~~Draft~~ Final Environmental Assessment for a Steelhead Hatchery Program and Sunset Falls Trap and Haul Program in the Skykomish River Basin

Prepared by the
National Marine Fisheries Service, West Coast Region

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Acronyms and Abbreviations

4(d) Rule	final rule pursuant to ESA section 4(d)
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWT	coded wire tag
DPS	distinct population segment
EA	environmental assessment
Ecology	Washington Department of Ecology
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESS	early summer steelhead
ESU	evolutionarily significant unit
fpp	fish per pound
HGMP	Hatchery and Genetic Management Plan
HSRG	Hatchery Science Review Group
NEPA	National Environmental Policy Act
NF	North Fork
NMFS	National Marine Fisheries Service (also called NOAA Fisheries)
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWFSC	Northwest Fisheries Science Center
NWIFC	Northwest Indian Fisheries Commission
pHOS	proportion of hatchery-origin spawners
PNI	proportionate natural influence
pNOB	proportion of natural-origin adults in broodstock
RCW	Revised Code of Washington
RM	river mile
SF	South Fork
~~SIWG~~	~~Species Interaction Work Group~~
USFWS	U.S. Fish and Wildlife Service
WDFW	Washington Department of Fish and Wildlife

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1 INTRODUCTION

The National Marine Fisheries Service (NMFS) has received the following two Endangered Species Act (ESA) applications:

- A Hatchery Genetics Management Plan (HGMP) for a new South Fork Skykomish River Summer-run Steelhead Hatchery Program (WDFW and Tulalip Tribes 2019) pursuant to Limit 6 of the ESA 4(d) Rule submitted by the Washington Department of Fish and Wildlife (WDFW) and the Tulalip Tribes (the applicants; also collectively referred to as the co-managers).
- A section 10 (a)(1)(A) permit application for the operation and maintenance of the Sunset Falls Fishway trap-and-haul program submitted by WDFW (WDFW and Tulalip Tribes 2019).

If the programs meet the criteria of ESA Section 4(d) and Section 10(a)(1)(A), respectively, NMFS can issue the Section 4(d) determination and the Section 10(a)(1)(A) permit. NMFS' Section 4(d) determination and issuance of the permit constitute the Federal action that is subject to analysis as required by the National Environmental Policy Act (NEPA) and is the topic of this environmental assessment (EA).

The ESA sections 10(a)(1)(A) permit would be issued for 10 years from the date of issuance. The Section 4(d) determination would be made for an unlimited amount of time, though the program is subject to periodic review and may require additional ESA review.

This EA is being prepared using the 1978 CEQ NEPA regulations. NEPA reviews initiated prior to the effective date of the 2020 CEQ regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA regulations was September 14, 2020. This review began on January 6, 2020, and the agency has decided to proceed under the 1978 regulations.

1.1 Purpose and Need

The purpose of the Proposed Action is to determine whether the summer-run steelhead hatchery program in the Skykomish River Basin, as described in the HGMPs submitted by the co-managers, meets the requirements of the ESA under Limit 6 of the 4(d) Rule, and whether the trap and haul program permit application meets the requirement of the ESA section 10(a)(1)(A). NMFS' need for the Proposed Action is to respond to the co-managers' request for approval of the hatchery program under Limit 6 of the 4(d) Rule and the trap and haul program under the ESA section 10(a)(1)(A); to ensure the recovery of ESA-listed Puget Sound salmon and steelhead by conserving their productivity, abundance, diversity and distribution; and to ensure NMFS meets its tribal trust responsibilities.

The co-managers' objectives in developing and submitting the HGMP for the new summer-run steelhead hatchery program in the Skykomish River Basin under Limit 6 of the 4(d) Rule include operation of their hatchery facilities to meet resource management and protection goals with the assurance that any harm, death, or injury to fish within a listed evolutionarily significant unit (ESU) or distinct population segment (DPS) does not appreciably reduce the likelihood of a species' survival and recovery and is not in the category of prohibited take under the 4(d) Rule. Further, WDFW and the Tulalip Tribes strive to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound steelhead and their ecosystems to sustain treaty ceremonial and subsistence fisheries and non-treaty recreational fisheries, non-consumptive fish benefits, and other cultural and ecological values. The co-managers' objective in developing and submitting a trap and haul program permit application under the ESA section 10(a)(1)(A) is to provide access to available spawning habitat for salmon, steelhead, and trout in a section of the South Fork Skykomish River upstream from a natural waterfall blocking anadromous fish migration.

Another objective of the co-managers is to develop and operate a new integrated steelhead hatchery program. The size of the proposed program would be similar to the current segregated program using existing facilities (Wallace River Hatchery, Reiter Ponds, and Sunset Falls Fishway) for conservation and mitigation. The proposed program would provide fish for tribal and non-tribal harvest implemented under United States v. Washington while meeting ESA requirements.

1.2 Project Area and Analysis Area

The project area is the geographic area where the Proposed Action would take place as illustrated in Figure 1. The project area includes the locations in the Skykomish River Basin (Water Resource Inventory Area 7[1]) where Summer-run steelhead would be collected for broodstock, spawned, incubated, reared, acclimated, and/or released under the proposed HGMP. The steelhead, salmon, and bull trout would be trapped and hauled above the impassable barriers under the section 10 (a)(1)(A) permit. Activities conducted as part of the proposed action would occur primarily at three facilities: Wallace River Hatchery (broodstock collection, spawning, incubation, and rearing), Reiter Ponds (broodstock collection, spawning, incubation, rearing and release), and Sunset Falls Fishway (trap and haul program and broodstock collection).

[1] Water resource inventory areas are a system used by Washington State for delineating watersheds.

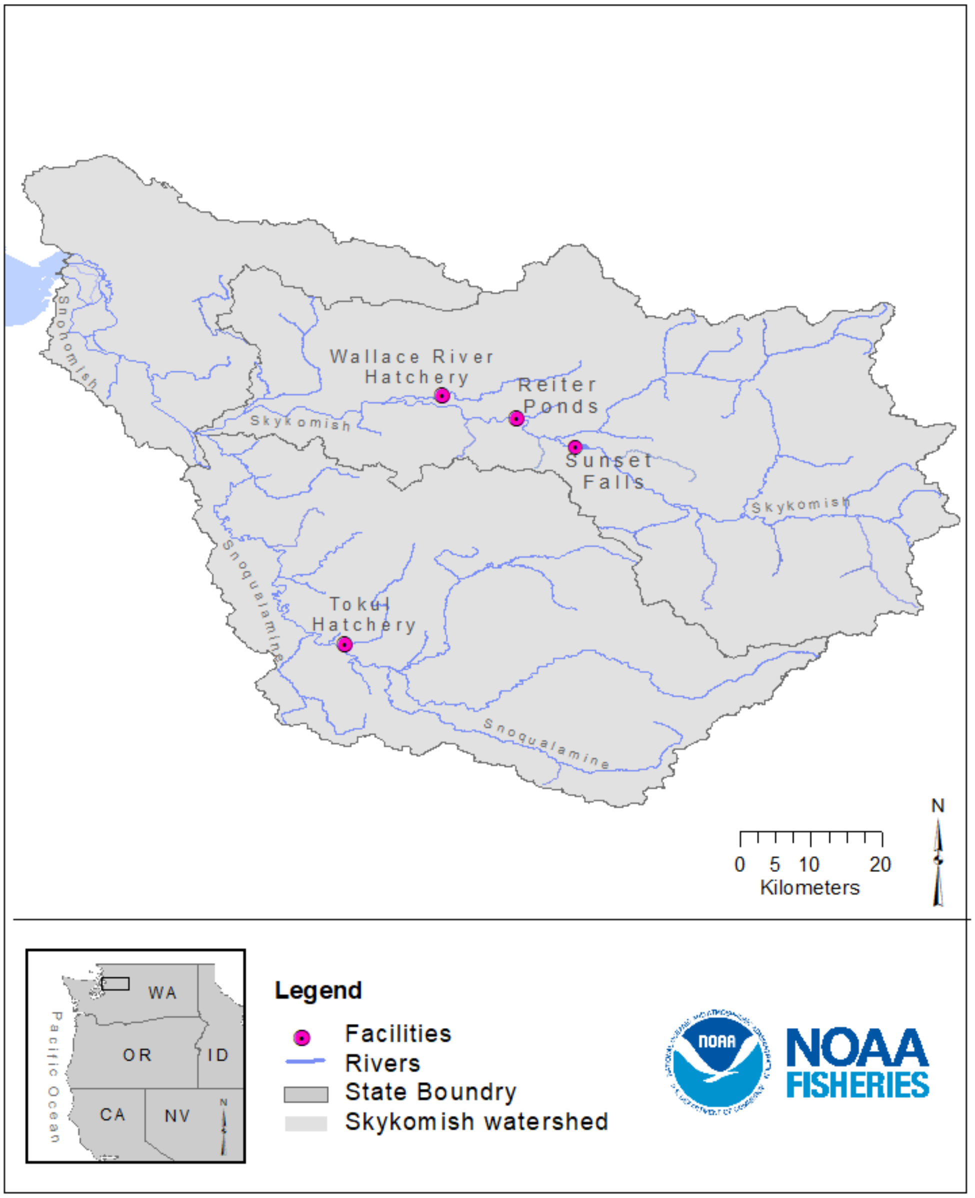

Figure 1. Hatchery facilities and the Sunset Falls Fishway in the Snohomish River Basin included in this EA.

