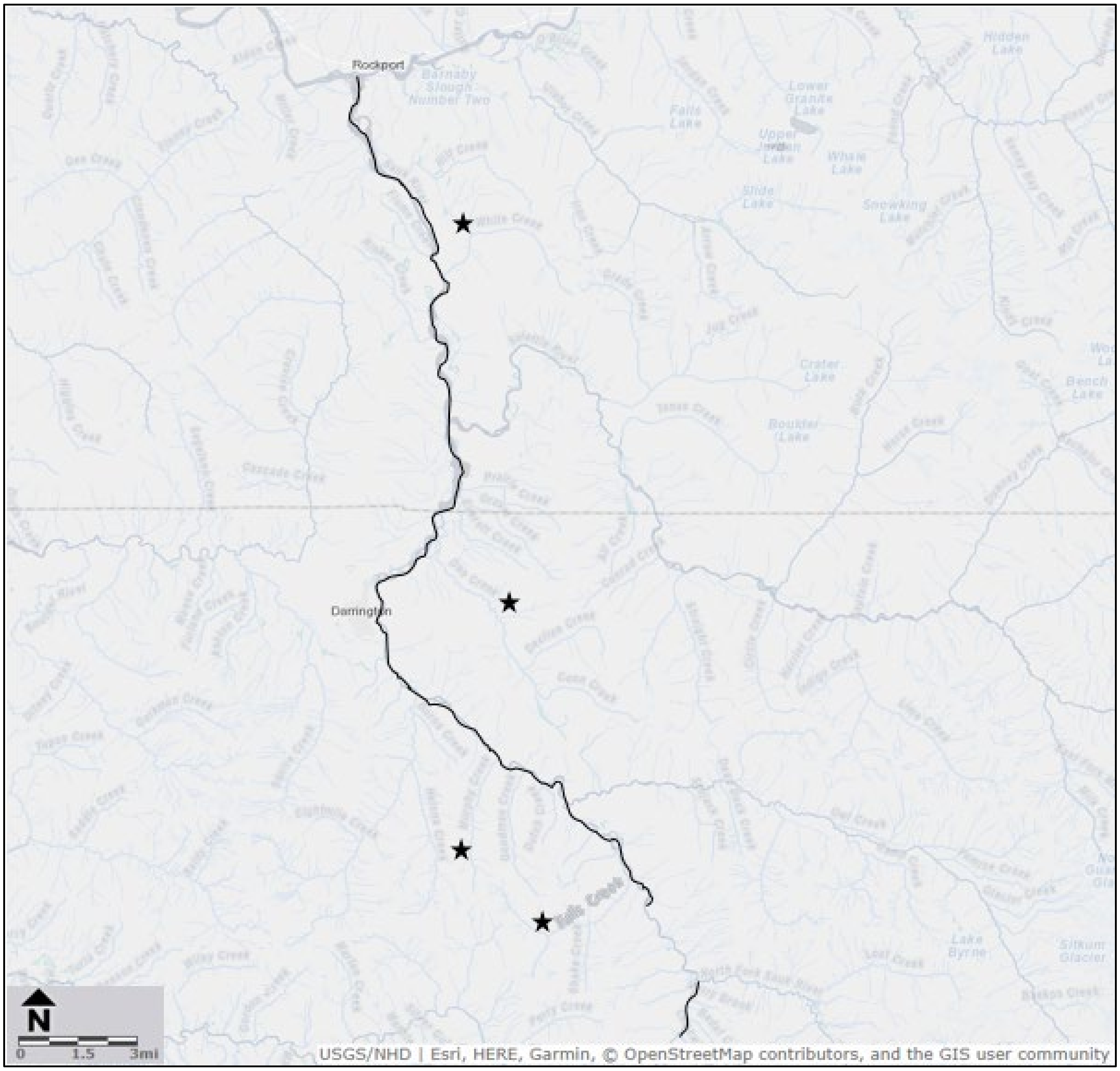


Figure 10. Annual steelhead spawning ground survey location in the Skagit River mainstem and tributaries. (base map, WDFW Salmon Scape) Sauk-Suiattle Indian Tribe et al. (2021).



USGS/NHD | Esri, HERE, Garmin, © OpenStreetMap contributors, and the GIS user community

Figure 11. Annual steelhead spawning ground survey location in the Sauk River and its tributaries (base map, WDFW Salmon Scape).

The co-managers note that Skagit River steelhead escapement (spawning abundance) surveys have been conducted on the Skagit River on a 10 to 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 (see Figure 12) Initiation of spawning in the Sauk River appears to be slightly later, although the preponderance of spawning still occurs in April and May (see Figure 13) (Sauk-Suiattle Indian Tribe et al. 2021).

The co-managers are also assessing *O. mykiss* habitat occupancy within the SMU. *O. mykiss* are found throughout the SMU anadromous zone and above some impassable barriers. In 2011-2012, *O. mykiss* were ubiquitous across the Skagit River Basin and occupied 95 percent of the sites surveyed (Sauk-Suiattle Indian Tribe et al. 2021). Larger *O. mykiss* tended to occupy large log jams and tributary streams. In the snow and rain hydro-regions larger *O. mykiss* occurred in greater densities and appear to trend towards a tributary specialist habit (Upper Skagit Indian Tribe (Shannahan), unpublished data; Sauk-Suiattle Indian Tribe et al. 2021).

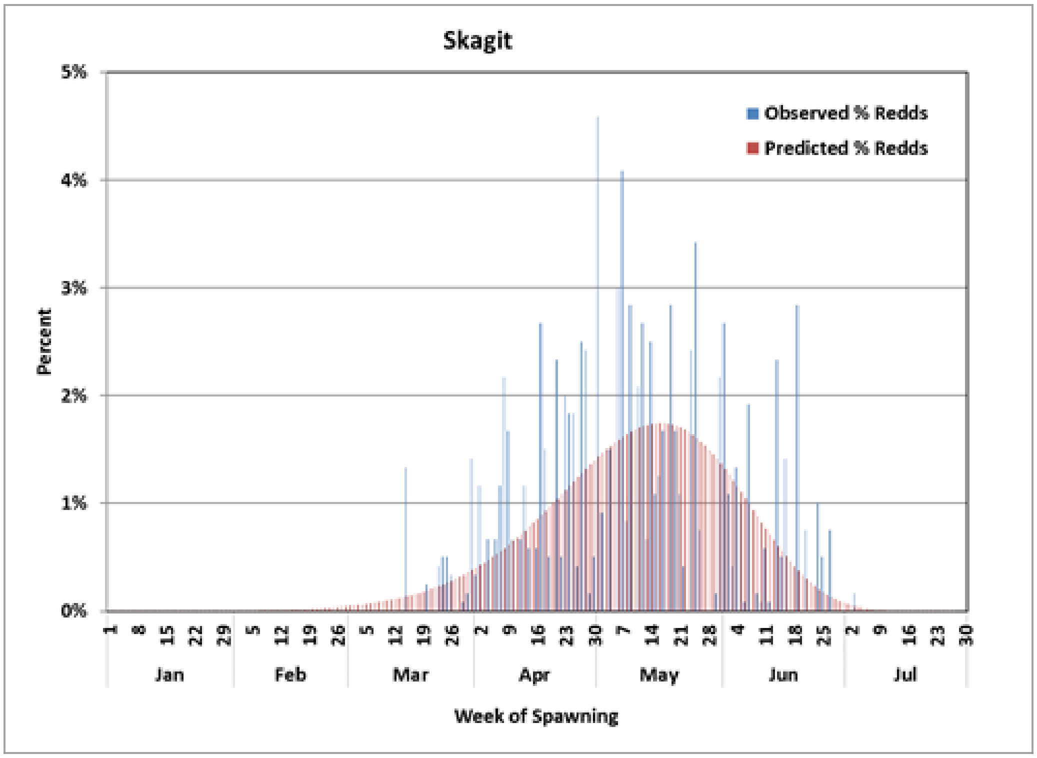


Figure 12. Skagit River winter steelhead observed and predicted percent redd observation over time (Sauk-Suiattle Indian Tribe et al. 2021).

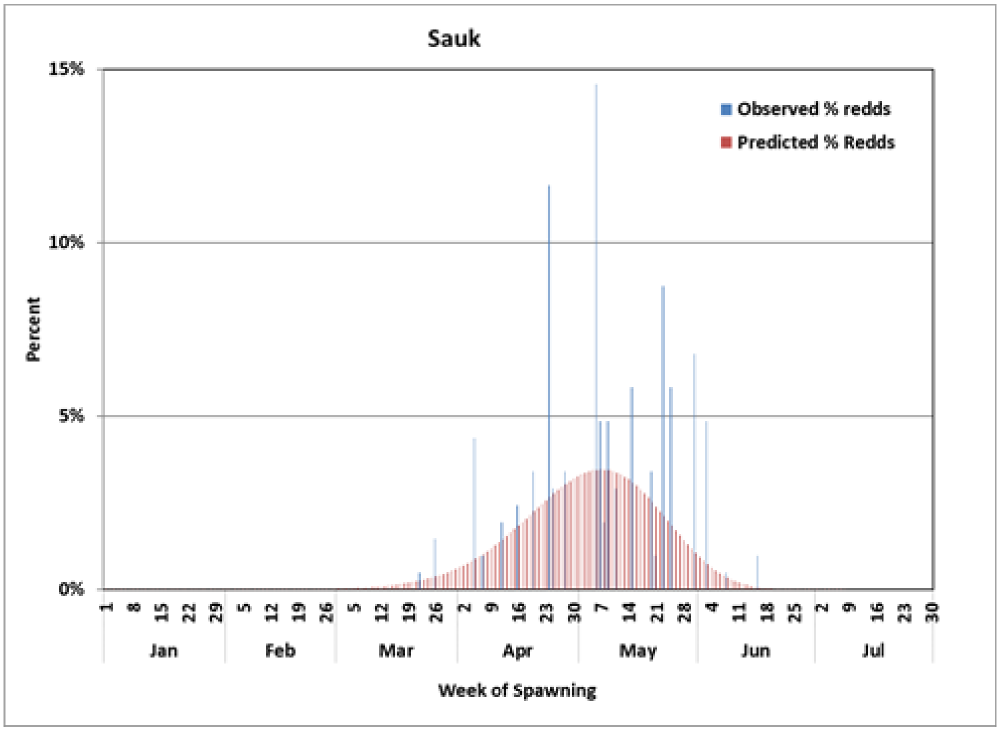


Figure 13. Sauk River winter steelhead observed and predicted percent redd observation over time (Sauk-Suiattle Indian Tribe et al. 2021).

There has also been recent work in the Skagit River Basin to survey and monitor juvenile steelhead spatial distribution throughout the watershed. Sauk-Suiattle Indian Tribe et al. (2018) juvenile habitat occupancy surveys indicate 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 84 percent of the sites surveyed in summer 2011 and 93 percent of the sites in winter 2012 (Table 9)(Upper Skagit Indian Tribe (USIT) and Seattle City Light, unpublished data; in Sauk-Suiattle Indian Tribe et al. 2018).

Table 9. 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 (Sauk-Suiattle Indian Tribe et al. 2021).

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 @ Illabot 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
Illabot 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 Upper Skagit Indian Tribe (USIT) and WDFW have operated steelhead smolt traps on Bacon Creek (2012 and 2013), Finney Creek (2013), Hansen Creek (2014-2019), Illabot Creek (2013-present), Diobsud Creek (2018-2019), and East Fork Nookachamps Creek (2021) with steelhead smolts captured at each of these locations (Kinsel et al. 2013; Kinsel et al. 2016; Thompson et al. 2021). USIT has conducted electrofishing mark-recapture surveys on Illabot Creek (2017-present), Hansen Creek (2017-present), and Diobsud Creek (2017-2019) to monitor juvenile *O. mykiss* survival and emigration (Thompson et al. 2021). Additionally, USIT has installed and operated passive integrated transponder (PIT) array infrastructure in Hansen Creek (2014-present), Illabot Creek (2015-present), and Diobsud Creek (2017-2019) to track the movement of migrating juvenile and adult *O. mykiss* that were PIT tagged at either a smolt trap or during electrofishing mark re-capture surveys (Thompson et al. 2021).

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). In the case of these three summer-run steelhead-bearing tributaries, cascades or falls may present a migratory 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 2016d).

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". 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. Pflug 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 14).

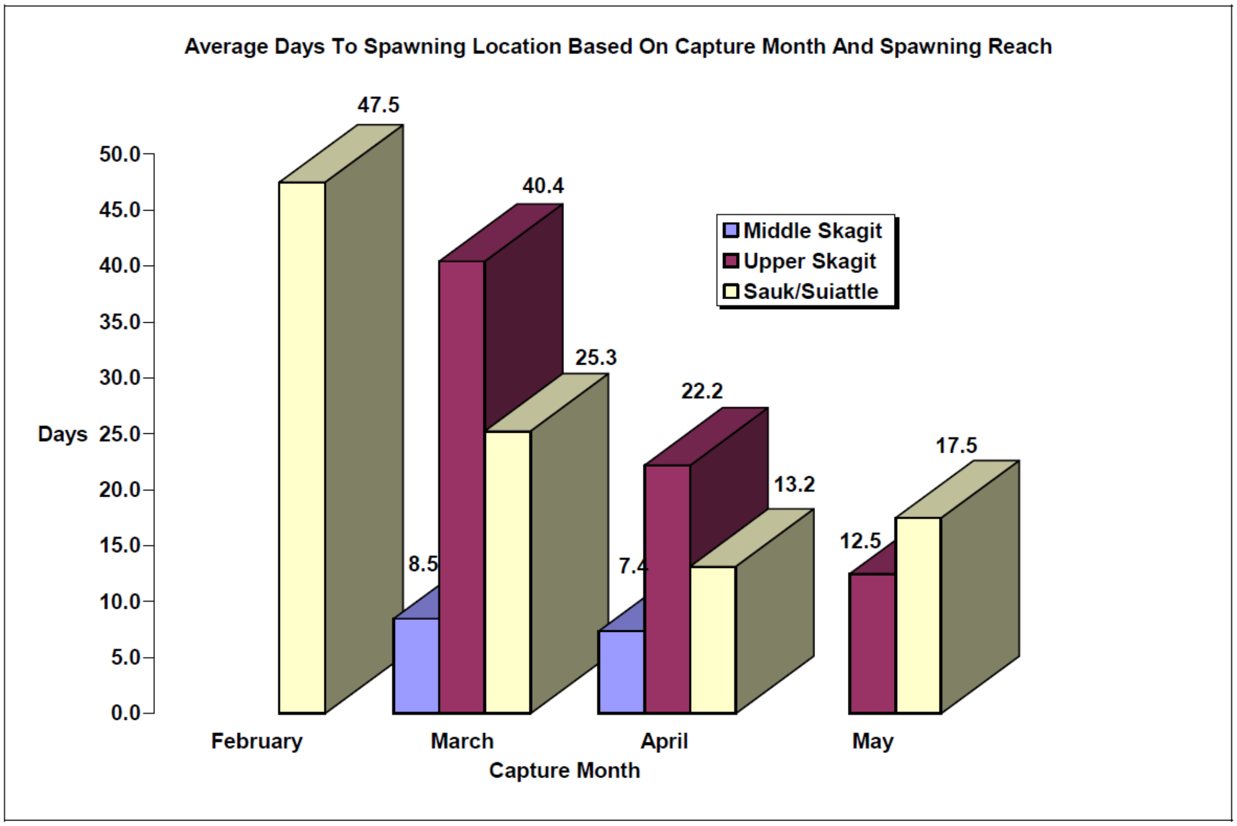


Figure 14. Average days to spawning location by natural-origin steelhead based on capture (tag) month and spawning reach (excerpted from Pflug et al. (2013; Figure 9).

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 (United States Bureau of Fisheries 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 10). This project is the most recent work indicating the potential breadth of the current Skagit River steelhead winter-run timing in the mid and upper Skagit Basin.

Table 10. 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 sub-basin, in the lower portion of the Skagit River, near Burlington, Washington. In contrast to much of the Skagit Basin, this lowland sub-basin 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). Intensive surveys in Nookachamps Creek in 2015 and 2016 reported approximately 250 steelhead spawners present in both years (Fowler and Turnbull 2016; WDFW unpublished data). Mean anadromous steelhead spawners in the Nookachamps from 2015 to 2019 were 211 (Sauk-Suiattle Indian Tribe et al. 2021).

Overall, regarding the status of spatial structure throughout the Puget Sound and the Skagit River Basin, there have been some significant improvements in spatial structure, but it is recognized that land development, loss of riparian and forest habitat, loss of wetlands, and demands on water allocation continue to degrade the quantity and quality of available fish habitat. However, ongoing small-scale improvements in habitat, restoration of riparian habitat, and reconnecting side- or off-channel habitats will allow better access to habitat types and niche diversification, and opportunities for improvement in steelhead spatial structure (Ford 2022).

Diversity can be measured through a variety of life-history trait metrics, for example, age structure, run timing, and spawning (Ford 2022). As described above in the Puget Sound Steelhead 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 and the Skagit River Basin (NMFS 2019e; Ford

2022). 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 (Pflug et al. 2013). As mentioned previously, these releases of hatchery steelhead were discontinued in the Skagit River Basin in 2013.

One of the few quantifiable risks to diversity is the loss of locally adapted traits through introgression by non-native or domesticated hatchery-origin fish (Ford 2022). 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 (2014b) estimated gene flow from returning hatchery-origin adult to natural-origin Skagit River steelhead and found that rates ranged from 2 percent for the Skagit and Nookachamps populations to 4 percent 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. NMFS (2016h) 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).

The PSSTRT identified two additional diversity characteristics, iteroparity and the abundance of sympatric resident fish, which can be important contributors to the viability of Puget Sound steelhead populations (Hard et al. 2015; NMFS 2019e).

Skagit Steelhead Iteroparity (Repeat Spawning)

Unlike salmon species of the same genus *Oncorhynchus,* steelhead are iteroparous, or capable of spawning in successive years. While the incidental impact on iteroparous steelhead, also known as kelts, may be relatively low (3-5 percent in the Skagit River), the contribution of repeat spawners to the reproductive success of steelhead may be meaningful (Hard et al. 2015; NMFS 2019e). Scott and Gill (2008) reported that repeat spawners averaged 6 percent (range of 0 percent to 12 percent) 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 15).

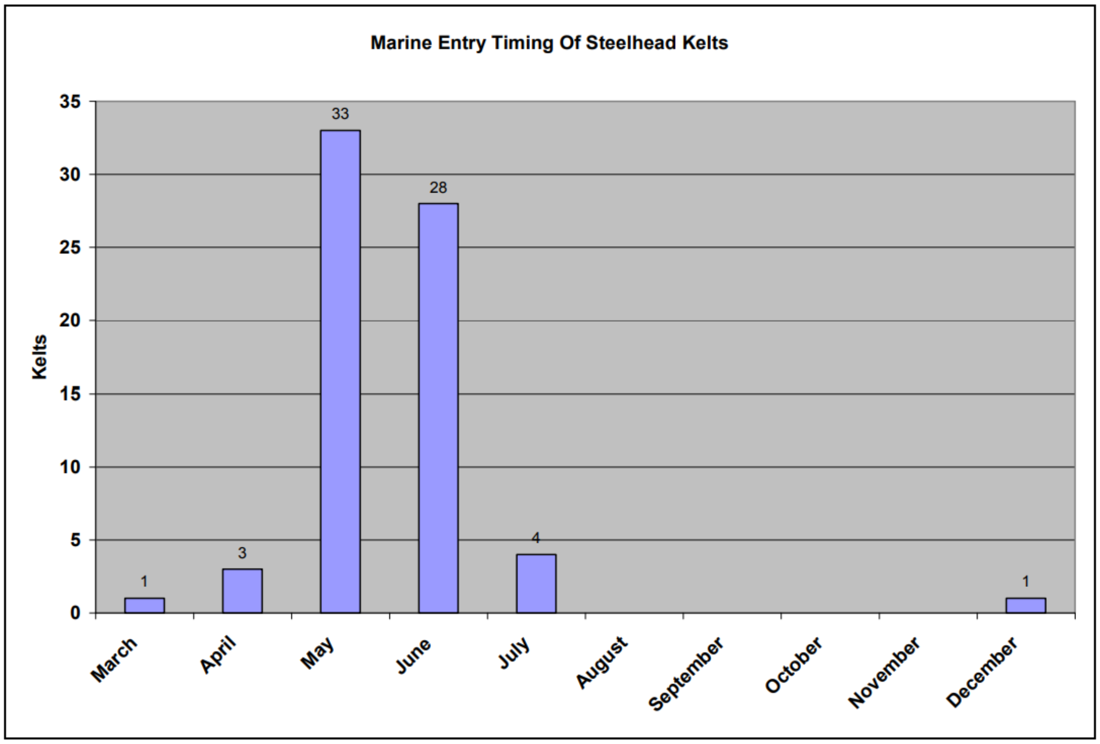


Figure 15. Marine entry-timing of Skagit River steelhead kelts. Numbers observed by month (Pflug et al. 2013).

Skagit River Resident Life-History

Resident life-history *O. mykiss* (Rainbow trout) are capable of producing anadromous offspring and interbreeding with anadromous life-history steelhead (NMFS 2019e). Resident life-history *O. mykiss* have an important role in the overall stability of the anadromous life-form of steelhead. Resident *O. mykiss* provide productivity reservoirs that can buffer against low marine survival periods and provide 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 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 a genetic signature of isolated residents above impassible structures within the anadromous zone (Pflug et al. 2013).

2.2.2 Status of Critical Habitat

Section 3(5)(A) of the ESA defines critical habitat as "(i) the specific areas within the geographical area occupied by the species, at the time it is listed . . . on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and (ii) specific areas outside the geographical area occupied by the species at the time it is listed . . . upon a determination by the Secretary that such areas are essential for the conservation of the species."

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

For salmon and steelhead, NMFS ranked watersheds within designated critical habitat at the scale of the fifth-field hydrologic unit code (HUC5) in terms of the conservation value they provide to each listed species they support[12]; the conservation rankings are high, medium, or low. To determine the conservation value of each watershed to species viability, NMFS' critical habitat analytical review teams (CHARTs; 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, 2013 (78 FR 2726). On February 12, 2016, NMFS announced the final critical habitat designation for Puget Sound steelhead (81 FR 9252). The basis for the designation is found in these documents, and is described briefly below.

Steelhead critical habitat includes 2,031 stream miles. There are 66 watersheds within the range of this DPS. Nine watersheds received a low conservation value rating, 16 received a medium rating, and 41 received a high rating to the DPS from the CHART (NMFS 2015a). Critical habitat for Puget Sound steelhead includes freshwater spawning sites, freshwater rearing sites, and freshwater migration corridors. Offshore marine waters were not designated critical habitat for this species. Additionally, designated critical habitat for Puget Sound steelhead does not include nearshore areas, as this species does not make extensive use of these areas during the

---

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

juvenile life stage. Approximately 138 stream miles, in areas where the conservation benefit to the species was relatively low (compared to the economic impacts of inclusion), were also excluded. Additionally, an approximate 1,361 stream miles covered by four habitat conservation plans, and approximately 70 stream miles on tribal lands were excluded because the benefits of exclusion outweighed the benefits of designation. NMFS also designated approximately 90 stream miles of critical habitat on the Kitsap Peninsula, which were originally proposed for exclusion, after considering public comments and determining 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 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.

NMFS (2015a) 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: https://www.fisheries.noaa.gov/action/designation-critical-habitat-lower-columbia-river-coho-salmon-and-puget-sound-steelhead-2016.

Physical or biological factors for Puget Sound steelhead involve those sites and habitat components that support one or more life stages, including general categories of: (1) water quantity, quality, and forage to support spawning, rearing, individual growth, and maturation; (2) areas free of obstruction and excessive predation; and (3) the type and amount of structure and complexity that supports juvenile growth and mobility. Major management activities effecting the 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.

Landslides can occur naturally in steep, forested lands, but inappropriate land use practices likely have accelerated their frequency within designated critical habitat and increased the amount of sediment delivered to streams. Fine sediment from unpaved roads has also contributed to stream sedimentation. Unpaved roads are widespread on forested lands in the Puget Sound Basin, and to a lesser extent, in rural residential areas. Historical logging removed most of the riparian trees near stream channels. Subsequent agricultural and urban conversion permanently altered riparian vegetation in the river valleys, leaving either no trees, or a thin band of trees. The riparian zones along many agricultural areas are now dominated by alder, invasive canary grass and blackberries, and provide substantially reduced stream shade and large wood recruitment (SSPS 2005).

Diking, agriculture, revetments, railroads, and roads in lower stream reaches have caused significant loss of secondary channels in major valley floodplains in this region. Confined main channels create high-energy peak flows that remove smaller substrate particles and large wood. The loss of side-channels, oxbow lakes, and backwater habitats has resulted in a significant loss of juvenile salmonid rearing and refuge habitat. When the water level of Lake Washington was lowered 9 feet in the 1910s, thousands of acres of wetlands along the shoreline of Lake

Washington, Lake Sammamish and the Sammamish River corridor were drained and converted to agricultural and urban uses. Wetlands play an important role in hydrologic processes, as they store water that ameliorates high and low flows. The interchange of surface and groundwater in complex stream and wetland systems helps to moderate stream temperatures. Forest wetlands are estimated to have diminished by one-third in Washington State (FEMAT 1993; Spence et al. 1996; SSPS 2005).

Loss of riparian habitat, elevated water temperatures, elevated levels of nutrients, increased nitrogen and phosphorus, and higher levels of turbidity, presumably from urban and highway runoff, wastewater treatment, failing septic systems, and agriculture or livestock impacts, have been documented in many Puget Sound tributaries (SSPS 2005).

Peak stream flows have increased over time to paving (roads and parking areas), reduced percolation through surface soils on residential and agricultural lands, simplified and extended drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2005). In urbanized Puget Sound, there is a strong association between land use and land cover attributes and rates of coho spawner mortality likely due to runoff containing contaminants emitted from motor vehicles (Feist et al. 1996).

Dams constructed for hydropower generation, irrigation, or flood control have substantially affected Puget Sound steelhead populations in a number of river systems. The construction and operation of dams have blocked access to spawning and rearing habitat, changed flow patterns, resulted in elevated temperatures and stranding of juvenile migrants, and degraded downstream spawning and rearing habitat by reducing recruitment of spawning gravel and large wood to downstream areas drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2005). These actions tend to promote downstream channel incision and simplification (Kondolf 1997), limiting fish habitat. Water withdrawals reduce available fish habitat and alter sediment transport. Hydropower projects often change flow rates, stranding and killing fish, and reducing aquatic invertebrate (food source) productivity (Hunter 1992).

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system. Blockages by dams, water diversions, and shifts in flow regime due to hydroelectric development and flood control projects are major habitat problems in many Puget Sound tributary basins drainage networks, loss of wetlands, and rain-on-snow events in higher elevation clear cuts (SSPS 2005).

The nearshore marine habitat included in the critical habitat designations has been extensively altered and armored by industrial and residential development near the mouths of many of Puget Sound's tributaries. A railroad runs along large portions of the eastern shoreline of Puget Sound, eliminating natural cover along the shore and natural recruitment of beach sand (SSPS 2005).

Degradation of the near-shore environment has occurred in the southeastern areas of Hood Canal in recent years, resulting in late summer marine oxygen depletion and significant fish kills. Circulation of marine waters is naturally limited, and partially driven by freshwater runoff, which is often low in the late summer. However, human development has increased nutrient loads from failing septic systems along the shoreline, and from use of nitrate and phosphate fertilizers on lawns and farms. Shoreline residential development is widespread and dense in many places. The combination of highways and dense residential development has degraded certain physical and chemical characteristics of the near-shore environment (HCCC 2005; SSPS 2005).

In summary, critical habitat for salmon and steelhead throughout the Puget Sound basin has been degraded by numerous management activities, including hydropower development, loss of mature riparian forests, increased sediment inputs, removal of large wood, intense urbanization, agriculture, alteration of floodplain and stream morphology (i.e., channel modifications and diking), riparian vegetation disturbance, wetland draining and conversion, dredging, armoring of shorelines, marina and port development, road and railroad construction and maintenance, logging, and mining. Changes in habitat quantity, availability, and diversity, and flow, temperature, sediment load and channel instability are common limiting factors in areas of critical habitat.

2.2.2.2. Critical Habitat in the Skagit River Basin

For 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 16)(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 sub-basins within the Skagit River Basin. Information is from NMFS (2015a) - *Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead, FINAL Biological Report*

Upper Skagit Sub-basin (HUC4# 17110005)

The Upper Skagit sub-basin is located in northern Puget Sound within Skagit and Whatcom Counties, Washington. The sub-basin contains five watersheds occupied by the Puget Sound Steelhead DPS and these watersheds encompass approximately 999 mi^2 (2,587 km^2). Fish distribution and habitat use data identify approximately 170 miles (274 km) of occupied riverine habitat in the watersheds (WDFW 2015; Treaty Indian Tribes in Western Washington 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 sub-basin. After reviewing the best available scientific data for this sub-basin, the CHART concluded that all of the occupied areas in this sub-basin contain one or more PCEs for this DPS.

Sauk Sub-basin (HUC4# 17110006)
The Sauk sub-basin is located in northern Puget Sound within Skagit and Snohomish Counties, Washington. The sub-basin contains four watersheds occupied by the Puget Sound Steelhead DPS and these watersheds encompass approximately 741 mi^2 (1,919 km^2). Fish distribution and habitat use data from identify approximately 154 miles (248 km) of occupied riverine habitat in the watersheds (WDFW 2015; Treaty Indian Tribes in Western Washington 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 sub-basin. After reviewing the best available scientific data for this sub-basin, the CHART concluded that all of the occupied areas in this sub-basin contain one or more PCEs for this DPS.

Lower Skagit Sub-basin (HUC4# 17110007)
The Lower Skagit sub-basin is located in northern Puget Sound within Skagit and Snohomish Counties, Washington. The sub-basin contains two watersheds occupied by the Puget Sound Steelhead DPS and these watersheds encompass approximately 447 mi^2 (1,158 km^2). Fish distribution and habitat use data identify approximately 210 miles (338 km) of occupied riverine/estuarine habitat in the watersheds (WDFW 2015; Treaty Indian Tribes in Western Washington 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 sub-basin. After reviewing the best available scientific data for this sub-basin, the CHART concluded that all of the occupied areas in this sub-basin contain one or more PCEs for this DPS.