The analysis area is the geographic extent that is being evaluated for each resource. Although the project area encompasses the full extent of project influence, the analysis area is specific to the resource being analyzed. For some resources (e.g., water quantity), the analysis area is limited to the area immediately surrounding the project facilities where operations could have a direct effect. For other resources, such as salmon and steelhead, the proposed programs could have wider geographic effects. The analysis area for each resource and current conditions are described in Chapter 3, Affected Environment. Direct and indirect impacts for each resource (e.g., water quality and quantity, wildlife) are analyzed in Chapter 4, Environmental Consequences. In addition, a larger analysis area is defined to consider past, present, and reasonably foreseeable future actions, for which the Proposed Action, could result in cumulative impacts on the human or natural environment. The evaluation of this larger analysis area for cumulative impacts is described in Chapter 5, Cumulative Impacts.

1.3 Relationship to Other Plans, Regulations, Agreements, Laws, Secretarial Orders, and Executive Orders

In addition to NEPA and the ESA, other plans, regulations, agreements, treaties, laws, and Secretarial and Executive Orders also affect hatchery operations in the action area. These are described in the following sections.

1.3.1 U.S. v. Washington

United States v. Washington, Phase I, (*Washington* 1974) is a Federal court proceeding that enforces and implements reserved treaty fishing rights to salmon and steelhead returning to the usual and accustomed fishing grounds and stations of the treaty tribes. These fishing rights and attendant rights of access were reserved by the tribes in the treaties of the 1850s. The court in *U.S. v. Washington* (1974) Phase I ruled that the tribes were entitled to 50 percent of the harvestable fish destined for the tribes' usual and accustomed fishing places. The ruling vests the tribes with the obligation and authority to co-manage fisheries resources with the State of Washington and Federal resource agencies (Stay 2012; NWIFC 2013). In 1976, the United States initiated Phase II of the litigation, asking for a declaratory judgement clarifying the Tribes' rights with respect to hatchery fish (*Washington* 1974). A Federal Court of Appeals decision subsequently held that hatchery fish must be included in determining the share of salmon to be allocated to the Tribes and that the tribes' treaty allocation includes both natural and hatchery origin fish (*Washington* 1974).

1.3.2 Federal-Tribal Trust Responsibilities and the Endangered Species Act

The United States government has a trust, or special, relationship with tribes. The unique and distinctive political relationship between the United States and tribes is defined by statutes, executive orders, judicial decisions, and agreements, and differentiates tribes from other entities that deal with, or are affected by the Federal government.

Secretarial Order 3206, *American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the Endangered Species Act* (Secretarial Order), clarifies the responsibilities of the agencies when actions taken under the ESA (USFWS and NMFS 1997). Specifically, USFWS and NMFS shall, among other things:

- Work directly with tribes on a government-to-government basis to promote healthy ecosystems
- Recognize that tribal lands are not subject to the same controls as Federal public lands, and
- Assist tribes in developing and expanding tribal programs so that healthy ecosystems are promoted, and conservation restrictions become unnecessary.

NMFS considers the responsibilities described above when taking ESA actions, such as issuing a section 10 permit and making section 4(d) determinations associated with an EA. Furthermore, NMFS has specified that the statutory goals of the ESA and the federal trust responsibility to Indian tribes are complementary (USFWS and NMFS 1997). The federal trust obligation is independent of the statutory duties and informs the way that statutory duties are implemented. The proposed programs promote the conservation of salmon and steelhead, which are tribal trust resources, and therefore fall within the scope of the Secretarial Order.

2 ALTERNATIVES

There are four alternatives being considered in this EA. All four alternatives involve ending the existing ~~Skamania~~early summer steelhead (ESS)[2] hatchery program as required by Settlement Agreement (WFC and WDFW 2019):

- Alternative 1 (No Action/Termination): NMFS would not make a determination under the 4(d) Rule for the Skykomish summer-run steelhead hatchery program HGMP nor issue a Section 10(a)(1)(A) for the Sunset Falls Fishway trap and haul program. Consequently, the programs would be terminated.
- Alternative 2 (Proposed Action): Under the Proposed Action, NMFS would make a determination that the HGMP for the proposed Skykomish summer-run steelhead hatchery program submitted by the co-managers meets ESA section 4(d) Limit 6 requirements and also issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program.
- Alternative 3 (Tolt River Source): NMFS would make a determination that a modified HGMP to use Tolt River natural-origin steelhead as a source to start a new summer-run steelhead program in the Skykomish River meets the criteria prescribed under Limit 6 of the 4(d) Rule and would issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program.
- Alternative 4 (Reduced Production): NMFS would make a determination that a modified HGMP limiting releases to 56,000 smolts yearly meets the criteria prescribed under Limit 6 of the 4(d) Rule and would issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program.

Table 1. Comparison of the Four Alternatives.

	Alternative 1 - No Action/ Termination	**Alternative 2 - Proposed Action (South Fork Skykomish River Broodstock)**	**Alternative 3 - Tolt River Source**	**Alternative 4 - Reduced Production (South Fork Skykomish River Broodstock)**
Sunset Falls Fishway	Limited operation of fishway to collect broodstock for Chinook and coho programs	Operate fishway to collect broodstock for summer-run steelhead and for Chinook and coho hatchery	Operate fishway to collect broodstock for summer-run steelhead and for Chinook and coho hatchery programs	Operate fishway to collect broodstock for summer-run steelhead and for Chinook and coho hatchery programs

[2] This program was called the Skamania program in the DEA, which was inaccurate. Although the broodstock has some Skamania ancestry, it in fact is of mixed Skamania/Skykomish ancestry (Crawford 1979; Warheit et al. 2021). It is now called the Early Summer Steelhead (ESS) program throughout the document. To distinguish with this program, the proposed summer steelhead program is called the Skykomish summer steelhead hatchery program.

	Alternative 1 - No Action/ Termination	Alternative 2 - Proposed Action (South Fork Skykomish River Broodstock)	Alternative 3 - Tolt River Source	Alternative 4 - Reduced Production (South Fork Skykomish River Broodstock)
trap and haul	outside of the scope of this EA Cease trap and haul program	programs outside the scope of this EA The trap and haul program operates	outside the scope of this EA The trap and haul program operates	outside the scope of this EA The trap and haul program operates
Broodstock Collection for Summer-run Steelhead	Phase out collecting ~~Skamania summer-run steelhead~~ESS broodstock at Reiter Ponds, Wallace Hatchery or Sunset Falls Fishway by 2020	**PHASE 1 -** Ramp up collection for new South Fork Skykomish River program while ramp down collection for ~~Skamania~~ESS program **PHASE 2** – Collect natural-origin fish from Sunset Falls Fishway (up to 30% of run or 120 fish) mixed with hatchery-origin South Fork Skykomish River program returns to Reiter Ponds, Wallace River Hatchery or Sunset Falls Fishway	**PHASE 1 -** Pump redds to meet egg take goal for new summer-run steelhead program while ramp down broodstock collection for ~~Skamania~~ESS program **PHASE 2 –** Hatchery-origin returns to Tolt River are transferred to Reiter Ponds, Wallace River Hatchery for initial release. Collect natural-origin fish from Falls Fishway (up to 30% of run or 120 fish) mixed with hatchery-origin returns to Reiter Ponds, Wallace River Hatchery or Sunset Falls Fishway	**PHASE 1 –** Collect broodstock at the initial level of Alternative 2 for the new South Fork Skykomish River program while ramp down collection for ~~Skamania~~ESS program **PHASE 2** – Collect natural-origin fish from Sunset Falls Fishway (up to 30% of run or 60 fish) mixed with hatchery-origin South Fork Skykomish River program returns to Reiter Ponds, Wallace River Hatchery or Sunset Falls Fishway
Incubation for Summer-run Steelhead	Phase out Incubation of Juveniles from the Skamania program at Wallace River Hatchery and Reiter Ponds through2021	**PHASE 1 -** Incubation of South Fork Skykomish River program eggs at Wallace River Hatchery and Reiter Ponds; and Incubation of ~~Skamania~~ESS program eggs at Wallace River Hatchery and Reiter Ponds through 2021 **PHASE 2 -** Incubation of South Fork Skykomish River program eggs at Wallace River Hatchery and Reiter Ponds	**PHASE 1 -** Incubation of Tolt River eggs for new summer-run steelhead program at Tokul Creek Hatchery through 2026; and Incubation of ~~Skamania~~ESS program eggs at Wallace River Hatchery and Reiter Ponds through 2021 **PHASE 2 -** Incubation of eggs for new summer-run steelhead program at Wallace River Hatchery and Reiter Ponds starting in 2027	**PHASE 1 –** Incubation of South Fork Skykomish River program eggs at Wallace River Hatchery and Reiter Ponds; and Incubation of ~~Skamania~~ESS program eggs at Wallace River Hatchery and Reiter Ponds through 2021 **PHASE 2 -** Incubation of South Fork Skykomish River program eggs at Wallace River Hatchery and Reiter Ponds

	Alternative 1 - No Action/ Termination	Alternative 2 - Proposed Action (South Fork Skykomish River Broodstock)	Alternative 3 - Tolt River Source	Alternative 4 - Reduced Production (South Fork Skykomish River Broodstock)
Rearing for Summer-run Steelhead	Phase out Rearing juveniles for ~~Skamania~~ESS program at Wallace River Hatchery and Reiter Ponds through 2022	**PHASE 1 –** Rearing South Fork Skykomish River program juveniles at Reiter Ponds and Wallace River Hatchery; Rear ~~Skamania~~ESS program juveniles at Reiter Ponds and Wallace River Hatchery through 2022 **PHASE 2 –** Rearing South Fork Skykomish program juveniles at Reiter Ponds and Wallace River Hatchery	**PHASE 1** – Rearing juveniles for new summer-run steelhead program at Tokul Creek Hatchery through 2026; and rearing juveniles for the ~~Skamania~~ESS program at Wallace River Hatchery and Reiter Ponds through 2022 **PHASE 2** - Rear juveniles for the new summer-run steelhead program at Reiter Ponds and Wallace River Hatchery	**PHASE 1 –** Rearing South Fork Skykomish River program juveniles at Reiter Ponds and Wallace River Hatchery; Rear ~~Skamania~~ESS program juveniles at Reiter Ponds and Wallace River Hatchery through 2022 **PHASE 2 –** Rearing South Fork Skykomish program juveniles at Reiter Ponds and Wallace River Hatchery
Release of Summer-run Steelhead	Phase out Releasing juveniles for the ~~Skamania~~ESS program at Reiter Ponds through 2022	**PHASE 1 and 2 –** Ramp up release of South Fork Skykomish River program juveniles; ramp down and discontinue the release of ~~Skamania~~ESS program juveniles, both to be released at Reiter Ponds	**PHASE 1** - Release juveniles for the new summer-run steelhead program at Tolt River and Tokul Creek Hatchery; ramp down and discontinue the release of ~~Skamania~~ESS program juveniles at Reiter Ponds. **PHASE 2 -** Release the new summer-run steelhead program juveniles at Reiter Ponds.	**PHASE 1 and 2 -** Release of South Fork Skykomish River program juveniles; ramp down and discontinue the release of ~~Skamania~~ESS program juveniles, both to be released at Reiter Ponds
Transplant Surplus hatchery-origin Adults	No transplants	~~Transplant surplus hatchery-origin adults to the North Fork Skykomish River~~ Transplant surplus hatchery-origin adults to the North Fork Skykomish River if agreed upon by a co-manager workgroup (see NMFS (2021c) for additional information)	~~Transplant surplus hatchery-origin adults to the North Fork Skykomish River during Phase two~~Transplant surplus hatchery-origin adults to the North Fork Skykomish River if agreed upon by a co-manager workgroup (see NMFS (2021b) for additional information)	No transplants

Table 2 lists the number of smolts and the type of smolts to be released under the four alternatives analyzed in this EA for each year ~~between 2021~~in 2022 and 2023, and onward.

Table 2. Number and type of steelhead smolts released ~~between 2021~~in 2022 and 2023 (and onward) for each of the alternatives analyzed in this EA

	Alternative 1	**Alternative 2**	**Alternative 3**	**Alternative 4**
~~2021~~	~~Up to 60,000 Skamania Smolts~~	~~Up to 60,000 Skamania Smolts; up to 56,000 Skykomish River smolts~~	~~Up to 60,000 Skamania Smolts; up to 56,000 Tolt River smolts~~	~~Up to 60,000 Skamania Smolts; up to 56,000 Skykomish River smolts~~
2022	Up to 40,000 ~~Skamania~~ESS Smolts	Up to 40,000 ~~Skamania~~ESS Smolts; up to 76,000 Skykomish River smolts	Up to 40,000 ~~Skamania~~ESS Smolts; up to 76,000 Tolt River smolts	Up to 40,000 ~~Skamania~~ESS Smolts; up to 56,000 Skykomish River smolts
2023 onward*	Zero ~~Skamania~~ESS Smolts	Zero ~~Skamania~~ESS Smolts; up to 116,000 Skykomish River smolts	Zero ~~Skamania~~ESS Smolts; up to 116,000 Tolt River smolts	Zero ~~Skamania~~ESS Smolts; up to 56,000 Skykomish River smolts

*The numbers for 2023 will continue annually in the future for the life of the 4(d) determination.

2.1 Alternative 1 (No Action/Termination): NMFS would not make a determination under the 4(d) Rule for the Skykomish summer-run steelhead hatchery program HGMP nor issue a Section 10(a)(1)(A) for the Sunset Falls Fishway trap and haul program.

NMFS would not make a determination under the 4(d) Rule for the Skykomish summer-run steelhead hatchery program HGMP nor issue a Section 10(a)(1)(A) for the Sunset Falls Fishway trap and haul program. Consequently, the programs would be terminated. For analysis purposes, NMFS has defined the No Action Alternative as the ramping down of the current ~~Skamania~~ESS steelhead hatchery program in the Skykomish River, consistent with the settlement agreement between Wild Fish Conservancy (WFC) and WDFW (WFC and WDFW 2019), and the Sunset Falls Fishway would be operated only to collect coho and Chinook salmon broodstock without the trap and haul program, which was analyzed in NMFS (2017a) and is not the subject of this EA. Salmon not targeted for broodstock collection, steelhead, and bull trout volitionally entering the Fishway from the South Fork Skykomish River would be released back into the South Fork Skykomish River below the falls. Under Alternative 1, we assume the Wallace River Hatchery and Reiter Ponds would operate incrementally less as summer-run steelhead hatchery production goes down. After 2022, we assume Wallace River Hatchery and Reiter Ponds would continue operating at a reduced level because other species are also produced at both facilities outside of the scope of this EA. However, it is possible that other salmonid species currently produced in these facilities and not part of the current EA would be produced in greater numbers in the future, so it is possible Wallace River Hatchery and Reiter Ponds would not operate incrementally less in the future under Alternative 1.

The last group of ~~Skamania~~ESS program broodstock was collected at Reiter Ponds, Wallace River Hatchery, and Sunset Falls Fishway in 2020. Incubation and rearing of ~~Skamania~~ESS program eggs would take place at Wallace River Hatchery and Reiter Ponds in order to continue to release juveniles through 2022. These fish from the ~~Skamania~~ESS program would be released from Reiter Ponds.