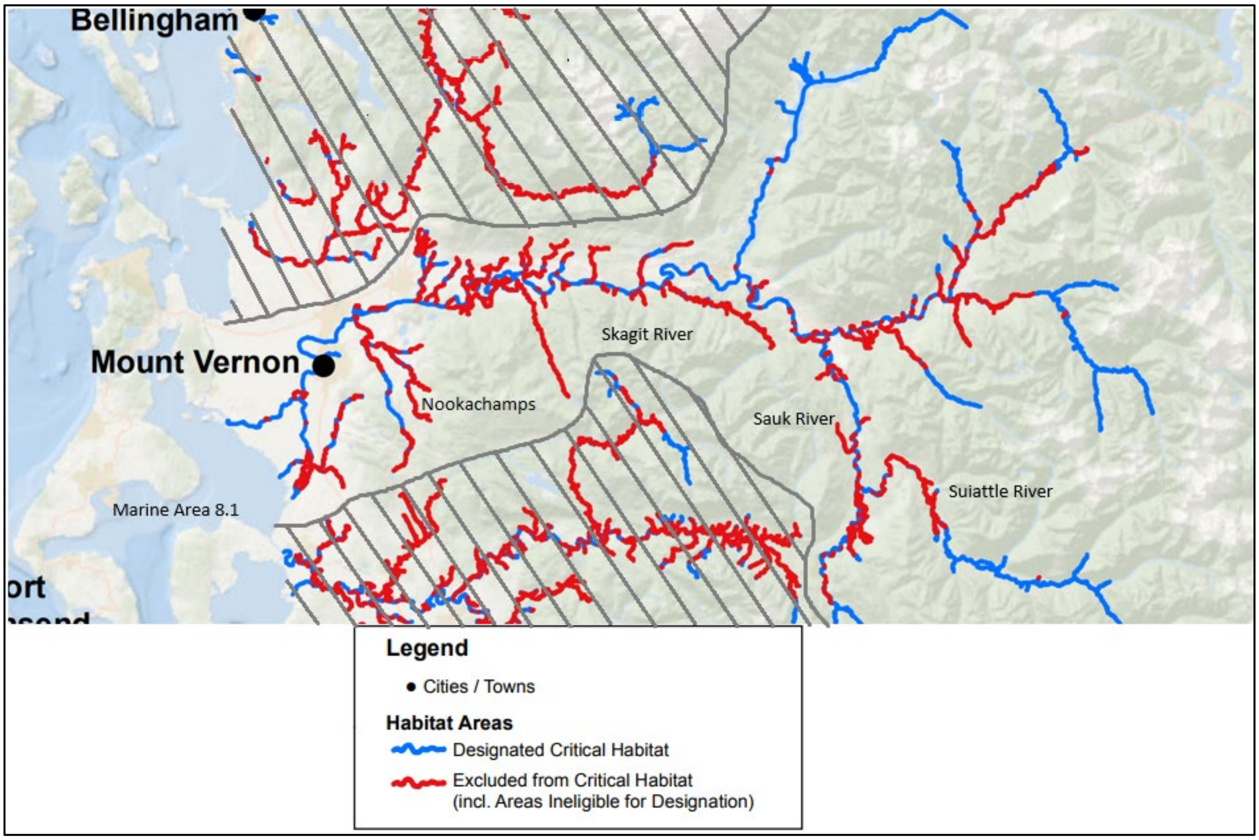


Figure 16. Map of steelhead Designated Critical Habitat in the Skagit Teminal Area, including the Skagit River, Nookachamps Creek, Sauk River, and Suiattle River (NMFS 2016b).

Most areas in the Skagit River watershed have some level of riparian degradation. In the lower Skagit subbasin, riparian areas have been heavily degraded. The loss of riparian forests has reduced suitable spawning habitat in some tributaries and the resulting increase in temperatures has created thermal barriers to Chinook salmon migration. In the mainstem, a majority of the river has at least moderately impaired riparian function. In the upper Skagit subbasin, with the exception of Illabot Creek, riparian function is substantially to moderately impaired. In the lower Sauk River, logging and ongoing agricultural practices have substantially diminished riparian forests in areas, resulting in less in-channel large wood. In the upper Sauk River, riparian degradation is moderate. Significant riparian degradation has occurred along the mainstem of the Suiattle River. There has been little riparian degradation in the Cascade River, with degradation almost entirely limited to coho tributaries.

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 historical levels, which contributes to increasing scour and fill of the channel bed. Hence, salmon and steelhead eggs are more easily and more frequently dislodged or buried, and fry emergence 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 (NMFS 2022a).

Spawning habitat in the lower Skagit River is believed to be very poor for egg incubation and survival. Aerial surveys of the mainstem have shown extensive fine sediment accumulation in areas 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 have caused both a loss of spawning area and poor egg-to-fry survival. In contrast, habitat in the upper Skagit River is relatively good for egg incubation. In the lower Sauk River, it is believed that spawning habitat is among the poorest in the system for incubation survival due to recent heavy accumulation of silt in the mainstem, and mass wasting and loss of pool-riffle sections in the tributaries. This problem is compounded by accelerating glacial melt from Glacier Peak, which has deposited large amounts of silt on the spawning grounds downstream of the Suiattle River, further impairing incubation survival. In addition, fish that migrate through the lower Sauk River and/or that come to the lower Sauk River from other areas to rear or forage (e.g., Upper Sauk Spring Chinook salmon) are subject to the sediment problems in this area. The upper Sauk River is considered impaired because of forest management activities and geology. Most streams in the Suiattle River system are in relatively pristine condition, although past forest practices and geological instability have caused sediment impairment in a few areas (NMFS 2022a).

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. Additionally, there are stand-alone research and monitoring activities. The impacts of these research activities pose both benefits and risks. In the short term, take may occur in the course of scientific research. However, these activities have a great potential to benefit ESA-listed species in the long-term. Most importantly, the information gained during research and monitoring activities will assist in planning for the recovery of listed species. Research on all listed fish species in the action area is currently provided coverage under Section 7 of the ESA or the 4(d) research Limit 7, or included in the estimates of fishery mortality discussed in the Effects of the Proposed Action (Section 2.5) in this opinion.

For the year 2012 and beyond, NMFS has issued several section 10(a)(1)(A) scientific research permits allowing lethal and non-lethal take of listed species (Table 11). In a separate process, NMFS also has completed the review of the state and tribal scientific research programs under ESA section 4(d) Limit 7. Table 11 displays the total take for the ongoing research authorized under ESA sections 4(d) and 10(a)(1)(A) for the listed Puget Sound Steelhead DPS.

Table 11. Total expected take of the ESA-listed species for scientific research and monitoring already approved through 2022 (NMFS 2022c).

Species	Life Stage	Production/Origin	Total Take	Lethal Take
Puget Sound Steelhead DPS	Adult	Natural	2,115	44
		Listed hatchery intact adipose	21	0
		Listed hatchery clipped adipose	35	7
	Juvenile	Natural	77,834	1,395
		Listed hatchery intact adipose	2,394	41
		Listed hatchery clipped adipose	9,063	172

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. NMFS research tracking system reveals that researchers, on average, end up taking about 37 percent of the number of fish they estimate needing. Second, the estimates of mortality for each proposed study are purposefully inflated (the amount depends upon the species) to account for potential accidental deaths. Therefore, it is very likely that fewer fish (in some cases many fewer), especially juveniles, than 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 Skagit steelhead in retention fisheries have decreased and has reduced information the co-managers had relied on to monitor Skagit River steelhead populations and provide for in-season updates. In response, the Upper Skagit Tribe 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. The RMP proposes to utilize the data that has been collected from this test fishery to generate in-season run size updates for the annual Skagit River steelhead return (Sauk-Suiattle Indian Tribe et al. 2021; 2022).

2.5 Effects of the Action on the Species and Designated Critical Habitat

Under the ESA, “effects of the action” are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

Following those considerations, we determined that the proposed action was not likely to adversely affect any ESA-listed species other than Puget Sound steelhead. Thus, while other listed species are discussed in the following analysis, the effects to other species are covered in section 2.12.

2.5.1 Puget Sound Steelhead

2.5.1.1 Assessment Approach

To assess the effects of the proposed action on listed Puget Sound steelhead, NMFS will utilize the information and analyses presented in the 2021 RMP, supplemental information and analysis provided by the co-managers, as well as existing data and information available from agency reports, and scientific literature.

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 a Skagit River steelhead (Sauk-Suiattle Indian Tribe et al. 2021). This reflects the difficulty in the ability to identify individual natural-origin steelhead, by population, unlike the ability to estimate population-specific impacts based on coded-wire tags in Chinook and coho salmon fisheries. Given the proximity of the marine area 8-1 to the Skagit River and the large size of the Skagit steelhead population abundance, compared to other Puget Sound populations, it is a reasonable assumption that the natural-origin steelhead encountered throughout the Skagit terminal area are of Skagit origin. As described in Section 2.4.2, there is currently insufficient information to assess abundance and productivity at the DIP-level (Sauk-Suiattle Indian Tribe et al. 2021). The assessment focuses on the impacts of the proposed action on the aggregate population of steelhead in the Skagit River. All impacts (direct and incidental) on natural-origin steelhead, in all salmon and steelhead fisheries in the action area, would be subject to the proposed RMP limits on harvest (4 percent to 25 percent, depending on run size forecasted; see Table 1). NMFS' assessment of the effects from the proposed action will focus on the effects on the Skagit River steelhead, as the proposed action is likely limited in its effect on the steelhead run returning to 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 decided to use a total spawner abundance value of 500 for all Skagit River steelhead DIPs (excluding Baker River), combined, as the critical threshold for their assessment, which is a higher spawner abundance than the three methods they reviewed Table 12.

Table 12. Methods and estimated critical thresholds considered in the development of the critical threshold used in the Skagit RMP assessment of effects and the final value used.

Method	Source	Criteria	Critical Threshold
Depensation	(Peterman 1977; Peterman 1987)	5% of Equilibrium Spawners (8,949) (Sauk-Suiattle Indian Tribe et al. 2021, Appendix B)	447
Effective Population Size	(Waples 1990; Heath et al. 2002; Ardren and Kapuscinski 2003; Waples 2004)	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**

Based on guidance from McElhany et al. (2000), and the preliminary recommended viability abundances from the Puget Sound TRT's viability assessment (Hard et al. 2015), the co-managers established the aggregate Skagit steelhead viable abundance threshold (V). These are: Nookachamps = 616; Skagit summer and winter = 32,338; and Sauk summer and winter = 11,615, for a total aggregate viable threshold of 44,619 spawners.

The co-managers included two additional aggregate abundance thresholds, which they identified as "Rebuilding" thresholds. These thresholds are associated with spawner abundances that maximize the long-term productivity of the aggregate 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 percent of the estimated equilibrium abundance).

The full set of abundance thresholds used in the co-managers assessment are presented in Table 13.

Table 13. Aggregate 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 comprises 24 annual estimates of spawning abundance and the total adult recruitment.

From this data set of spawners and 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. 2021; Appendicies 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 14). 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 versus Beverton-Holt (Sauk-Suiattle Indian Tribe et al. 2021).

Table 14. Transformed parameter and standard deviation estimates for the Skagit RMP spawner-recruit analysis (Sauk-Suiattle Indian Tribe et al. 2021).

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 Figure 17 (Ricker) and Figure 18 (Beverton-Holt).

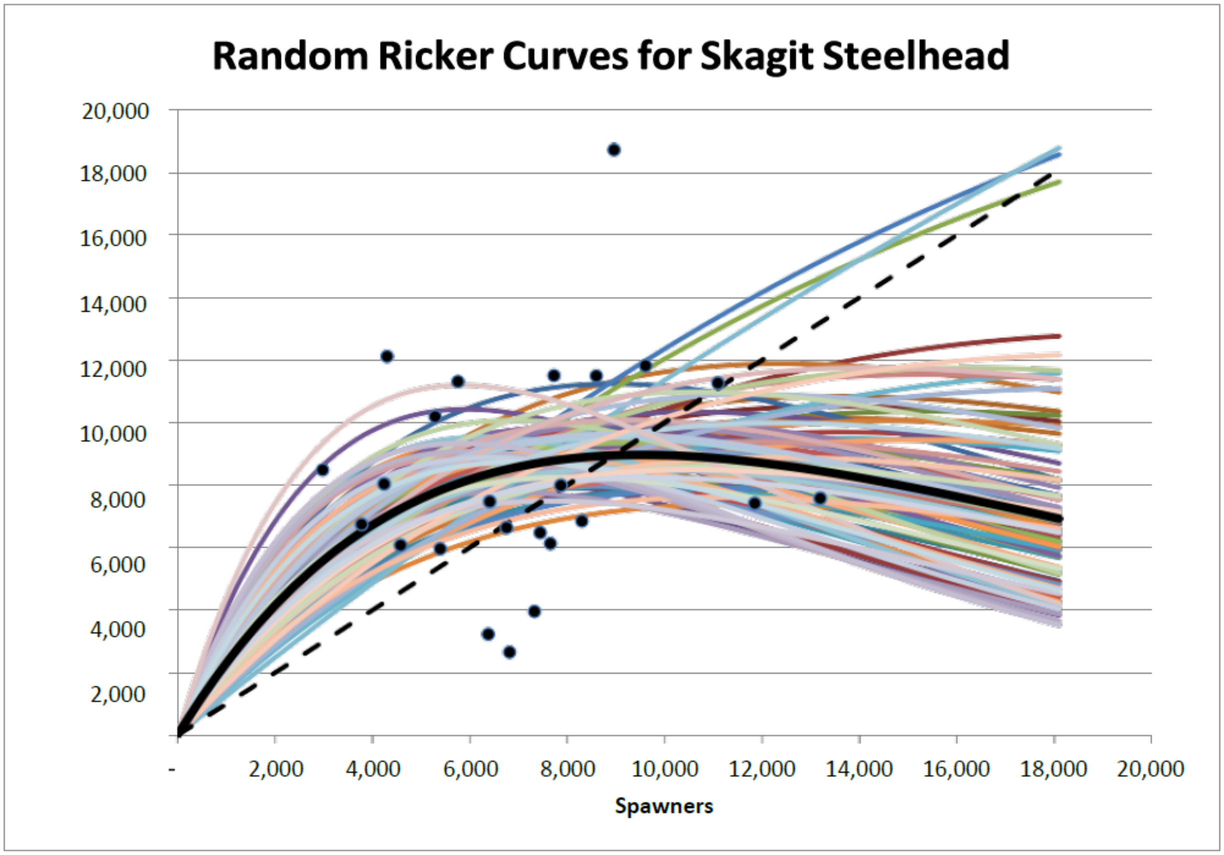


Figure 17. Random Ricker curves generated from the analysis of the 1978-2007 spawner-recruit data. The dashed black line represents the one-to-one relationship between spawners and recruits. The solid black line (curve) represents the median curve and the function (relationship) used in the modeling (Ricker) of the proposed harvest regime (Sauk-Suiattle Indian Tribe et al. 2021, Appendix B).

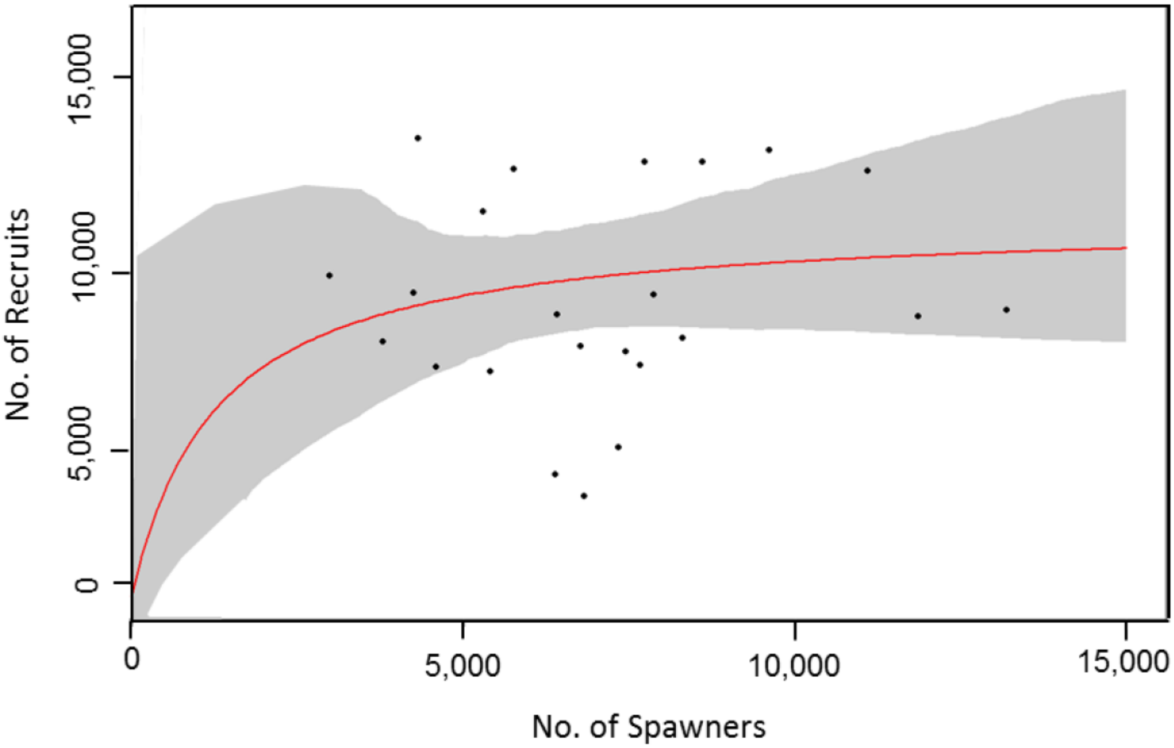


Figure 18. Median Beverton-Holt spawner-recruit curve (red line) and range of Beverton-Holt curves generated (grayed area) (n=642). The red line represents the curve and the function (relationship) used in the modeling (Beverton-Holt) of the proposed harvest regime (Sauk-Suiattle Indian Tribe et al. 2021, 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. 2021):

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 assess how the proposed harvest regime would affect the frequency of meeting or exceeding the abundance reference points (Table 13). Additional analysis produced distributions of the full range and frequency of both total estimated run-sizes (pre-harvest) and total estimated spawner abundance (post-harvest) under simulations of: No Fishery, constant 4.2 percent incidental harvest rate (to simulate the recent (pre-2018) harvest estimates), the proposed RMP abundance-stepped harvest rates.

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; 87 FR 78944) in December of 2022.

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 percent), which is significantly higher than the highest rate proposed in the RMP of 0.25 (25 percent (Sauk-Suiattle Indian Tribe et al. 2021). Additionally, the highest rate would only occur when run sizes are forecast to exceed 8,000 adults. However, because the co-manager's simulations, evaluating the impacts of proposed RMP harvest regime utilized these spawner-recruit relationships, it's important to explore several of the uncertainties relate to the general, adult-to-adult based spawner-recruit relationship used in the RMP analysis. In particular, due to the RMP's analysis of recruitment at the adult life-stage and in a single, basin-wide aggregated management unit, there may be underlying aspects of the estimated productivity and capacity relationship, which could be masked by this approach.

A primary concern with any recruitment relationship time series is one of stationarity (stability) 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 3), there has been variation in the productivity of the Skagit River steelhead over the historical timeframe used in constructing the spawner-recruit functions (1978-2007). 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. In response to NMFS' review of the 2016 Skagit RMP, commenters pointed to evidence of non-stationarity in the recruits per spawner relationship over the time series, 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 (1990 forward), 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 have been support for a finding of non-stationarity in the historical time series (1978-2007), the discernable impact on the RMP assessment, is likely minimal and would fall within the margin of error between the estimates.

Based on a longer-term set of brood year productivity estimates from the 2021 RMP (1978-2018), the productivity of the aggregate Skagit steelhead shows a stationary relationship over this time period. Utilizing the Augmented Dickey-Fuller test Said and Dickey (1984; R series package), produced a score of -4.65 and a p-value of 0.01, providing support for rejecting the null hypothesis of non-stationarity. Additionally, utilizing the KPSS test (Kwiatkowski et al. 1992; R tseries package), produced a score of 0.24 and a p-value of 0.1, which is not supportive of rejecting the null hypothesis of stationarity.

Considering the non-statistical difference between the earlier 1978-2007 spawner-recruit relationship (used in the RMP) and the 1990-2007 timeframe (Gayeski 2018), as well as the apparent stationarity of the longer-term recruitment (1978-2018), as described above, the use of the original, 2016 RMP spawner-recruit relationship is supportable.

An additional concern, raised during the public review of the PEPD, is that density-dependence within the Skagit River may be incompletely characterized by the RMP analysis. That is, the use of adult spawner-to-adult recruit estimates in the RMP analysis (as opposed to adding in multi life stage density-dependent relations), and the aggregation of the spawners and recruits at the basin-wide scale, could result in capacity parameters that may underestimate the system capacity and result in management objectives that underutilize available productive habitat.

In interpreting traditional Ricker or Beverton-Holt spawner-recruit relationships, the assumption is that the inflection point (where the recruits/spawner drops below 1) 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. 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 estimates 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.

While there is potential that the use of basin-wide, adult-to-adult productivity estimates could mask higher system capacity for spawners, there is consistent relationship, over the larger, 40-year timeseries (1978-2018) of recruitment estimates that does demonstrate a generally inverse relationship for recruitment at higher abundances (Figure 19). Over this timeframe the average spawner abundance that resulted in positive recruitment was 6,118, while the average spawning abundance resulting in negative recruitment was 8,377. While this does not, conclusively demonstrate that the spawning capacity of the Skagit River is not underestimated by the use of the basin-wide, adult-to-adult spawner-recruit data, this general pattern of negative recruitment at higher spawner abundances, including abundances just over 13,000 spawners, indicates that the capacity parameters (Ricker=9,529; BH=10,321) calculated for the RMP recruitment analyses are reasonable for the assessment of effects from the RMP harvest levels. Additionally, more recent work (Scheuerell et al. 2020), discussed below, estimated a lower current carrying capacity (7,700) than the RMP assessment.

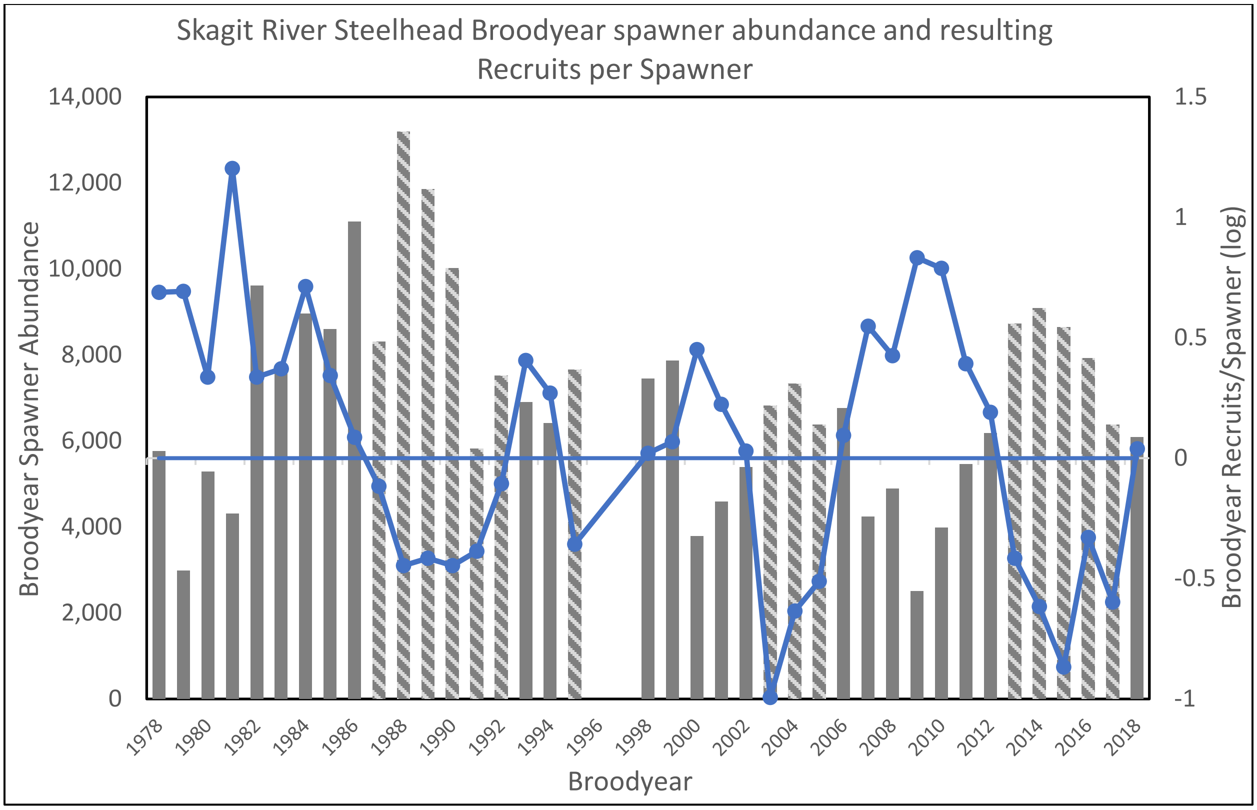
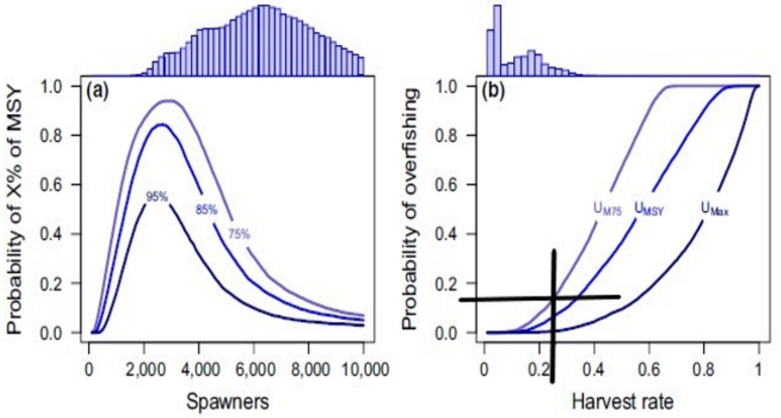


Figure 19. Skagit River steelhead annual spawning abundance (Sauk-Suiattle Indian Tribe et al. 2021; WDFW 2022) and broodyear estimated productivity (log). Blue line represents broodyear-specific productivity estimates (Sauk-Suiattle Indian Tribe et al. 2021). Vertical columns represent annual spawner abundances, with solid, dark gray representing abundances resulting in positive recruitment and striped columns representing abundances resulting in negative recruitment.

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 percent, in 5 percent increments due to climate change, specific events like landslides, or other causes—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.

A more recent analysis of the Skagit steelhead population dynamics, including an examination of environmental covariates, as well as the impact of past hatchery steelhead releases, on the productivity of the population was published in 2020. Scheuerell et al. (2020) developed a Bayesian Integrated Population Model (IMP) model to examine the underlying relationship of Skagit steelhead spawner abundance and resulting adult recruitment and tested this relationship against environmental covariates affecting survival at different life-history stages—peak winter Skagit River flows, low summer Skagit River flows, North Pacific Gyre Oscillation, and historical hatchery releases into the Skagit basin.

The resulting analysis from the model development in Scheuerell et al. (2020) was the selection of the Beverton-Holt form of underlying spawner/recruit relationship, with the parameterization of median intrinsic productivity (alpha) of 4.8 (CI 1.4-41.0) and a median carrying (beta) of 7,700 (CI 5,900-12,000) and an optimal yield (recruits) at approximately 2,000-3,000 spawners This results in a harvest rate (HR) at MSY of nearly 80 percent at the median intrinsic productivity estimate of 4.8 recruits/spawner and a harvest rate of roughly 29 percent at the low end of the credibility interval (1.4 R/S), both of which are higher than the proposed maximum HR of 25 percent in the 2021 RMP. Additionally, the Scheuerell et al. (2020) work looked at the probability of overfishing the population (defined as reducing the resulting spawner level to below the $S_{MSY)}$ and found that harvest levels at 75 percent of MSY (roughly 60 percent HR at median alpha (4.8) or roughly 22 percent HR at low alpha 1.4)) could increase the probability of overfishing the population by roughly 15 percent, over no fishing (Panel b in Figure 20). This is an important frame of reference for the abundance-based harvest rates proposed in the 2021 RMP. The 2021 RMP would only implement allowable rates of up to 25 percent at run sizes exceeding 8,000 adults. Based on the work in Scheuerell et al. (2020), this would result in minimal chance for fisheries proposed in the RMP to overharvest the population to below its most productive spawning abundances. In fact, even at the highest proposed rate of 25 percent, the resulting spawning abundance (>6,000) from the highest allowable harvest rate on the smallest abundance allowed in the RMP (8,001), would be nearly 3 times the S_{MSY} estimated in the Scheuerell (2020) work and 1.5-3 times the S_{MSY} calculated in the RMP assessment (Table 13). This spawning level would also exceed the RMP's higher rebuilding abundance reference (R_{60}) points (Table 13).



Plots of (a) the probability that a given number of spawners produces average yields achieving 95%, 85% or 75% of the estimated maximum sustainable yield (MSY); and (b) the cumulative probability of overfishing the population, based on harvest rates equal to those at 75% of MSY, at MSY and at the maximum per recruit. The histograms above (a) and (b) are distributions of the posterior estimates for the number of spawners and harvest rates respectively; the histogram in (a) has been truncated at 10^4

Figure 20. Probability plots for Skagit River steelhead spawner levels and harvest rates. Excerpted from Scheuerell et al. (2020; Figure 6), with panel b lines approximating the 2021 RMP's maximum allowable harvest rate of 25 percent.

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 SMU level (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 these limitations (Sauk-Suiattle Indian Tribe et al. (2021), Section 8.4 - Additional Conservation Actions for Populations and Diversity). As described in Section 1.3, proposed action, 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 on Puget Sound Steelhead

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 (Figure 21 to Figure 24), the first two represent the resulting changes based on simulations using the Ricker recruitment model, and last two 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 Table 15 and Table 16. For comparing the potential effects of the proposed RMP harvest regime, both a "No Fishing" simulation and a "constant 4.2 percent HR" simulation are presented (Sauk-Suiattle Indian Tribe et al. 2018). The No Fishing simulation assumes no harvest of Skagit River steelhead at all, direct or indirect. The 4.2 percent harvest rate simulation is meant to represent the recent (pre-2018) take limit from the existing Puget Sound salmon and steelhead fisheries (See Section 2.4.1.) and the pre-listing harvest level. For reference we will utilize the average total run size from the historical time series used in the recruitment analysis (1978-2007)—8,335 (average total run size) (Sauk-Suiattle Indian Tribe et al. 2021, Appendix Table A-2). Due to the limitations of the abundance bins from 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. Additionally, the 2019 recovery plan (NMFS 2019e) identifies an interim, aggregate spawner abundance objective for viability of 15,000 adults. To assess the impacts of the proposed RMP we will examine the differences in the frequency of spawner abundances above levels of 14,000-16,000 and 16,001 anticipated under the RMP.

Based on the Ricker model simulations (Figure 21), 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% points cumulative across bins) of run-sizes below 8,000, with slight reductions at the 0-2,000 and 2,001-4,000 levels of -0.2% points and -0.1% points, respectively and slight increases at the 4,001-6,000 and 6,001-8,000 levels of +0.8% points and +0.4% points, respectively (Figure 21, Table 15). 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% points) of run-sizes above 8,001, with slight increase at the 8,001-10,000 and 10,001-12,000 levels of +0.1% points and +0.2% points, respectively) and with slight reductions at the 12,001-14,000, 14,001-16,000, and the >16,000 levels of -0.4% points, -0.1% points, and -0.5% points, respectively (Figure 21, Table 15). 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 15).