The Settlement Agreement requires that WDFW limit releases of juveniles for the ~~Skamania~~ESS ~~steelhead~~ hatchery program into the Skykomish River, including its tributaries, as shown in Table 2.

Resource monitoring as described in the HGMP (WDFW and Tulalip Tribes 2019) and permit application (WDFW 2019c) may or may not continue to occur under Alternative 1.

2.2 Alternative 2 (Proposed Action): NMFS would make a determination that the submitted HGMP meets the requirements of the 4(d) Rule and issue a Section 10(a)(1)(A) for the Sunset Falls Fishway trap and haul program.

Under the Proposed Action, NMFS would make a determination that the HGMP for the proposed steelhead hatchery program submitted by the co-managers meets ESA section 4(d) Limit 6 requirements and also issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program. The new steelhead hatchery program in the Skykomish River Basin would be implemented as described in the submitted HGMP (WDFW and Tulalip Tribes 2019). The Sunset Falls Fishway trap and haul program would continue as under existing conditions and operated as described in the permit application (WDFW 2019c).

Following is a description of the proposed summer-run steelhead hatchery program and the proposed trap and haul program (including a description of the facilities used, broodstock collection, juvenile release sites, adult management, facility operation, and research, monitoring and evaluation activities). The hatchery program and the trap and haul program are described separately.

2.2.1 Proposed Summer-run Steelhead Hatchery Program

The proposed South Fork Skykomish River summer-run steelhead program would replace the current ~~Skamania~~ESS program. Natural-origin fish from the South Fork Skykomish River would be used to start this new program, while the current ~~Skamania~~ESS program is phased out over the next ~~two~~few years ~~(2021-2022)~~. The following sections summarize information from the proposed HGMP (WDFW and Tulalip Tribes 2019).

2.2.1.1 Broodstock Collection

Initially for the proposed program, summer-run steelhead broodstock will be collected at the Sunset Falls Fishway exclusively from natural-origin returns. These initial natural-origin broodstock collections may not exceed 120 adults or 30% of the returns to Sunset Falls each year. Once hatchery-origin returns from this new program (as differentiated by an adipose clip and blank wire tag (BWT) and/ or Passive Induced Transponder (PIT) tag) become available for broodstock, this program would continue as an integrated program using a mixture of hatchery-origin returning to Sunset Falls Fishway, Reiter Ponds, and Wallace River Hatchery and natural-origin fish returning to Sunset Falls Fishway. Integration rates for the new program would be determined annually based on the number of hatchery-origin and natural-origin spawners available.

Hatchery-origin adults returning from the new integrated program that exceed broodstock needs will be passed upstream of the Sunset Falls Fishway, though the number of hatchery-origin adults passed upstream would be limited by genetic considerations. Integrated hatchery-origin fish collected in surplus of program goals (for upstream passage and broodstock needs), or that return to Reiter Ponds or Wallace River Hatchery facilities, could be utilized for outplanting into the North Fork Skykomish River, reintroduction into other unused or under-utilized habitats, or possibly used to augment a mark-selective fishery above the falls (all of these based on co-manager agreement), or if not agreed-to by the co-managers, they will be removed from the system. Surplus returns may also be utilized to assist in replacing other summer steelhead stocks where appropriate and as agreed-to by the co-managers. If the co-managers reach consensus on using this stock in other places, it may require a new NEPA and ESA review. Removed fish may be donated to Tulalip Tribes and approved charitable organizations or used for nutrient enhancement into the South Fork Skykomish River if not suitable for human consumption.

2.2.1.2 Spawning, Incubation, and Early Rearing

Spawning would occur at either Reiter Ponds or Wallace River Hatchery. Fish may be live-spawned. Spawners would be selected based on ripeness and spawned randomly on any spawn day. Live-spawned natural-origin fish may be released back into the river to allow for repeat spawning. Mortalities would be examined to determine cause of death. Incubation of South Fork Skykomish River program eggs would be at Wallace River Hatchery and Reiter Ponds. Early rearing of South Fork Skykomish River program juveniles would be at Wallace River Hatchery and Reiter Ponds.

The last set of ~~Skamania~~ESS program broodstock would be spawned in 2021 as under Alternative 1, and these eggs will be incubated at the Wallace River Hatchery and at Reiter Ponds. Then, through 2022, early rearing of ~~Skamania~~ESS program juveniles would be at Wallace River Hatchery and Reiter Ponds (see Alternative 1).

2.2.1.3 Final Rearing and Release

Final rearing for and release of South Fork Skykomish River program and ~~Skamania~~ESS program juveniles would take place at Reiter Ponds. The goal for this new Skykomish summer-run steelhead program is to ramp up the release to 116,000 smolts volitionally for four weeks during April-May each year at Reiter Ponds (Skykomish River mile (RM) 46), starting no earlier than April 15. However, as the new program becomes established, the actual releases of juveniles from the Skykomish program would be less than the 116,000 goal. ~~For years 2021 and 2022, summer~~Summer-run steelhead released into the Skykomish River from the new program would be combined with the ~~Skamania~~ESS program as shown in Table 2.

Reiter Ponds would be the release location for the releases listed for Alternative 2 in Table 2, but alternate release sites such as Wallace River Hatchery and the North Fork Skykomish River may be examined in the future; WDFW staff would discuss these options as they arise with NOAA and co-manager staff to reach consensus on the best course of action. If the course of action changes, this change may require a new NEPA review.

Yearling smolts ~~are expected to be released.~~will be volitionally released until the last day, when all remaining fish will be forced out of the ponds. Average size of smolts in a given year ranges from about 6.6 to 7.1 inches long (8 to 10 fish per pound). At program startup, 100 percent of the released fish would be adipose fin-clipped and BWT (with only an Agency code on it) or PIT tagged. ~~Fish that do not reach the release size or remain in the pond post release may be held an additional year and released as two-year old smolts. Any fish that do not migrate after their second year will be considered non-migratory and~~

~~planted into lakes not connected to marine waters.~~ Once hatchery returns are established, 100 percent[3] of the released fish would be adipose fin-clipped with additional BWT or PIT tags as necessary to achieve program objectives.

2.2.1.4 Adult Management

Returning hatchery-origin summer-run steelhead from the proposed program collected at Reiter Ponds, Wallace River Hatchery, or Sunset Falls Fishway facilities in surplus of program goals (for upstream passage and broodstock needs) ~~would be utilized for reintroduction into the North Fork Skykomish River. Up to 250 adults may be transplanted to the North Fork Skykomish River from 2025 to 2032.~~could be utilized for outplanting into the North Fork Skykomish River upon agreement of the co-managers.[4] Up to 250 adults may be potentially outplanted to the North Fork Skykomish River once a workgroup that is made up of the co-managers and NMFS determines that the North Fork summer steelhead population would benefit from outplanting fish from the South Fork steelhead population (NMFS 2021c). Food-grade quality carcasses may be distributed to the Tulalip Tribes for ceremonial and subsistence purposes or approved charitable organizations. Nonfood-grade carcasses would be disposed of or placed in local streams for nutrient enhancement according to Disease Control Policy guidelines.

Returning hatchery-origin adults will be passed above Sunset Falls, used for hatchery-origin broodstock, or surplused as described previously and below. During the years of abundant natural-origin returns, passage of hatchery-origin steelhead would be limited to meet gene flow needs (described in detail in Section 2.5.2.2). During the years of low natural-origin returns, hatchery-origin steelhead would be passed above Sunset Falls to allow up to 250 spawners (natural- and hatchery-origin).

2.2.1.5 Research, Monitoring and Evaluation

Snohomish-region hatchery programs include extensive monitoring, evaluation and adaptive management, and many other actions to monitor and address potential risks to natural-origin juvenile and

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[3] Although 100 percent clipping is the goal, typically a small number of fish escape clipping. The historical average for Skamania releases in the Snohomish is 1 percent escape (Regional Mark Information System Database [online database]. Continuously since 1977. Portland (OR): Regional Mark Processing Center, Pacific States Marine Fisheries Commission. URL:<http://www.rmpc.org>). Similarly, a small number may escape tagging, and some tags may be lost during a fish's life.

[4] The biological opinion for this Skykomish summer steelhead hatchery program (NMFS 2021c) requires that a co-manager work group be created to explore the relationship between North Fork- and South Fork Skykomish steelhead populations. In addition, this group will determine whether outplanting of steelhead to the North Fork Skykomish steelhead population would increase viability.

adult fish. The co-managers conduct numerous ongoing monitoring programs.[5] RM&E activities related to the hatchery program under Alternative 2[6] include:

- Marking (adipose clip) and tagging (BWT, PIT) juvenile summer-run steelhead prior to release.
- Examination of juvenile and adult summer-run steelhead ~~(observed in snorkel surveys or collected with hook and line or electrofishing gear)~~ for an adipose clip and checking clipped fish for the presence of a tag (BWT, PIT).
- Obtaining tissue samples from broodstock in the South Fork Skykomish River and from juveniles in the North Fork Skykomish River to genetically monitor diversity and assist in verification of steelhead population structure (WDFW 2021).

In addition, the work group that will be formed to determine whether outplanting hatchery-origin fish from the new summer steelhead program into the North Fork Skykomish River will be relying on information obtained through the various monitoring programs.

2.2.1.6 Facility Operation

Facilities that would be used for Alternative 2 are summarized in Table 3. Screening of water diversions at Wallace River Hatchery does not meet NMFS (2011) screen criteria. WDFW will modify screening at Wallace River Hatchery to comply with NMFS screening requirements to protect natural-origin fish from entrainment and impingement that may lead to injury and mortality (WDFW 2013b). Design and permitting to bring the screens in compliance with NMFS (2011) fish passage and screening criteria are projected to be completed by 2023, along with the construction of a new two-bay pollution abatement pond. These construction activities will be subject to a separate ESA permitting process and are not part of this alternative for NEPA analysis. Under Alternative 2, we assume the facilities will operate at similar

[5] These include the following: a) Section 7(a)(2) WCR-2019-00381 Annual, 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; b) 4(d) limit 7 authorization ("Snohomish and Stillaguamish watersheds annual salmonid biological sampling"), Annual WDFW Research and Monitoring; c) Section 10(a)(1)(A) 1345-9A, Warmwater Fish Species Monitoring; and d) limit 6 determination ("Joint Hatchery and Genetic Management Plans for Bernie Kai-Kai Gobin Salmon Hatchery "Tulalip Hatchery" Subyearling Summer Chinook Salmon, Tulalip Bay Hatchery Coho Salmon, Tulalip Bay Hatchery Chum Salmon, Wallace River Hatchery Summer Chinook Salmon, Wallace River Hatchery Coho Salmon, and Everett Bay Net-Pen Coho Salmon"), Tulalip Tribes smolt trap operations in the lower mainstem of the Skykomish River.

[6] While the Skykomish summer steelhead hatchery program will have other RM&E activities, the activities listed here are the only activities that do not have existing ESA authorizations and therefore would be part of the proposed action.

levels as under current conditions, as the total target summer-run steelhead Skykomish summer steelhead hatchery production would be the same from year to year.

Table 3. Details for facilities operation under Alternative 2.

Facility	Water source	Discharge Location	Meet NMFS Screening Criteria (Criteria year)?
Wallace River Hatchery	Wallace River	Wallace River[1]	NMFS (1995)
	May Creek	May Creek	NMFS (1995)
Reiter Ponds	Austin Creek (Spring fed)[2]	Austin Creek	NA
	Hogarty Creek (spring fed)[2]	Hogarty Creek	NA
Sunset Falls Fishway	South Fork Skykomish River	South Fork Skykomish River	NA
Tokul Creek Hatchery	Tokul Creek	Tokul Creek	NMFS (2011)
	Unnamed Creek	Tokul Creek	NMFS (2011)

[1] During low water periods (May through October), water is discharged to May Creek.
[2] Not an anadromous bearing stream

The hatchery weirs on Wallace River at RM 4.0 and near the mouth of May Creek are operated seasonally from June through October 1, and June through March, respectively. During these times, the weirs act as temporary barriers to upstream and downstream adult fish passage.

Screening of water diversions at Reiter Ponds do not need to meet NMFS (2011) screen criteria because the spring-fed water sources (Austin Creek and Hogarty Creek) are not anadromous fish bearing streams. The Reiter trap is currently operated from mid –May through March 15.

The operation of the trap and haul program at the Sunset Falls Fishway, which is part of the proposed action, is discussed below.

2.2.2 Proposed Sunset Falls Fishway Trap and Haul Program

The primary objectives of the Sunset Falls Fishway trap and haul program would be to provide access for Chinook, coho, pink, chum, and sockeye salmon, steelhead, and bull trout habitat above a natural impassable barrier and to collect broodstock for hatchery programs in the Skykomish River Basin. The trap will be operated from July 1 through December 31 each year, weather conditions permitting. The Sunset Falls Fishway trap and haul program also would provide an opportunity to conduct biological sampling important for monitoring salmon and steelhead in the Skykomish River Basin. Fish species and abundance data collected each year through the Sunset Falls Fishway trap and haul program would be used by WDFW and the Puget Sound Treaty Tribes (in particular, the Tulalip Tribes) to estimate salmon and steelhead escapements and run sizes. Fish species and abundance data would also be used to develop preseason forecasts of abundance and productivity estimates for stocks originating from the Skykomish watershed (WDFW 2019c).

The Sunset Falls Fishway is located on the South Fork Skykomish River approximately 1.9 miles (3 kilometers) above the confluence of the North Fork and South Fork Skykomish River ~~tributaries~~ near the town of Index, Washington. The Sunset Falls Fishway begins at the base of the falls and leads to a trap located about a third of the distance between the base and top of the falls. Beginning in 1958 and continuing through the present, the Sunset Falls Trap and Haul Fishway program has been operated to provide adult Chinook, coho, pink, chum, and sockeye, steelhead, and bull trout access to approximately 69 miles (111 kilometers) of habitat upstream of three natural impassable barriers to anadromous migration. The trap and haul program has served to promote and maintain natural production within a watershed in the South Fork Skykomish River with higher properly functioning conditions than is otherwise currently accessible to anadromous fish. Providing for natural salmon and steelhead spawning and rearing above the falls is an important component of actions implemented for the benefit of salmon and steelhead conservation and recovery in the Snohomish River Basin (Snohomish Basin Salmon Recovery Forum 2005). Also, counts of live fish at Sunset Falls are essential to estimating annual escapement and run reconstruction for ESA-listed Skykomish Chinook salmon and steelhead, as well as other non-listed anadromous fish mentioned above.

The Sunset Falls Fishway trap and haul program would include:

- Operation and maintenance of the trap facility
- Trapping migrating fish, including ESA-listed Chinook salmon and steelhead, which volitionally enter the Sunset Falls Fishway from the South Fork Skykomish River
- Enumerating these fish by species and origin (natural versus hatchery based on differential marks and/or tagging)
- Collecting biological samples and PIT tagging (or otherwise externally marking) these fish
- Monitoring of Chinook salmon, steelhead, and other fish species as needed, as part of a basin-wide monitoring program
- Moving captured migrating hatchery-origin and natural-origin adult fish from the trap into a tanker truck and transporting them upstream of three impassable barriers for release into suitable spawning and rearing habitat (Table 4), or to other hatchery programs for use as broodstock according to prescribed limits (see bullet below)
- Collection of Chinook salmon, coho, ~~chum~~, and summer steelhead adults for use as broodstock for annual salmon/steelhead enhancement programs
- Removal of captured adult hatchery-origin steelhead returning from the ~~Skamania~~ESS -origin, ~~summer-run steelhead~~program at the Reiter Ponds facility. ~~Initially this~~This will be done ~~during~~

~~the transition period to the new program as the old program is being phased out, which began with the reduced releases in 2019 and will last~~ until there are no more ~~Skamania~~ESS fish returning to the Wallace Hatchery, Reiter trap, and Sunset Falls trap. Note that natural-origin Skykomish River summer Chinook are currently passed upstream of the falls.

Table 4. Number of ~~salmon and steelhead~~salmonids transported by the trap and haul program at Sunset Falls. Transported steelhead data specify origin: hatchery (H) or natural (N). NC = Not counted.