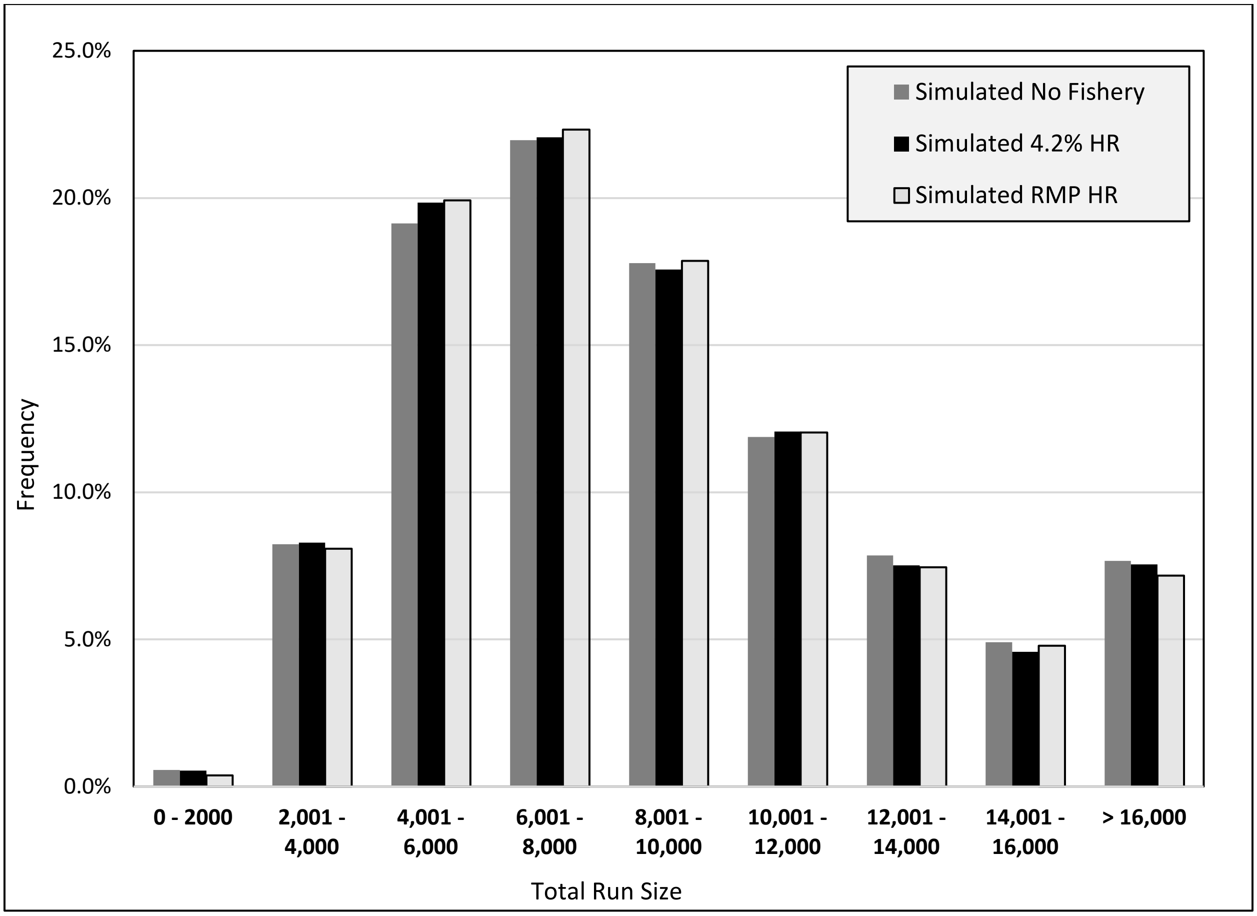


Figure 21. Skagit River steelhead total run size projections from Ricker model simulations of three harvest scenarios, based on the Skagit RMP Ricker recruitment function. Simulated scenarios are: No

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 22), 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% points cumulative across bins) 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% points, +8.6% points, and +9.6% points, respectively (Figure 22, Table 15). 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% points) of spawner abundances above 8,001, with decreases at the 8,001-10,000 abundances of -4.7% points; decreases at the 10,001-12,000 abundance levels of -4.8% points; decreases at the 12,000-14,000 abundances of -4.2% points; decreases at the 14,000-16,000 abundances of -2.9% points; and decreases in abundance above 16,000 of -5.3% points (Figure 22, Table 15). Relative to the "4.2 percent 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% points) of spawner abundances below 8,000, with a slight decrease in the frequency (-0.1% points) 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% points, respectively (Figure 22, Table 15). 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% points) of spawner abundances above 8,001, with decreases in the frequency, between -2.1% and -4.5% points, of all spawner abundance bins (Figure 22, Table 15).

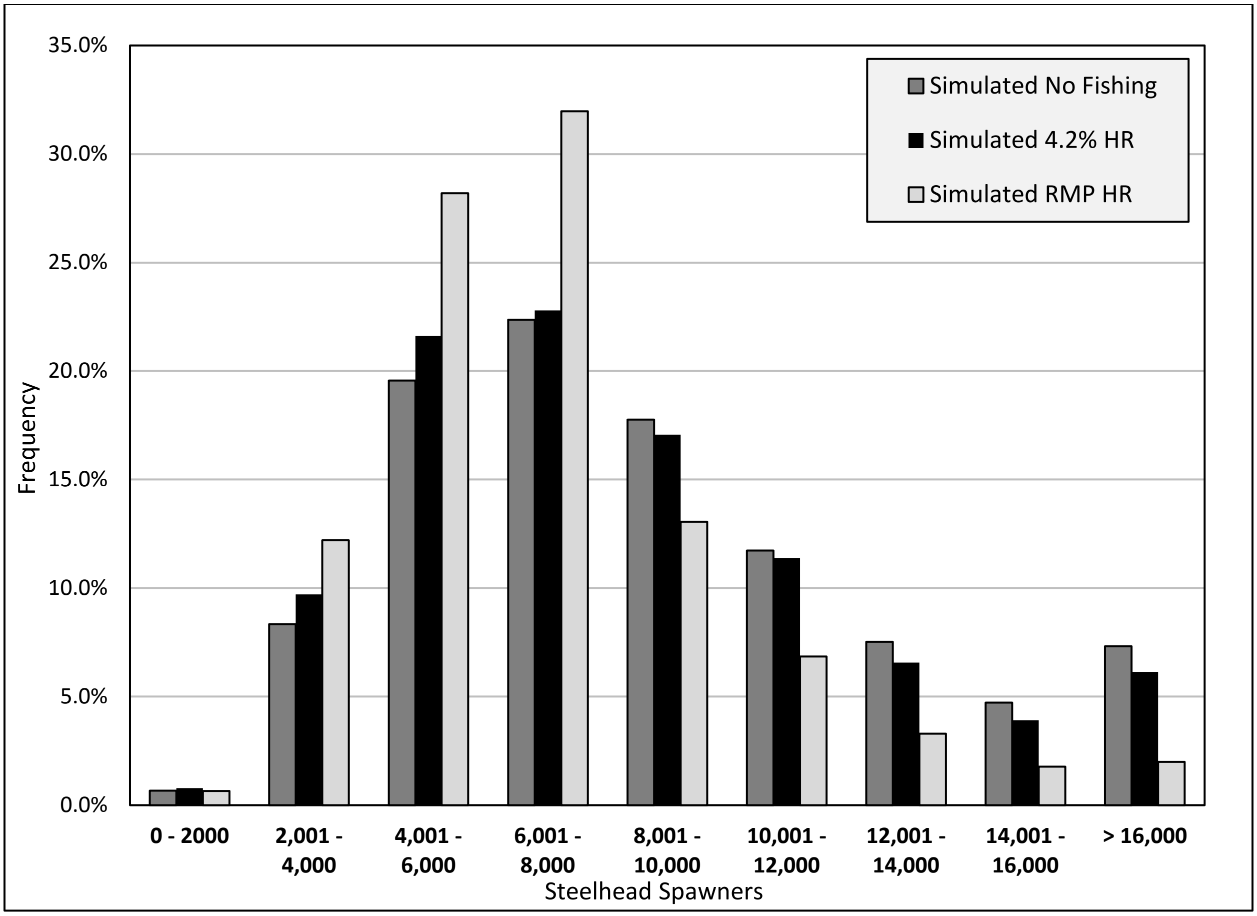


Figure 22. Skagit River steelhead spawner abundance projections from Ricker model simulations of three harvest scenarios, based on the Skagit RMP Ricker recruitment function. Simulated scenarios are: No Fishing (charcoal bars); 4.2% Harvest Rate (HR) (black bars); and the proposed Skagit RMP stepped HR regime (light gray bars). Source data - Sauk-Suiattle Indian Tribe et al. (2018).

Table 15. 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**	**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% points	-0.2% points
2,001 - 4,000	8.2%	8.3%	8.1%	-0.1% points	-0.2% points
4,001 - 6,000	19.1%	19.8%	19.9%	0.8% points	0.1% points
6,001 - 8,000	22.0%	22.1%	22.3%	0.4% points	0.3% points

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

Based on the Beverton-Holt model simulations (Figure 23), 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 (+1.3% points cumulative across bins) 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% points, respectively and a slight decrease in the 6,001-8,000 level of -0.3% points (Figure 23, Table 16). 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 (-1.3% points) of run-sizes above 8,001, with a decrease at the 8,001-10,000 abundances of -0.4% points; decreases at the 10,001-12,000 abundance levels of -0.1% points; decreases at the 12,000-14,000 abundances of -0.1% points; decreases at the 14,000-16,000 abundances of -0.3% points; and decreases in abundance above 16,000 of -0.4% points (Figure 23, Table 16).

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% points cumulative across bins) 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% points, respectively (Figure 23, Table 16). 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% points) of run sizes above 8,001, with slight decreases in the frequency, between -0.1% and 0.4% points, of all run size levels above 8,001 (Figure 23, Table 16).

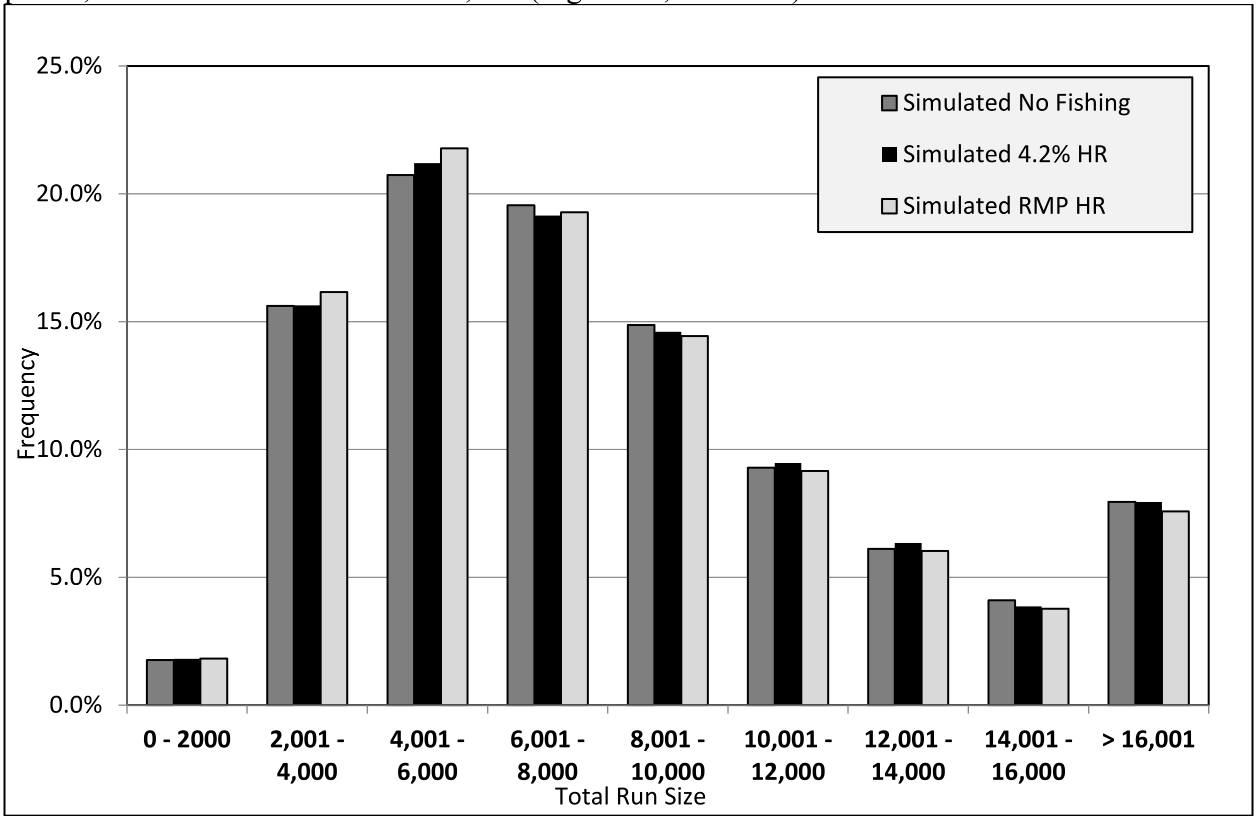


Figure 23. Skagit River steelhead total run size projections from Beverton-Holt model simulations of three harvest scenarios, based on the Skagit RMP Beverton-Holt recruitment function. Simulated scenarios are: No Fishing (charcoal bars); 4.2% Harvest Rate (HR) (black bars); and the proposed Skagit RMP stepped HR regime (light gray bars). Source data - Sauk-Suiattle Indian Tribe et al. (2018).

Based on the Beverton-Holt model simulations (Figure 24), 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% points) 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% points, respectively (Figure 24, 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 (-19.2% points) of spawner abundances above 8,001, with decreases in the 8,001-10,000 levels of -4.5 % points, decreases in the 10,001-12,000 levels of -4.0% points, decreases in the 12,001-14,000 levels of -2.7% points, decreases in the 14,001-16,000 levels of -2.1% points, and decreases in the spawner abundance levels above 16,000 of -5.9% points (Figure 24, Table 16). 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% points) 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% points, respectively (Figure 24, 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 (-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 24, Table 16).

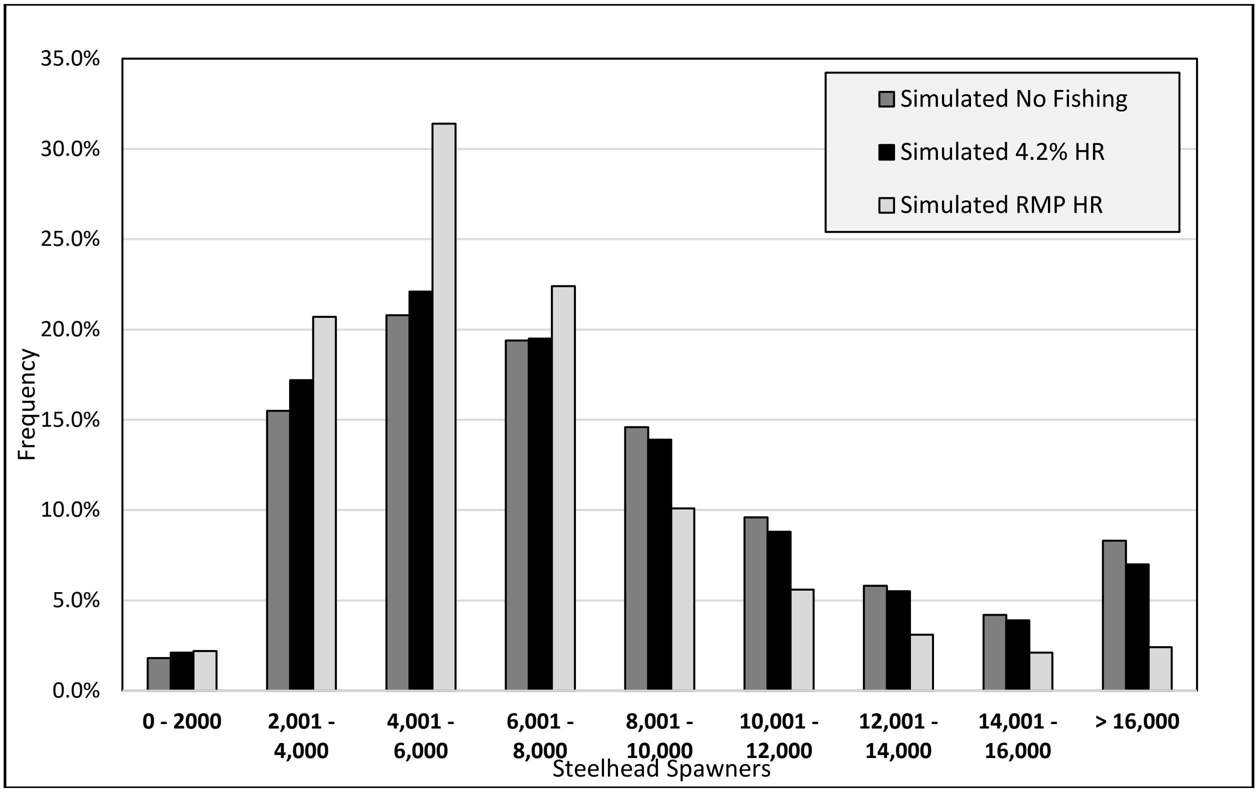


Figure 24. Skagit River steelhead spawner abundance projections from Beverton-Holt model simulations of three harvest scenarios, based on the Skagit RMP Beverton-Holt recruitment function. Simulated scenarios are: No Fishing (charcoal bars); 4.2% Harvest Rate (HR) (black bars); and the proposed Skagit RMP stepped HR regime (light gray bars). Source data - Sauk-Suiattle Indian Tribe et al. (2018).

Table 16. 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% points	0.0% points
2,001 - 4,000	15.6%	15.6%	16.2%	0.5% points	0.5% points
4,001 - 6,000	20.7%	21.2%	21.8%	1.0% points	0.6% points
6,001 - 8,000	19.6%	19.1%	19.3%	-0.3% points	0.1% points
% Projected Run Size ≤8,000	**57.7%**	**57.8%**	**59.0%**	**1.3%**	**1.2%**
8,001 - 10,000	14.9%	14.6%	14.4%	-0.4% points	-0.2% points
10,001 - 12,000	9.3%	9.5%	9.2%	-0.1% points	-0.3% points
12,001 - 14,000	6.1%	6.3%	6.0%	-0.1% points	-0.3% points
14,001 - 16,000	4.1%	3.9%	3.8%	-0.3% points	-0.1% points
> 16,000	8.0%	7.9%	7.6%	-0.4% points	-0.4% points
% Projected Run Size >8,001	**42.3%**	**42.2%**	**41.0%**	**-1.3% points**	**-1.2% points**

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% points	0.1% points
2,001 - 4,000	15.5%	17.2%	20.7%	5.2% points	3.5% points
4,001 - 6,000	20.8%	22.1%	31.4%	10.6% points	9.3% points
6,001 - 8,000	19.4%	19.5%	22.4%	3.0% points	2.9% points
% Projected Abundance ≤8,000	**57.5%**	**60.9%**	**76.7%**	**19.2% points**	**15.8% points**
8,001 - 10,000	14.6%	13.9%	10.1%	-4.5% points	-3.8% points
10,001 - 12,000	9.6%	8.8%	5.6%	-4.0% points	-3.2% points
12,001 - 14,000	5.8%	5.5%	3.1%	-2.7% points	-2.4% points
14,001 - 16,000	4.2%	3.9%	2.1%	-2.1% points	-1.8% points
> 16,000	8.3%	7.0%	2.4%	-5.9% points	-4.6% points
% Projected Abundance >8,001	**42.5%**	**39.1%**	**23.3%**	**-19.2% points**	**-15.8% points**

The effect of the proposed Skagit RMP harvest regime on the frequency of attaining the two reference rebuilding spawner abundance levels (R_{msy} and R_{60}), 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 given the similarity in results between the 4.2% and RMP scenarios described above. This analysis shows that the proposed action would change the frequency at which these spawner abundances are attained or exceeded, relative to the “No Fishing” simulation Table 17. The proposed harvest regime under the RMP 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.

Table 17. 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% points)	99%	99% (0%)
Exceeds Rebuilding (R_{60}) (5,370; 4,844)	78%	68% (-10% points)	82%	75% (-7% points)

Source: Sauk-Suiattle Indian Tribe et al. (2021).

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 spawner 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 there would be reductions in the frequency of spawner abundances above R_{MSY}, as the incremental survival reduction is increased (Table 18). These reductions range from -3% points, at a 15% survival reduction, to -13% points, at a 35% survival reduction, under the Ricker simulation and from -1% points, at a 15% survival reduction, to -8% points, at a 35% survival reduction, under the Beverton-Holt simulation.

Table 18. Percentage (frequency) of simulated spawner abundances that are above R_{MSY} levels, under reduced survival assumptions (Sauk-Suiattle Indian Tribe et al. 2016) and the proposed RMP framework.

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%

In summary, the potential effect to total run sizes of steelhead returning to Skagit River under the proposed Skagit RMP harvest framework, on balance, would have a minimal effect on the run sizes recruiting to 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% points 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% points) in the frequency of run sizes greater than 8,001, with the 12,001-14,000 and >16,000 levels 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% points) 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% points) 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, on average, would produce higher recruits per spawner and that spawner abundances in the higher ranges of the historical range, while important for probing the capacity of the system, are not likely to produce run sizes as high as at the more moderate ranges of spawners.

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% points, 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 (Table 16 and Table 17). The frequency of spawner abundances over the 8,000 spawner levels would decrease by roughly -22% and -19% points under the Ricker and Beverton-Holt models, respectively, with the majority of the decreases spread more evenly across the 8,001 to >16,000 spawner levels (Table 16 and Table 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 (Table 16 and Table 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, even under the No Fishing simulations, that these levels of spawning abundance (4,000-8,000) are the most frequent levels expected in the Skagit River (Figure 22 and Figure 24). 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 consistently test the Skagit basin capacity over time and take advantage of any positive changes in the system habitat, not precluding increases toward recovery as system capacity improves.

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 No Fishery regime (Table 16 and Table 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 and does not preclude achievement of the viability abundance goal. 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 2016h). 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, 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, will likely see benefits from the low overall levels of fishing pressure, compared to the high levels seen for more than half a century from the targeting of early returning hatchery steelhead. When combined with the conservative harvest rates in the RMP, as shown by the analysis of those effects, 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.

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

As discussed above, critical habitat has been designated in areas throughout the Skagit Terminal Area (78 Fed. Reg. 2726) (Figure 16). 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 Terminal Area (Section 2.3) occur from boats or along river banks. The gear used in the proposed fishing activities under the 2021 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 similar 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 and 402.17(a)). 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).

The Federally approved Shared Strategy for Puget Sound Recovery Plan for Puget Sound Chinook Salmon (SSDC 2007) describes, in detail, the on-going and proposed state, tribal, and local government actions that are targeted to reduce known threats to listed Puget Sound Chinook salmon in the Snohomish River watershed. Similarly, a recovery plan for Puget Sound steelhead was recently issued (NMFS 2019c), and many of the actions implemented for Chinook salmon recovery will also benefit steelhead. Future tribal, state, and local government actions will likely be in the form of legislation, administrative rules, policy initiatives, and land use and other types of permits. Government and private actions may include changes in land and water uses, including ownership and intensity, which could affect listed species or their habitat. Government actions are subject to political, legislative and fiscal uncertainties.

Non-Federal actions are likely to continue affecting listed species. State, tribal, and local governments have developed plans and initiatives to benefit listed species (e.g., SSDC (2007)). The cumulative effects of non-Federal actions in the action area are difficult to analyze because of the political variation in the Action Area, and the uncertainties associated with funding and implementation of government and private actions. However, we expect the activities identified in the baseline to continue at similar magnitudes and intensities as in the recent past.

On-going State, tribal, and local government salmon restoration and recovery actions implemented through plans such as the recovery plans (SSDC 2007; NMFS 2019e) would likely continue to help lessen the effects of non-Federal land and water use activities on the status of listed fish species. The temporal pace of reducing these effects would be similar to the pace observed in recent years. Habitat protection and restoration actions implemented thus far have focused on preservation of existing habitat and habitat-forming processes; protection of nearshore environments, including estuaries, marine shorelines, and Puget Sound; instream flow protection and enhancement; and reduction of forest practice and farming impacts on salmon habitat. Because the projects often involve multiple parties using Federal, state, and utility funds, it can be difficult to distinguish between projects with a Federal nexus and those that can be properly described as Cumulative Effects. These actions are likely to make beneficial contributions to species recovery, but it is not possible to assign specific benefits for the purposes of this Opinion.

With these improvements, however, based on the trends discussed above, there is also the potential for adverse cumulative effects associated with some non-Federal actions to increase, such as those associated with urban expansion and development (Judge 2011). To help protect environmental resources from potential future urbanization and development effects, Federal, state, and tribal laws, regulations, and policies are designed to conserve air, water, and land resources. A few examples include the Federal Navigable Waters regulations of the Clean Water Act, and in Washington state, various habitat conservation plans (HCPs) have been implemented, such as the Washington Department of Natural Resources Forest Practices HCP (WDNR 2005).

Some continuing non-Federal activities will 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 and those from cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the Environmental Baseline (Section 2.4) and included in our Opinion thusly.

NMFS anticipates that human development activities will continue to have adverse effects on listed species in the Action Area. NMFS also expects that these activities will continue to, on balance, degrade available designated critical habitat. NMFS is also certain that available scientific information will continue to grow and tribal, public, and private support for salmon recovery will remain high. This should continue to fuel the upward trend in habitat restoration and protection actions as well as hatchery, harvest, and hydropower reforms that are likely to result in improvements in fish survival. On balance, the continued pressures of human development and the possibility of beneficial habitat restoration projects aimed at salmon and steelhead survival lead NMFS to conclude that its Opinion should not reflect major positive or negative habitat changes from this factor.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in assessing the risk that the proposed action poses to species and critical habitat. 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 diminish the value of designated or proposed critical habitat as whole for the conservation of the species.

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), Environmental Baseline (Section 2.4), 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. The proposed action would isolate the effects to the Skagit River steelhead DIPs and the effect to the Skagit River steelhead DIPs' viability is low. This is expected to allow the Skagit DIPs to maintain their current moderate status (Ford 2022), 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.

We described the Status of the Puget Sound DPS in terms of the Viable Salmonid Population attributes: Abundance and Productivity, and Diversity and Spatial Structure. "Viability" is a level of population and species persistence associated with low risk of extinction and is necessary for recovery of a species. The current status was described as depressed and not currently viable (Hard et al. 2015). The status of the Skagit River steelhead populations was 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, hatchery management practices, harvest, and scientific research. 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.

As described in Section 2.5.1.2, 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 with the potential for improvement. 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 and recovery potential of the Puget Sound Steelhead DPS. 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 environmental baseline, NMFS 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 as described by applicable treaties and priority to conduct their fisheries within the limits of conservation constraints.

We 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 expected to occur in the future because they occurred frequently in the recent past. 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. These cumulative effects do not alter the effects of the action to the species, summarized as low effects to species viability. Thus, the species' survival and recovery would not be significantly altered by the proposed action.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the 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). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "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.

2.9.1 Amount or Extent of Take

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

NMFS anticipates incidental take of Skagit steelhead to occur in Skagit River terminal area fisheries directed at other salmon species, annually, through April 30, 2032 through contact with fishing gear.

The Skagit River steelhead fishery RMP will implement annual limits of total harvest rate on the Skagit steelhead runs, inclusive of all direct and indirect fishery-related mortality from steelhead-directed fisheries as well as from fisheries directed at other species. Due to the combined nature of the annual harvest rate limits proposed in the RMP, it is not practical to parse out specific indirect take from the overall impact rate. Therefore, with respect to Puget Sound steelhead, NMFS will rely on a surrogate measure of incidental take, in the form of the total allowable harvest rate, annually implemented, based on the annual forecasted terminal run size of Skagit River steelhead, as described in Table 19, below. This is reasonable because incidental take occurs simultaneously with the direct take related to fishing, and the extent of incidental take will likely track the extent of overall take. Moreover, the limit on allowable impact rate necessarily places a limit on incidental take by including it in the calculation of impact rate. Therefore, this surrogate is reasonable as both an indicator of potential take as well as the need to reinitiate consultation. Finally, the impact rate from the fisheries can be reasonably and reliably measured by the monitoring and reporting activities identified as part of the proposed action.

Table 19. Stepped fishing regime proposed for managing steelhead fisheries in the Skagit River Terminal Area (Sauk-Suiattle Indian Tribe et al. 2021).

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

2.9.2 Effect of the Take

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

2.9.2.1 Reasonable and Prudent Measures

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

The following reasonable and prudent measures are included in this incidental take statement for the *Puget Sound Steelhead DPS* considered in this opinion. Although the federal agencies are responsible for carrying out this reasonable and prudent measure, in practical terms, it is the states and tribes that monitor catch impacts and regulate fisheries:

(1) In-season management actions taken during the course of the fisheries shall be consistent with the level of incidental take established and defined in Section 2.9.1.2.
(2) Catch and the implementation of management measures used to control fisheries shall be monitored using best available measures
(3) The fisheries shall be sampled for biological information.
(4) Post season reports shall be provided describing the take of listed steelhead in the proposed fisheries
(5) Managers shall use results to improve management of Skagit River steelhead to ensure management objectives are met.

2.9.2.2 Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agencies must comply (or ensure that any applicant complies) with the following terms and conditions. The NMFS and any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in the ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, the protective coverage for the proposed actions would likely lapse.

The following terms and conditions implement reasonable and prudent measures for the *Puget Sound Steelhead DPS*:

1. The NMFS will work with the Puget Sound tribes and WDFW to ensure that in-season management actions taken during the course of the fisheries are consistent with the levels of anticipated take.
2. The NMFS will work with the Puget Sound treaty tribes and WDFW to ensure that the catch and implementation of management measures associated with fisheries that are the subject of this opinion are monitored at levels that are comparable to those used in recent years or using suitable alternatives if sampling access is limited. The effectiveness of the management measures will be assessed in the postseason report.
3. The NMFS will work with the Puget Sound treaty tribes and WDFW to ensure that the fisheries that are the subject of this opinion are sampled, to the extent possible, for biological information (age, sex, size, pre or post (kelt) spawn status)) to allow for a thorough post-season analysis of fishery impacts on steelhead and to improve preseason forecasts of abundance.
4. The NMFS will work with the Puget Sound treaty tribes and WDFW to provide annual post-season reports for the Skagit RMP fisheries that include estimates of catch and encounters of listed steelhead. The reports will also include annual spawner abundance estimates for Skagit steelhead and numbers of kelts (post-spawn) steelhead encountered in the fisheries. The report will also include the estimated total annual run size of Skagit steelhead and the annual calculated harvest rate.
5. The NMFS will work with the Puget Sound treaty tribes and WDFW, annually, prior to annual steelhead fisheries commencing to review the annual forecasted runsize and to review the harvest plan for the year. NMFS will work with the Puget Sound treaty tribes and WDFW to adaptively manage the fisheries based on information collected from prior years' fisheries, to improve the performance of the fisheries relative to the take limits defined in Section 2.9.1.

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, refine the strategy to evaluate and further improve the ability of the RMP to conserve the specified populations or diversity components (Sauk-Suiattle Indian Tribe et al. 2021, 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, 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 ten-year period, through April 30, 2032.

Under 50 CFR 402.16(a): “Re-initiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action.”

2.12 “Not likely to Adversely Affect” Determinations

NMFS anticipates the proposed action is not likely to adversely affect the Puget Sound Chinook Salmon ESU, Southern Resident Killer Whale DPS, Southern DPS of green sturgeon, or Southern DPS of 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 steelhead fisheries carried out under the 2021 Skagit RMP. Due to late annual start of the proposed fishery in the 2021 Skagit RMP, well after the fall Chinook run has ended, and the early end of the proposed fisheries (April 15 for tribal and April 30 for sport), 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, and otherwise in freshwater systems outside the range of SRKW. 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. SRKW have only been sighted one time in Skagit Bay in last 10 years 2012-2021 (in sightings quadrants 366-371, see Olson et al. (2018) for quadrant map) (Whale Museum unpublished data). While there is evidence that SRKW utilize steelhead as winter prey (Hanson and Emmons 2010; Ford et al. 2016; Hanson et al. 2021), this consumption is limited compared to certain other salmonids see Hanson et al. (2021), and SRKW do not frequently occur in the area and most fishing occurs nearshore/in river, so the fish caught would have already exited most marine areas where they would have been encountered as prey. Although steelhead are iteroparous and could return to marine waters if not caught in freshwater fisheries, this would only be small portion of a small catch and therefore unlikely to overlap with SRKW. Therefore, 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 adversely affect the SRKW's primary prey species, Chinook salmon. Thus, the proposed action is not likely to adversely affect Southern Resident killer whales or their 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 than sturgeon. Additionally, these fisheries 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 by this gear 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 in any Puget Sound salmon fisheries (NMFS 2017). 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 the southern DPS of 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, including the Skagit Terminal Area, 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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

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

3.1 Essential Fish Habitat Affected by the Project

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, redd or juvenile fish disturbance, and fishing vessel operation on habitat are also potential concerns for the fisheries in the Skagit Terminal Area.

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 mainstem freshwater areas. The gear fishermen use include hook-and-line, drift and set gillnets, and dipnets. The types of salmon fishing gear that are used in Skagit terminal area 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. 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 other 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, gillnets, purse seines, and other material, are occasionally lost to the aquatic environment. Recreational fisheries also contribute to the problem.