Year	Coho salmon	Coho jack*	Chinook salmon	Chinook jack	Pink Salmon	Chum salmon	Sockeye salmon	Summer Steelhead		Bull trout	Cutthroat trout	Mountain Whitefish
								H	N			
2009	25,038	54	250	92	98,195	19	21	59	311	52	1	NC
2010	8,889	139	399	80	2	25	53	0	369	97	-	NC
2011	27,916	151	318	175	26,645	10	37	21	307	60	1	NC
2012	20,724	222	414	117	1	27	35	0	592	55	1	NC
2013	20,887	320	157	35	54,657	45	14	46	407	46	2	247
2014	11,278	376	344	52	4	21	41	0	284	67	1	251
2015	6,507	183	498	93	17,297	1	8	14	235	23	1	381
2016	12,947	275	280	65	1	43	29	13	261	34	1	431
2017	4,231	167	269	62	1,205	-	94	2	164	9	-	437
2018	10,734	114	97	29	-	-	51	0	221	10	-	82
Mean	**14,915**	**200**	**303**	**80**	**19,801**	**19**	**38**	**16**	**315**	**45**	**1**	**305**

*Jacks are males that return a year earlier than most adult fish

2.3 Alternative 3 (Tolt River Source): NMFS would make a determination that a Modified HGMP meets the requirements of the 4(d) Rule and issue a Section 10(a)(1)(A) for the Sunset Falls Fishway trap and haul program.

Under Alternative 3, NMFS would make a determination that the modified HGMP using Tolt River steelhead as the initial source for a new summer-run steelhead hatchery program in the Skykomish River meets ESA section 4(d) Limit 6 requirements and also would issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program as described under Alternative 2.

Following are a description of the summer-run steelhead hatchery program under Alternative 3. The research, monitoring and evaluation activities under a modified HGMP and the Sunset Falls Fishway trap and haul program would be the same as under Alternative 2 and will not be described here.

2.3.1 Proposed Skykomish Summer-run Steelhead Hatchery Program

The new steelhead Skykomish summer steelhead hatchery program would use Tolt River summer-run steelhead as a source for developing broodstock and would replace the current ~~Skamania stock summer-run steelhead~~ESS program. This new program would initially be run at the Tokul Hatchery (Figure 1), then it would be transferred to the Skykomish Basin to establish a new summer-run steelhead program in the Skykomish River of Tolt River origin.

2.3.1.1 Broodstock Collection

During phase one (eight years), natural-origin adult steelhead would not be collected as broodstock. Instead, summer-run steelhead redds in the Tolt River would be pumped to meet egg needs, collected representatively over the realized spawn timing in order to meet release goals according to an established matrix (Table 5).

Table 5. Release goals that would be used to determine egg needs.

	Tolt River Smolt Release	Tokul Hatchery Smolt Release
< 50 Natural Origin Spawners[1]	5,200-15,500	
51-120 Natural Origin Spawners[2]	15,500-28,000	
<120 Natural Origin Spawners	Up to 8,000	Up to 20,000
>120 Natural Origin Spawners	Up to 3,500	Up to 20,000

[1] Focus is on the conservation program and preserving the Tolt River Population. Captive broodstock considered

[2] Joint Focus Tolt and Local Broodstock

Once hatchery returns are established at Tokul Creek Hatchery (eight years after program initiation), those adult hatchery steelhead collected at Tokul Creek Hatchery would be used as broodstock to start the Skykomish River summer-run steelhead program (phase two) at Reiter Ponds. The program would initially be operated to only use the hatchery fish returning to Tokul Creek Hatchery but would include natural-origin steelhead from the South Fork Skykomish River after the phase two hatchery-origin returns are established.

2.3.1.2 Incubation and Rearing

During phase one, incubation of Tolt-origin eggs would be at Tokul Creek Hatchery. During phase two (2027 onward), incubation of Tolt/Skykomish River summer-run steelhead program eggs would be at Wallace River Hatchery and Reiter Ponds. During phase one, rearing of Tolt-origin juveniles would be at Tokul Creek Hatchery. During phase two (2027 onward), rearing of Tolt/Skykomish River summer-run steelhead program eggs would be at Reiter Ponds.

During 2021, incubation of ~~Skamania~~ESS program eggs would be at Wallace River Hatchery and Reiter Ponds, as described under Alternative 1. Through 2022, rearing of ~~Skamania~~ESS program juveniles would take place at Wallace River Hatchery and Reiter Ponds.

2.3.1.3 Release

The goal for this program would be to ramp up to the release of up to 116,000 smolts volitionally at Reiter Ponds for four weeks during April-May each year, starting no earlier than April 15. However, this program is designed in two phases. Per Table 1, phase one releases would occur at Tolt River and Tokul Creek Hatchery. Releases from the ~~Skamania~~ESS program would also occur through 2022, as described under Alternative 1. During phase two, releases would occur at Reiter Ponds. While the program is established, actual releases would be less than the 116,000 smolt goal for Reiter Pond releases. Through 2022, the summer-run steelhead releases from the new program into the Skykomish River would be combined with the ~~Skamania~~ESS program as shown in Table 2.

During 2023-2026, the program may continue to release up to the juvenile release limit as outlined in Table 5 at Tolt River and Tokul Creek Hatchery. From 2027-forward, Reiter Ponds would be the primary release location with a release goal of up to 116,000 juveniles from the Tolt/Skykomish program.

Yearling smolts are expected to be released. Average size of smolts in a given year ranges from about 6.6 to 7.1 inches long (8 to 10 fish per pound). At program startup, 100% of the released fish would be PIT tagged. Other tagging may also be used.

2.3.1.4 Adult Management

Returning hatchery-origin Skykomish summer steelhead~~summer-run steelhead~~ from ~~phase two~~ the proposed program collected at Reiter Ponds, Wallace River Hatchery, or Sunset Falls Fishway facilities in surplus of program goals (for upstream passage and broodstock needs) ~~would~~could be utilized for ~~reintroduction~~outplanting into the North Fork Skykomish River upon agreement of the co-managers (see footnote 4). Up to 250 Skykomish summer steelhead hatchery-origin adults may be transplanted to the North Fork Skykomish River ~~from 2025 to 2032.~~if a workgroup that is made up of the co-managers and NMFS determines that the North Fork summer sdteelhead population would benefit from outplanting fish from the South Fork steelhead population (NMFS 2021c). Food-grade quality carcasses may be distributed to the Tulalip Tribes for ceremonial and subsistence purposes or approved charitable organizations. Nonfood-grade carcasses would be disposed of or placed in local streams for nutrient enhancement according to Disease Control Policy guidelines.

2.3.1.5 Facility Operation

During phase one of Alternative 3, Tokul Creek Hatchery would be used to start this new hatchery program. The Wallace River Hatchery and Reiter Ponds would be operated as described under Alternative 1, including hatchery operations that are not part of this EA evaluated in NMFS (2017b). The hatchery ~~weirs~~weir on~~Tolt River and~~ Tokul Creek Hatchery are operated seasonally from June through October 1, and June through March, respectively. Trapping protocols applied at the ~~Tolt~~Tokul River weir minimize the duration of migration delay and prospects for fish injury during trapping. Screening criteria for water intake meet NMFS' 2011 screening criteria (Table 6).

Table 6. Information on Tokul Creek Hatchery for Alternative 3.

Facility	Water source	Discharge Location	Meet NMFS Screening Criteria (Criteria year)?
Tokul Creek Hatchery	Tokul Creek	Tokul Creek	(NMFS 2011)
	Unnamed Creek	Tokul Creek	(NMFS 2011)

During phase two of Alternative 3, Tokul Creek Hatchery, Wallace River Hatchery, Reiter Ponds, and the Sunset Falls Fishway would operate as described in Alternative 2 (Section 2.2).

RM&E activities under Alternative 3 would be the same as under Alternative 2.

The trap and haul program under Alternative 3 would operate the same as under Alternative 2.