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 fishing gear 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 additional outreach and assessment efforts (i.e. Gibson 2013), and recent lost net inventories (Beattie and Adicks 2012; Beattie 2013; James 2017) it is likely that fewer nets will become derelict in the upcoming 2022/23 fishing season compared to several years or previous decades (previous estimates of derelict nets were 16 to 42 annually (NRC 2010)). In 2020, an estimated three nets became derelict, and all three of them were recovered (James 2020). In 2019, an estimated seven nets became derelict, and five of them were recovered (James 2020). In 2018, an estimated eight nets became derelict, and six of them were recovered(James 2019). In 2017, an estimated 11 nets became derelict (though not all of them may have been associated with a salmon fishery) and 10 were recovered (James 2018a). In 2016, an estimated 14 nets became derelict, nine of which were recovered (James 2017). 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). These reports cover the entirety of the Puget Sound marine and freshwater net fishing areas, of which the Skagit terminal area is a small part. We do not have estimates specific to this area but given the size of the Skagit terminal area compared to the geographic scope of Puget Sound salmon fishing it is reasonable to assume that the proportion of nets lost in the Skagit terminal area may be a small fraction of the total and that the majority of this gear is recovered. Given this, the proposed action will result in comparatively small-scale fisheries within the Skagit Terminal Area. 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 Skagit River steelhead fisheries, i.e., recreational boating and other 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 under the proposed action. Aside from the effects of the reduction in steelhead spawners from the proposed action and that are evaluated in the biological opinion, 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, the Federal agency must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation from NMFS. 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 NMFS 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.

Because there are no conservation recommendations, no response is required here.

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 opinion are the NMFS. Other interested users could include State and Tribal co-managers, fishery and conservation groups, etc. Individual copies of this opinion were provided to the NMFS. The document will be available within 2 weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. 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 part 600.

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

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

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

5.0 References

Ardren, W. R., and A. R. Kapuscinski. 2003. Demographic and genetic estimates of effective population size (N_e) reveals genetic compensation in steelhead trout. Molecular Ecology 12:35-49.

Atlas, W. I., T. W. Buehrens, D. J. F. McCubbing, R. Bison, 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):1-12.

Battin, J., M. W. Wiley, M. H. Ruckelshaus, 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., 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. J., E. Buhle, M. Ruckelshaus, A. Fullerton, and L. Holsinger. 2006. Hydrologic regime and the conservation of salmon life history diversity. Biological Conservation 130(4):560-572.

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

Blum, A. G., Y. Kanno, and B. H. Letcher. 2018. Seasonal streamflow extremes are key drivers of Brook Trout young-of-the-year abundance. Ecosphere 9(8):1-16.

Booth, D. B., 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):835-947.

Cram, J. M., N. Kendall, A. Marshall, T. Buehrens, T. Seamons, B. Leland, K. Ryding, and E. Neatherlin. 2018. Steelhead At Risk Report: Assessment of Washington's Steelhead Populations. October, 2018. 181 pages.

Crawford, B. A. 1979. The Origin and History of the Trout Brood Stocks of the Washington Department of Game. WDG, Olympia, Washington. 86p.

Crozier, L. G., M. M. McClure, T. Beechie, S. J. Bograd, D. A. Boughton, M. Carr, T. D. Cooney, J. B. Dunham, C. M. Greene, M. A. Haltuch, E. L. Hazen, D. M. Holzer, D. D. Huff, R. C. Johnson, C. E. Jordan, I. C. Kaplan, S. T. Lindley, N. J. Mantua, P. B. Moyle, J. M. Myers, M. W. Nelson, B. C. Spence, L. A. Weitkamp, T. H. Williams, and E. Willis-Norton. 2019. Climate vulnerability assessment for Pacific salmon and steelhead in the California Current large marine ecosystem. PLoS One 14(7):e0217711.

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

Drake, J. S., E. A. Berntson, J. M. Cope, R. G. Gustafson, E. E. Holmes, P. S. Levin, N. Tolimieri, R. S. Waples, S. M. Sogard, and G. D. Williams. 2010. Status Review of Five Rockfish Species in Puget Sound, Washington Bocaccio (*Sebastes paucispinis*), Canary Rockfish (*S. pinniger*), Yelloweye Rockfish (*S. ruberrimus*), Greenstriped Rockfish (*S. elongatus*), and Redstripe Rockfish (*S. proriger*). December 2010. NOAA Technical Memorandum NMFS-NWFSC-108. 247p.

Einum, S., G. Robertsen, and I. A. Fleming. 2008. Adaptive landscapes and density-dependent selection in declining salmonid populations: Going beyond numerical responses to human disturbance. Ecological Applications 1(2):239-251.

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

Feist, B. E., J. J. Anderson, and R. Miyamoto. 1996. Potential impacts of pile driving on juvenile pink (*Oncorhynchus gorbuscha*) and chum (*O. keta*) salmon behavior and distribution. Fisheries Research Institute Report No. FRI-UW-9603. 67p.

FEMAT. 1993. Forest Ecosystem Management: An Ecological, Economic, and Social Assessment. Report of the Forest Ecosystem Management Assessment Team. 1993-793-071. U.S. Gov. Printing Office. 1039p.

Finstad, A. G., L. M. Sættem, and S. Einum. 2013. Historical abundance and spatial distributions of spawners determine juvenile habitat accessibility in salmon: implications for population dynamics and management targets. Canadian Journal of Fisheries and Aquatic Sciences 70:1339–1345.

Ford, M. J., (editor). 2022. Biological viability assessment update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. NOAA Technical Memorandum. NMFS-NWFSC-171. U.S. Department of Commerce. January 2022. 337 pages. Available at: https://doi.org/10.25923/kq2n-ke70.

Ford, M. J., T. Cooney, P. McElhany, N. J. Sands, L. A. Weitkamp, J. J. Hard, M. M. McClure, R. G. Kope, J. M. Myers, A. Albaugh, K. Barnas, D. Teel, and J. Cowen. 2011. Status Review Update for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Pacific Northwest. NOAA Technical Memorandum NMFS-NWFSC-113. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. November 2011. 307 pages.

Ford, M. J., A. R. Murdoch, M. S. Hughes, T. R. Seamons, and E. S. LaHood. 2016. Broodstock history strongly influences natural spawning success in hatchery steelhead (*Oncorhynchus mykiss*). PLoS One 11(10):1-20.

Fowler and Turnbull. 2016. WDFW unpublished data.

Gayeski, N. 2018. Illustration of the development of a management strategy evaluation for harvest of ESA-listed wild Skagit River winter-run steelhead. Wild Fish Conservancy. January 8th, 2018. 13 pages.

Gibson, C. 2013. Preventing the Loss of Gillnets in Puget Sound Salmon Fisheries. August 2013. Northwest Straits Marine Conservation Foundation. 15p.

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(1-2):217-225.

Hanson, M. B., and C. K. Emmons. 2010. Annual Residency Patterns of Southern Resident Killer Whales in the Inland Waters of Washington and British Columbia. Revised Draft - 30 October 10. 11p.

Hanson, M. B., C. K. Emmons, M. J. Ford, M. Everett, K. Parsons, L. K. Park, J. Hempelmann, D. M. Van Doornik, G. S. Schorr, J. K. Jacobsen, M. F. Sears, M. S. Sears, J. G. Sheva, R. W. Baird, and L. Barre. 2021. Endangered predators and endangered prey: seasonal diet of Southern Resident killer whales. PLoS One 16(3):e0247031.

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. May 2015. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-129. 367p.

Hard, J. J., J. M. Myers, M. J. Ford, R. G. Kope, 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*). June 2007. NOAA Technical Memorandum NMFS-NWFSC-81. 137p.

Hay, D. E., and P. B. McCarter. 2000. Status of the eulachon *Thaleichthys pacificus* in Canada. DFO Canadian Stock Assessment Secretariat, Research Document 2000-145. Fisheries and Oceans Canada, Nanaimo, B.C. 92p.

HCCC. 2005. Hood Canal Coordinating Council Salmon Habitat Recovery Strategy for the Hood Canal & Eastern Strait of Juan de Fuca. Version 09-2005. 72p. www.hccc.wa.gov.

Heath, D. D., C. A. Bryden, J. M. Shrimpton, G. K. Iwama, J. Kelly, and J. W. Heath. 2002. Relationships between heterozygosity, allelic distance (d^2), and reproductive traits in Chinook salmon, *Oncorhynchus tshawytscha*. Canadian Journal of Fisheries and Aquatic Sciences 59:77-84.

HSRG. 2009. Columbia River Hatchery Reform System-Wide Report. February 2009. Prepared by Hatchery Scientific Review Group. 278p.

Hunter, M. A. 1992. Hydropower flow fluctuations and salmonids: A review of the biological effects, mechanical causes, and options for mitigation. Washington Department of Fisheries. Technical Report No. 119. Olympia, Washington. 58p.

ISAB. 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife. ISAB Climate Change Report ISAB 2007-2. Prepared for Northwest Power and Conservation Council, Columbia River Basin Indian Tribes, and National Marine Fisheries Service, Portland, OR. May 11, 2007. 146 pages.

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

James, C. 2017. 2016 reported loss of salmon fishing gear. Electronic letter from Chris James (Northwest Indian Fisheries Commission) to Dan Tonnes (National Marine Fisheries Service). Sent May 10, 2017.

James, C. 2018a. 2017 reported loss of salmon fishing gear. Electronic letter from Chris James (Northwest Indian Fisheries Commission) to Dan Tonnes (National Marine Fisheries Service). Sent June 19, 2018.

James, C. 2018b. Personal communication, regarding Chris James, Conservation Planning Biologist, Northwest Indian Fisheries Commission. April 18, 2018. Personal communication via phone with Molly Gorman, NMFS contractor, regarding steelhead assessment for marks in treaty fisheries.

James, C. 2019. 2018 reported loss of salmon fishing gear. Electronic letter from Chris James (Northwest Indian Fisheries Commission) to Dan Tonnes (National Marine Fisheries Service). Sent July 19, 2019.

James, C. 2020. 2019 reported loss of salmon fishing gear. Electronic letter from Chris James (Northwest Indian Fisheries Commission) to Dan Tonnes (National Marine Fisheries Service). Sent August 17, 2020. 2p.

Jording, J. 2021. Personal communication, letter to Tandy Wilbur (Fisheries Manager, Swinomish Indian Tribal Community), Jason Joseph (Natural Resources Director, Sauk-Suiattle Tribe), Scott Schuyler (Policy Representative, Upper Skagit Indian Tribe), and Edward Eleazer (Region 4 Fish Program Manager, Washington Department of Fish and Wildlife), regarding Skagit steelhead RMP 2022-2032. December 14, 2021.

Kinsel, C., J. Anderson, and M. LeMoine. 2016. Skagit River Tributary Steelhead Trapping Annual Report 2016. Washington Department of Fish and Wildlife, Fish Program, Science Division, Olympia, WA. 16 pages.

Kinsel, C., 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, Olympia, WA. June 2013. 43 pages.

Kondolf, G. M. 1997. Hungry water: Effects of dams and gravel mining on river channels. Environmental Management 21(4):533-551.

Kwiatkowski, D., P. C. B. Phillips, P. Schmidt, and Y. Shin. 1992. Testing the null hypothesis of stationarity against the alternative of a unit root: How sure are we that economic time series have a unit root? Journal of Econometrics 54(1):159-178.

Little, A. C. 1898. Ninth Annual Report of the State Fish Commissioner. Washington Department of Fisheries and Game. 115 pages.

Mantua, N., I. Tohver, and A. Hamlet. 2009. Impacts of Climate Change on Key Aspects of Freshwater Salmon Habitat in Washington State. Pages 217 to 253 (Chapter 6) *in*: Washington Climate Change Impacts Assessment: Evaluating Washington’s Future in a Changing Climate. Climate Impacts Group, University of Washington, Seattle, Washington. 37p.

Mauger, G. S., J. H. Casola, H. A. Morgan, R. L. Strauch, B. Jones, B. Curry, T. M. B. Isaksen, L. W. Binder, M. B. Krosby, and A. K. Snover. 2015. State of Knowledge: Climate Change in Puget Sound. Prepared by the Climate Impacts Group, University of Washington, Seattle for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration, Seattle, WA. November 2015. 309 pages.

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 254:111-128.

McCullough, D. A. 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. EPA 910-R-99-010, July 1999. CRITFC, Portland, Oregon. 291p.

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. NOAA Technical Memorandum NMFS-NWFSC-42. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. June 2000. 156 pages.

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(6):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. 23p.

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. March 2015. U.S. Dept. Commer., NOAA Technical Memorandum NMFS NWFSC-128. 175p.

Myrvold, K. M., and B. P. Kennedy. 2018. Increasing water temperatures exacerbate the potential for density dependence in juvenile steelhead. Canadian Journal of Fisheries and Aquatic Sciences 75(6):897-907.

NMFS. 2005. Final assessment of NOAA Fisheries' Critical Habitat Analytical Review Teams for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead. NMFS NWR Protected Resources Division, Portland, Oregon. 587p.

NMFS. 2006. Endangered Species Act Section 7 Consultation Biological Opinion and Section 10 Statement of Findings and Magnuson-Stevens Fishery Conservation and Managment Act Essential Fish Habitat Consultation. Washington State Forest Practices Habitat Conservation Plan. NMFS Consultation No.: NWR-2005-07225. 335p.

NMFS. 2008a. 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. February 5, 2008. NMFS Consultation No.: NWR-2007-02301. 137p.

NMFS. 2008b. Endangered Species Act Section 7 Consultation Final Biological Opinion and Magnuson-Stevens Fishery Conservation and Managment Act Essential Fish Habitat

Consultation. Implementation of the National Flood Insurance Program in the State of Washington Phase One Document-Puget Sound Region. NMFS Consultation No.: NWR-2006-00472. 226p.

NMFS. 2008c. Endangered Species Act Section 7(a)(2) Consultation Biological Opinion 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. December 22, 2008. NMFS Consultation No.: NWR-2008-07706. 422p.

NMFS. 2010a. Draft Puget Sound Chinook Salmon Population Recovery Approach (PRA). NMFS Northwest Region Approach for Distinguishing Among Individual Puget Sound Chinook Salmon ESU Populations and Watersheds for ESA Consultation and Recovery Planning Purposes. November 30, 2010. Puget Sound Domain Team, NMFS, Seattle, Washington. 19p.

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. NMFS Consultation Number: F/NWR/2010/03521. Sustainable Fisheries Division, Northwest Region. July 28, 2010. 96 pages.

NMFS. 2010c. NMFS Endangered Species Act Section 7(a)(2) Consultation Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. 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 and the Puget Sound/Georgia Basin Rockfish Distinct Population Segments. NMFS Northwest Region. May 5, 2010. NMFS Consultation No.: NWR-2010-01850. 47p.

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. NMFS Seattle, Washington. May 27, 2011. NMFS Consultation No.: NWR-2010-06051. 244p.

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. January 2, 2013. NMFS Consultation No.: 2012-00293. NMFS, Seattle, Washington. 82p.

NMFS. 2014a. Draft Environmental Impact Statement on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs. National Marine Fisheries Service, West Coast Region, Sustainable Fisheries Division, Lacey, WA. July 2014. 1650 pages.

NMFS. 2014b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Act Essential Fish Habitat Consulation on impacts of programs administered by the Bureau of Indian Affairs that support 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, Seattle, Washington.

NMFS. 2014c. Endangered Species Act Section 7(a)(2) Biological Opinion, Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation, Mud Mountain Dam, Operations and Maintenance. NMFS, West Coast Region. October 3, 2014. .

NMFS. 2015a. Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead, Final Biological Report. December 2015. NMFS, Portland, Oregon. 171p.

NMFS. 2015b. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation. Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries. Authorized by the U.S. Fraser Panel in 2015. NMFS, Seattle, Washington. May 7, 2015. NMFS Consultaton No.: WCR-2015-2433. 172p.

NMFS. 2016a. 2016 5-Year Review: Summary & Evaluation of Snake River Sockeye Snake River Spring-Summer Chinook Snake River Fall-Run Chinook Snake River Basin Steelhead. National Marine Fisheries Service, West Coast Region, Portland, Oregon. 128p.

NMFS. 2016b. Endangered and Threatened Species; Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead. Federal Register 81: 9252-9325. 75p.

NMFS. 2016c. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation, Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2016. June 6, 2016. NMFS Consultation No.: F/WCR-2016-4418. 192p.