2.4 Alternative 4 (Reduced Production): NMFS would make a determination that a Modified HGMP meets the requirements of the 4(d) Rule and issue a Section 10(a)(1)(A) for the Sunset Falls Fishway trap and haul program

Under Alternative 4, the South Fork Skykomish River summer-run steelhead program would run as under Alternative 2, except the production goals after phasing out the current ~~Skamania~~ESS program would be up to 56,000 yearlings yearly. Under Alternative 4, through 2022, juvenile summer-run steelhead from the ~~Skamania~~ESS program would be released, as described under Alternative 1. Under Alternative 4, the Sunset Falls Fishway trap and haul program would not cease as under Alternative 1 and would operate the same as under current conditions and Alternatives 2 and 3. If hatchery-origin Skykomish summer steelhead~~summer-run steelhead~~ that return to the hatchery facilities or the Sunset Falls Fishway are not needed for broodstock under Alternative 4, they may be passed above the impassable barriers at Sunset Falls. However, under this alternative, the returning hatchery-origin adults are not expected to be abundant enough to transplant to other locations, such as the North Fork Skykomish River. Under Alternative 4, we assume the facilities to use less water and produce slightly less effluent as under current conditions, as the summer-run steelhead hatchery production would be reduced from a target of 116,000 to 56,000.

Facility Operations and RM&E activities under Alternative 4 would be the same as those under Alternatives 2 and 3.

The trap and haul program under Alternative 4 would operate the same as under Alternatives 2 and 3.

2.5 Alternatives Considered but Rejected from Further Analysis

The following alternatives were considered but not analyzed because the alternatives would not meet the Federal purpose and need or would not be analytically different from one of the four alternatives described above.

2.5.1 Increase Current Hatchery Production Levels

Increased production alternatives have been proposed for some Puget Sound hatcheries with the objective of providing additional prey resources for Southern Resident killer whales (SRKWs) (NMFS 2019b). SRKWs have not been found to prefer steelhead (Ford et al. 2016), so increased production would have limited benefit to SRKW in this case.

2.5.2 Continued Operations with ESS broodstock

This alternative would represent continued operations of the hatchery program using ~~Skamania~~ESS broodstock and releasing juveniles at current level, without the phasing out approach of Alternative 1.

This alternative was not analyzed in detail because there is a Settlement Agreement between WFC and WDFW to phase out ~~Skamania~~ESS releases into the Skykomish River Basin (WFC and WDFW 2019). Also, NMFS wrote a letter to WDFW encouraging the agency to work with the tribal co-managers and other stakeholders to review the effects of ~~Skamania~~ESS hatchery programs on the ESA-listed summer-run steelhead populations and to develop alternatives to the current segregated hatchery programs (Thom 2017).

3 AFFECTED ENVIRONMENT

This chapter describes current conditions for nine resources that may be affected by implementation of the EA alternatives:

- Water quantity—Section 3.1
- Water quality—Section 3.2
- Salmon and steelhead—Section 3.3
- Other fish species—Section 3.4
- Wildlife—Section 3.5
- Socioeconomics—Section 3.6
- Cultural Resources—Section 3.7
- Environmental Justice—Section 3.8

Internal scoping identified no other resources that would potentially be impacted by the Proposed Action or alternatives. Each resource's analysis area includes the Project Area as a minimum area, but may include locations beyond the Project Area if discernible effects of the EA's alternatives on that resource would be expected to occur outside the immediate area of the proposed activities (Section 1.2, Project Area and Analysis Area).

3.1 Water Quantity

The analysis area for Water Quantity is discontinuous areas of the stream where the water is diverted from the stream for use at the hatchery facilities described in Chapter 2. The description of existing conditions for water quantity focuses on water resources associated with the Wallace River Hatchery, Reiter Ponds, Tokul Creek Hatchery, and Sunset Falls Fishway - where the range of alternatives would occur. These facilities take and use water from a nearby stream (surface water) or from wells or springs (ground water) (Table 7). Water use information associated with the hatchery programs and facilities being evaluated in this EA is presented in Table 7.

The use of surface water for the facilities listed in Table 7 may reduce instream flow but does not result in substantial reduction in stream flow between the water intake and discharge structures for any of the facilities analyzed in this EA. Additionally, all surface water used in the affected facilities is non-consumptive because, with the exception of small amounts lost through leakage or evaporation, water that is diverted from a river is discharged back to the river after it circulates through the hatchery facility within a short distance of the intake[7]. Although groundwater usage is not directly replenished (i.e., at Reiter Ponds), it is discharged after circulating through the facility, sometimes increasing by a small amount the stream flow below the discharge point.

Table 7. Water use associated with the hatchery programs facilities being evaluated in this EA.

Facility	Water source	Permitted Water Use (cfs)	Water Diversion Distance (ft)	Discharge Location	WDOE Water Right Certificate #
Wallace River Hatchery[1]	Wallace River	40	5	Wallace River (RM 4.0)	S1-00108C S1-00109C
	May Creek	14	76	May Creek	S1-05617C S1-23172C
Reiter Ponds[2]	Austin Creek (spring fed)	10	3,960	Mainstem Skykomish	S1-00667C
	Hogarty Creek (spring fed)	10	2,904	Mainstem Skykomish	S1-00313C
Sunset Falls Fishway	SF Skykomish River	180	368	Mainstem Skykomish	S1-14279C
Tokul Creek	Tokul Creek	12.0	184 (raceways/ incubation) 488 (rearing pond/ trap channel)	Tokul Creek	S1-03416C S1-21399C
	Unnamed Creek	6.0	157	Tokul Creek	S1-08944C

The Wallace River Hatchery facility uses surface water exclusively, withdrawn through water intakes on the Wallace River and May Creek. Wallace River Hatchery may withdraw up to 40 cfs of surface water from the Wallace River and up to 14 cfs from May Creek. Current pumping capacity from the Wallace River and May Creek are 26.7 cfs and 1.8 cfs, respectively. Assuming hatchery water withdrawals at 26.7 cfs (i.e., maximum pumping capacity), 73 percent of the 95 percent exceedance low flow (36.4 cfs based on scaled USGS streamflow records) in the Wallace River is currently diverted into Wallace River Hatchery to support various hatchery programs, and 12 percent of the water in the river is withdrawn during median flows (220 cfs) (NMFS 2016a). For May Creek, assuming hatchery water withdrawal at 1.8 cfs (i.e., maximum pumping capacity), 30 percent of the instream flow is withdrawn during 95 percent exceedance low flow (6.0 cfs based on scaled USGS streamflow records) and is diverted into the Wallace

[7] Non-consumptive in the context of this EA means that water taken from the stream, minus minimal evaporation, is returned to the same stream where the water taken would have normally flowed if not taken for use in the facility.

River Hatchery, and 3 percent of the water in May Creek is withdrawn during median flows (65 cfs). However, these scenarios of 95 percent exceedance low flow are unlikely because by definition, 95 percent of all daily average flows on record are greater than the pumping capacity at both facilities. No listed fish originate above the hatchery in May Creek, and withdrawal of water up to permitted levels from the Wallace River would not lead to stream dewatering that would affect listed fish migration and survival (NMFS 2016a). All water withdrawn for use in the freshwater fish rearing locations are returned to surface waters in close proximity to the point of withdrawal or impoundment (Table 7).

The Reiter Ponds facility uses surface water diverted from Austin and Hogarty creeks. Flows fluctuate depending on weather conditions and time of year: Austin Creek stream flow ranges from 6.7 to 300 cfs, and Hogarty Creek stream flow ranges from 1.3 to 100 cfs (NMFS 2016a). The Reiter Ponds facilities can divert up to 10 cfs each from Austin and Hogarty creeks, though they only withdraw up to 4 cfs combined during the drier months in the summer. While the diversion distance is longer than most other facilities, the effects of dewatering on the resources under consideration are not important because neither Austin Creek nor Hogarty Creek are considered to be anadromous habitat. Also, Hogarty Creek dries out naturally on its own during the summer months even without hatchery withdrawals.

Water to operate the Sunset Falls Fishway is diverted through the ladder around Sunset Falls, which has an average of 2,427 cfs. There are no dewatering effects in the South Fork Skykomish River from the operation of the fishway because water is discharged just below the falls and there is no habitat on the falls itself.

The Tokul Creek Hatchery facility uses mainly surface water with a backup source of groundwater pumped from a single well (NMFS 2016a). Surface water is withdrawn from an unnamed spring and from Tokul Creek itself. Assuming hatchery water withdrawals at maximum permitted levels (12 cfs), up to 92 percent of the water during the lowest streamflow on record (13 cfs; discontinuous USGS stream gage records from 1907 to 1945) or 75 percent of the 99 percent exceedance low flow (16 cfs) in Tokul Creek would be diverted into Tokul Creek Hatchery to support the current ~~Skamania summer-run steelhead~~ESS program; however, these scenarios of low flow are extremely unlikely because these low flows are examples of extreme low flow years. The instream flow is more likely to be closer to the median flows (72 cfs), and 17 percent of the water in the stream would be withdrawn at median flows. The highest hatchery water withdrawal needs, during the spring months when hatchery fish are at their largest size and need high rearing flows for fish health maintenance, do not coincide with periods when natural flows are low (NMFS 2016a).