NMFS. 2016d. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat 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. June 24, 2016. NMFS Consultation No.: WCR-2016-4914. 196p.

NMFS. 2016e. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. National Marine Fisheries Service (NMFS) Evaluation of 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. April 15, 2016. NMFS Consultation No.: WCR-2015-2024. 220p.

NMFS. 2016f. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. National Marine Fisheries Service (NMFS) Evaluation of 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. April 15, 2016. NMFS Consultation No.: WCR-2015-2024. 220p.

NMFS. 2016g. Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. National Marine Fisheries Service (NMFS) Evaluation of Two Hatchery and Genetic Management Plans for Early Winter Steelhead in the Snohomish River basin under Limit 6 of the Endangered Species Act Section 4(d) Rule. April 15, 2016. NMFS Consultation No.: WCR-2015-3441. 189p.

NMFS. 2016h. Final Environmental Impact Statement to Analyze 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. March 2016. NMFS, Lacey, Oregon. 326p.

NMFS. 2017. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response:. 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. May 3, 2017. NMFS Consultation No.: F/WCR-2017-6766. 201p.

NMFS. 2018a. 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. NMFS Consultation Number: WCR-2017-7053. April 11, 2018. 118 pages.

NMFS. 2018b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2018-2019 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 2018. May 9, 2018. NMFS, West Coast Region. NMFS Consultation No.: WCR-2018-9134. 258p.

NMFS. 2018c. Final Environmental Assessment Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Consideration of the Skagit River Steelhead Fishery Resource Management Plan under Limit 6 of the 4(d) Rule of the Endangered Species Act (ESA). National Marine Fisheries Service, West Coast Region, Lacey, Washington. April 2018. 172 pages.

NMFS. 2019a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response: Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2019-2020 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 2019. May 3, 2019. National Marine Fisheries Service, West Coast Region. NMFS Consultation No.: WCR-2019-00381. 284p.

NMFS. 2019b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and MagnusonStevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Ten Hatchery Programs for Salmon and Steelhead in the Duwamish/Green River Basin. NMFS Consultation Number: WCR-2016-00014. April 15, 2019. 160 pages.

NMFS. 2019c. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and MagnusonStevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Ten Hatchery Programs for Salmon and Steelhead in the Duwamish/Green River Basin. April 15, 2019. NMFS Consultation No.: WCR-2016-00014. 160p.

NMFS. 2019d. Endangered Species Act Section 7(a)(2) Biological Opinion, Conference Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation, Howard Hanson Dam, Operations and Maintenance Green River (HUC17110013) King County, Washington. NMFS, West Coast Region. February 15, 2019. .

NMFS. 2019e. ESA Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (*Oncorhynchus mykiss*). National Marine Fisheries Service, Office of Protected Resources and West Coast Region, Seattle, WA. December 20, 2019. 174 pages.

NMFS. 2019f. ESA Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (Oncorhynchus mykiss). National Marine Fisheries Service. Seattle, WA. 174p.

NMFS. 2020a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Response Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2020-2021 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 2020. May 8, 2020. NMFS Consultation No: WCR-2020-00960. 345p.

NMFS. 2020b. Endangered Species Act Section 7(a)(2) Jeopardy Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Issuance of Permits for 39 Projects under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act for Actions related to Structures in the Nearshore Environment of Puget Sound. NMFS Consultation Number: WCRO-2020-01361. November 9, 2020. 327p.

NMFS. 2021a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation: A Hatchery Program for Summer Steelhead in the Skykomish River and the Sunset Falls Trap and Haul Fishway Program in the South Fork Skykomish River. WCRO-2019-04075. April 23, 2021.

NMFS. 2021b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Response. Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2021-2022 Puget Sound Chinook Harvest Plan, the Role of the U.S. Fish and Wildlife Service in Activities Carried out under the Hood Canal Salmon Management Plan and in Funding the Washington Department of Fish and Wildlife under the Sport Fish Restoration Act in 2021-2022, and the Role of the National Marine Fisheries Service in authorizing fisheries consistent with management by the Fraser Panel and Funding Provided to the Washington Department of Fish and Wildlife for Activities

Related to Puget Sound Salmon Fishing in 2021-2022. NMFS Consultation Number: WCRO-2021-01008. Sustainable Fisheries Division. May 19, 2021. 405 pages.

NMFS. 2022a. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation National Marine Fisheries Service (NMFS) Evaluation of Three Hatchery and Genetic Management Plans for Skagit River Basin Chum Salmon under Limit 6 of the Endangered Species Act Section 4(d) Rule. NMFS Consultation Number: Log No. WCRO-2018-02183. Lacey, WA. October 26, 2022. 212 pages.

NMFS. 2022b. Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Impacts of the Role of the BIA Under its Authority to Assist with the Development of the 2022-2023 Puget Sound Chinook Harvest Plan, the Role of the U.S. Fish and Wildlife Service in Activities Carried out under the Hood Canal Salmon Management Plan and in Funding the Washington Department of Fish and Wildlife under the Sport Fish Restoration Act in 2022-23, and the Role of the National Marine Fisheries Service in authorizing fisheries consistent with management by the Fraser Panel and Funding Provided to the Washington Department of Fish and Wildlife for Activities Related to Puget Sound Salmon Fishing in 2022-2023. NMFS Consultation Number: WCRO-2022-01000. NMFS West Coast Region. May 13, 2022. 451 pages.

NMFS. 2022c. National Marine Fisheries Service Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response. Consultation on the Issuance of 52 ESA Section 10(a)(1)(A) Scientific Research Permits in Oregon, Washington, Idaho, and California affecting Salmon, Steelhead, Eulachon, Green Sturgeon, and Rockfish in the West Coast Region. NMFS Consultation Number: WRCO-2021-03174. April 14, 2022. 286 pages.

NMFS. 2023. (4)d Rule Limit 6 Final Evaluation and Recommended Determination for Skagit River Steelhead Fishery Resource Management Plan. WCR-2021-03137.

NRC. 2010. Rockfish within derelict gear. Electronic communication from Jeff June to Dan Tonnes. Sent February 8, 2010.

NWFSC. 2015. Status Review Update for Pacific Salmon and Steelhead listed under the Endangered Species Act: Pacific Northwest. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle, WA. December 21, 2015. 356 pages.

NWFSC. 2020. Draft Status review update for Pacific Salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. In prep April 2021.

NWIFC. 2016. 2016 State of Our Watersheds, WRIAs 1-23. A report by the Treaty Tribes in Western Washington. Northwest Indian Fisheries Commission Member Tribes. 336p.

NWIFC. 2020. 2020 State of Our Watersheds A Report by the Treaty Tribes in Western Washington. 390p. Retrieved from website shoughton.

Olson, J. K., J. Wood, R. W. Osborne, L. Barrett-Lennard, and S. Larson. 2018. Sightings of southern resident killer whales in the Salish Sea 1976-2014: the importance of a long-term opportunistic dataset. Endangered Species Research 37:105-118.

Parker, J., and K. Susewind. 2020. 2020-2021 Puget Sound Steelhead Harvest Management Plan. Washington Department of Fish and Wildlife and Puget Sound Treaty Indian Tribes. Memo regarding 2020-21 Incidental steelhead impacts. Included in 2020-2021 Puget Sound Harvest Management Plan.

Pess, G., M. McHenry, K. Denton, J. Anderson, and M. Liermann. 2020. Initial response of Chinook salmon (Oncorhynchus tshwytscha) and steelhead (Oncorhynchus mykiss) to removal of two dams on the Elwha River, Washington State, U.S.A. Draft 75p. .

Peterman, R. M. 1977. A simple mechanism that causes collapsing stability regions in exploited salmonid populations. Journal of the Fisheries Research Board of Canada 34:1130-1142.

Peterman, R. M. 1987. Review of the components of recruitment of Pacific salmon. American Fisheries Society Symposium 1:417-429.

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. Saltonstall-Kennedy Grant Program. NMFS-FHQ-2008-2001011. March 2013. 207 pages.

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, Oregon. 90p.

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

PSIT and WDFW. 2010b. Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component. Puget Sound Indian Tribes and Washington Department of Fish and Wildlife. April 12, 2010. 237 pages. Available at:

https://wdfw.wa.gov/sites/default/files/publications/00854/wdfw00854.pdf. Retrieved from website March 22, 2018.

PSSTRT. 2013. Viability Criteria for Puget Sound Steelhead. Final Review Draft. April 2013. 372p.

Puget Sound Steelhead Technical Recovery Team. 2011. Identifying Historical Populations of Steelhead within the Puget Sound Distinct Population Segment. 31 October 2011 Review Draft. NMFS NWFSC, Seattle, Washington. 110p.

Ravenel, W. d. C. 1901. Report on the propogation and distribution of food-fishes. Report of the Commissioner for the year ending June 30, 1900. U.S. Commission of Fish and Fisheries. 25-118 pages.

Said, S. E., and D. A. Dickey. 1984. Testing for unit roots in autoregressive-moving average models of unknown order. Biometrika 71(3):599-607.

Salish Sea Marine Survival Project, Long Live The Kings and the Pacific Salmon Foundation. 2015. Why focus on the Salish Sea?, at https://marinesurvivalproject.com/the-project/why/. Website accessed April 21, 2022.

Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, and Skagit River System Cooperative. 2018. Comanagers' response to request for supplementary information: Skagit River steelhead fishery resource management plan. February 2, 2018. 14 pages.

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. 53p.

Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, and Washington Department of Fish and Wildlife. 2021. Skagit River Steelhead Fishery Resource Management Plan. December 6, 2021. 69 pages.

Sauk-Suiattle Indian Tribe, Swinomish Indian Tribal Community, Upper Skagit Indian Tribe, and Washington Department of Fish and Wildlife. 2022. Skagit River Steelhead ISU Description and New Methods. August 23, 2022.

Scheuerell, M. D., C. P. Ruff, J. H. Anderson, and E. M. Beamer. 2020. An integrated population model for etimating the relative effects of natural and anthropogenic factors on a threatened population of steelhead trout. Journal of Applied Ecology 58:114-124.

Scott, J. B., and W. T. Gill (editors). 2008. *Oncorhynchus mykiss*: Assessment of Washington State's Steelhead Populations and Programs. Preliminary draft edition. Washington Fish & Wildlife Commission, Olympia, Washington. 424 pages.

Spence, B. C., G. A. Lomnicky, R. M. Hughes, and R. P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. December 1996. TR-4501-96-6057. Corvallis, Oregon. 206p.

SSDC. 2007. Puget Sound Salmon Recovery Plan. Shared Strategy for Puget Sound, Seattle, WA. January 19, 2007. 480 pages. https://repository.library.noaa.gov/view/noaa/16005. Retrieved from website September 30, 2022.

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.

Thompson, A., M. LeMoine, R. Hartson, J.-P. Shannahan, B. Laneouette, G. Rowles, B. McClure, and C. Kohn. 2021. To Move or Not to Move: Investigating *Oncorhynchus mykiss* survival, residualizations, emigration, and migrations tendencies in the Skagit River Basin. in prep.

Thorne, K., G. MacDonald, G. Guntenspergen, R. Ambrose, K. Buffington, B. Dugger, and J. Holmquist. 2018. U.S. Pacific coastal wetland resilience and vulnerability to sea-level. Science Advances 4(2):1-10.

Treaty Indian Tribes in Western Washington. 2011. Treaty Rights At Risk. Ongoing Habitat Loss, the Decline of the Salmon Resource, and Recommendations for Change. Northwest Indian Fisheries Commission, Olympia, WA. July 14, 2011. 35 pages. Available at: http://nwifc.org/w/wp-content/uploads/downloads/2011/08/whitepaper628finalpdf.pdf. Retrieved from website December 13, 2019.

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

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

United States Bureau of Fisheries. 1900. Report of the U.S. Commissioner of Fish and Fisheries.

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.

Waples, R. S. 1990. Conservation genetics of Pacific salmon III. Estimating effective population size. Journal of Heredity 81:277-289.

Waples, R. S. 2004. Salmonid insights into effective population size. Pages 295-314 *in* Hendry, A. P., and S. C. Stearns (editors): Evolution illuminated: salmon and their relatives. Oxford University Press.

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. 191p.

Warheit, K. I. 2014a. Measuring reproductive interaction between hatchery-origin and Wild steelhead (*Oncorhynchus mykiss*) from northern Puget Sound populations potentially affected by segregated hatchery programs. November 10, 2014. Unpublished Final Report. WDFW, Olympia, Washington. 14p.

Warheit, K. I. 2014b. 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. WDFW, Olympia, Washington. 92p.

WDFW. 2019. Swinomish Indian Tribe, Upper Skagit Indian Tribe and Sauk-Suiattle Indian Tribe. 2018-2019 Wild Skagit Steelhead Management Season Post-Season Report. December 4, 2019. 6p.

WDFW. 2021. Final Part I Status and Trends Analysis of Adult Abundance Data. Prepared in Support of Governor's Salmon Recovery Office 2020 State Salmon in Watersheds Report. WDFW Authors: Thomas Buehrens and Neala Kendall. Sent to Erik Neatherlin and Jennifer Johnson (GSRO) from Laurie Peterson (WDFW) on January 13, 2021. 28p.

WDFW. 2022. Skagit River Summer and Winter Steelhead. Queried from the Salmon Conservation and Reporting Engine (SCoRE) (Version April 7, 2022), an internet-accessible database (https://fortress.wa.gov/dfw/score/score/species/population_details.jsp?stockId=6049). Accessed May 19, 2022.

WDFW, and PSIT. 2017. 2015/2016 Puget Sound Steelhead Harvest Management Plan Report. Chris James (Northwest Indian Fisheries Commission) and Robert Leland (Washington Department of Fish and Wildlife (eds). March 27, 2017. 10p.

WDFW, and PSTIT. 2017. 2015/2016 Puget Sound Steelhead Harvest Management Plan Report. Chris James (Northwest Indian Fisheries Commission) and Robert Leland (Washington Department of Fish and Wildlife (eds). March 2017. 10p.

WDFW, and PSTIT. 2018. 2017-2018 Wild Skagit Steelhead Management Season Post-Season Report. November 29, 2018. 6p.

WDFW, and PSTIT. 2019. 2017/2018 Puget Sound Steelhead Harvest Management Report. January 25, 2019. 13p.

WDFW, and PSTIT. 2020. 2018/2019 Puget Sound Steelhead Harvest Management Report. February 19, 2020. 13p.

WDFW, and PSTIT. 2021. 2019/2020 Puget Sound Steelhead Harvest Management Report. February 10, 2021. 13p.

WDFW, and PSTIT. 2022. 2020/2021 Puget Sound Steelhead Harvest Management Report. February 17, 2022. 12 pages.

WDFW, Swinomish Indian Tribe, Upper Skagit Indian Tribe, and Sauk-Suiattle Indian Tribe. 2021a. 2019-2020 Wild Skagit Steelhead Management Season Post-Season Report. January 7, 2021. 6 pages.

WDFW, Swinomish Indian Tribe, Upper Skagit Indian Tribe, and Sauk-Suiattle Indian Tribe. 2022a. 2020-2021 Wild Skagit Steelhead Management Season Post-Season Report. January 18, 2022. 7 pages.

WDFW, Swinomish Indian Tribe, Upper Skagit Indian Tribe, and Sauk-Suiattle Indian Tribe. 2022b. 2021-2022 Wild Skagit Steelhead Management Season Preseason Plan. January 10, 2022. 2 pages.

WDFW, Swinomish Indian Tribe, Upper Skagit Indian Tribe, and Sauk-Suiattle Inidian Tribe. 2021b. 2019-2020 Wild Skagit Steelhead Management Season Post-Season Report. January 7, 2021. Final version updated January 28, 2021. 6p.

WDNR. 2005. Forest Practices Habitat Conservation Plan. Washington Department of Natural Resources, Olympia, WA. December 2005. 274 pages. Available at: https://www.dnr.wa.gov/programs-and-services/forest-practices/forest-practices-habitat-conservation-plan. Retrieved from website October 4, 2022.

Wilcox, W. A. 1895. Fisheries of the Pacific Coast. Report of the Commissioner for 1893. U.S. Bureau of Commercial Fisheries. 139-304 pages.

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. U.S. Bureau of Commercial Fisheries. 501-574 pages.