3.2 Water Quality

The analysis area for Water Quality includes stream reaches downstream from where facilities are located up until the point where effluent effects are sufficiently diluted to have no effect. Wallace River Hatchery, Reiter Ponds, and Tokul Creek Hatchery primarily affect water quality by discharging treated wastewater from adult holding, spawning, incubation, and juvenile rearing activities to downstream receiving waters. No feed or chemicals are used at the Sunset Falls Fishway facility. Therefore, the effects of Sunset Falls trap and haul operation on water quality are not further analyzed.

Hatchery operations are required to comply with the Clean Water Act, including obtaining National Pollutant Discharge Elimination System (NPDES) permits for discharge from hatchery facilities. The direct discharge of hatchery facility effluent is regulated by the EPA or WDOE under the Clean Water Act through NPDES permits to minimize effects on water quality. These agencies are responsible for issuing and enforcing NPDES permits that ensure water quality standards for surface waters that remain consistent with public health and enjoyment and the propagation and protection of fish, shellfish, and wildlife (33 U.S.C. §1251(a)(2)). All the facilities considered in this EA are operating under NPDES permits. The Sunset Falls Fishway does not need NPDES permits because no feeding or rearing occurs at this facility.

Because hatchery production concentrates large numbers of fish within hatcheries, they can produce effluent with elevated levels of ammonia, organic nitrogen, total phosphorus, biochemical oxygen demand (BOD), pH, and solids levels. In addition, the use of water in unshaded ponds and mixing with well water has the potential to change water temperatures.

As part of administering elements of the Clean Water Act, WDOE is required to assess water quality in all rivers, lakes, and marine waters within the state. These assessments are published in what are referred to as the 305(b) report and the 303(d) list (the numbers referring to the relevant sections of the original Clean Water Act text). The 305(b) report reviews the quality of all waters of the state. The 303(d) list identifies specific water bodies considered impaired, based on the number of exceedances of water quality criteria in a water body segment. Skykomish River is impaired for temperature and dissolved oxygen, though no pollution control program (known as TMDL) is in place. Tokul Creek is impaired for temperature and bacteria and is being regulated under the Snoqualmie River Watershed Temperature TMDL and the Snoqualmie River Watershed Multiparameter TMDL, respectively.

Regular monitoring of effluent occurs for total suspended solids, settleable solids, chlorine, and temperature level of the effluent. Monitoring of chemical effluent concentrations applied in the hatcheries for fish pathogen control is not required as part of the NPDES discharge permit; chemical concentrations are applied at the levels indicated on the treatment label for the safe treatment of fish before being discharged.

3.3 Salmon and steelhead

3.3.1 Analysis Area

The analysis area for Salmon and Steelhead resource includes the Snohomish River Basin (Figure 1) and estuary that is immediately adjacent nearshore marine areas where hatchery-origin steelhead juveniles from the ongoing ~~Skykomish River~~ESS program initially forage and congregate prior to moving offshore. The analysis area for salmon and steelhead also includes locations where hatchery fish are captured, reared, and released, as well as areas where they are currently monitored or known to stray, including upstream of release sites. Hatchery fish from the ~~ongoing~~ ESS program may currently interact with salmon and steelhead during two different life phases: first, as smolts for those released from facilities; and second, as adults upon return. Additionally, the analysis area for salmon and steelhead includes the area above Sunset Falls in the South Fork Skykomish River where the trap and haul program would haul and release adult anadromous fish.

3.3.2 ESA-listed Populations

NMFS has identified two salmon Evolutionarily Significant Units (ESUs) (Puget Sound Chinook Salmon and Hood Canal Summer-run Chum Salmon) and one steelhead Distinct Population Segment (DPS) (Puget Sound Steelhead) in Puget Sound that are protected under the ESA. The Puget Sound Chinook Salmon ESU was listed as threatened in 1999 (64 Fed. Reg. 14308, March 24, 1999) and reaffirmed in 2005 and 2014 (70 Fed. Reg. 37160, June 28, 2005, and 79 Fed. Reg. 20802, April 14, 2014). The Hood Canal Summer-run Chum salmon ESU was listed as threatened in 1999 (64 Fed. Reg. 14508, March 24, 1999) and reaffirmed in 2005 and 2014 (70 Fed. Reg. 37160, June 28, 2005, and 79 Fed. Reg. 20802, April 14, 2014). However, Hood Canal summer-run chum salmon do not occur in the Snohomish River Basin and will not be discussed further in this EA. The Puget Sound Steelhead DPS was listed as threatened in ~~2001~~2007 (72 Fed. Reg. 26722, May 11, 2007) and reaffirmed in 2014 (79 Fed. Reg. 20802, April 14, 2014). The ESA-listed salmon and steelhead populations in the analysis area are part of major population groups (MPGs) within the Puget Sound Chinook Salmon ESU and the Puget Sound Steelhead DPS.

Overall, NWFSC (2015) concluded that the most recent information on viability, including abundance, productivity, spatial structure, and diversity, suggested the biological risk category remain threatened for the Puget Sound Chinook Salmon ESU and the Puget Sound Steelhead DPS.

3.3.2.1 Puget Sound Steelhead

Best available information indicates that the Puget Sound Steelhead DPS is at high risk and is threatened with extinction (NWFSC 2015). The final Puget Sound Steelhead Technical Recovery Team (PSSTRT) report describing historical population structure was released in March 2015 (Myers et al. 2015). NMFS also released the final PSSTRT report describing viability criteria for Puget Sound steelhead in May 2015 (Hard et al. 2015).

Puget Sound steelhead populations are aggregated into three extant Major Population Groups (MPGs) containing a total of 32 Demographically Independent Populations (DIPs) based on genetic, environmental, and life history characteristics ~~(PSSTRT 2013).~~(Myers et al. 2015; NMFS 2019a). DIPs can include summer-run steelhead only, winter-run steelhead only, or a combination of summer and winter-run timing (i.e., summer/winter). Also included as part of the ESA-listed DPS are six hatchery-origin stocks that are derived from and integrated with local natural steelhead populations (FR 79 20802, April 14, 2014).

The Northern Cascades MPG has 16 DIP's including eight summer or summer/winter, and eight winter DIPs. Eight of the 10 DIPs in the DPS with extant summer run-timing or summer-run components are in this MPG. The North Cascades steelhead MPG, relatively speaking, is at a lower extinction risk and is a stronghold in terms of life history diversity and abundance (NWFSC 2015).

The Snohomish Basin (Northern Cascades MPG) includes five steelhead DIPs: Snohomish/Skykomish winter-run; Pilchuck winter-run; Snoqualmie winter-run; Tolt summer-run; and North Fork Skykomish summer-run ~~(PSSTRT 2013).~~(Myers et al. 2015; NMFS 2019a). The DPS viability criteria developed by NMFS (Hard et al. 2015), require that at least 40 percent of the steelhead populations within each MPG achieve viability (restored to a low extinction risk), as well as at least 40 percent of each major life history type (e.g., summer-run and winter-run) historically present within each MPG achieve viability.

In a recent genetic analysis (Warheit et al. 2021), WDFW found that summer-run steelhead in the South Fork Skykomish River were as representative of a native summer-run steelhead in the Snohomish River basin as steelhead from the North Fork Skykomish River and the South Fork Tolt River. That is, this analysis showed that the previous assumptions to consider the South Fork Skykomish River summer-run steelhead as being more closely related to the out-of-basin Skamania stock than neighboring populations (Myers et al. 2015) should be re-examined. This more recent analysis illustrated the phylogeny and genetic relationships among summer steelhead in the Snohomish River Basin, showing that the North Fork Skykomish River, South Fork Skykomish River, and South Fork Tolt River summer-run populations were genetically similar (Warheit et al. 2021). This analysis and a closer examination of the history of steelhead hatchery management in the Skykomish River further supports the idea that, although it is hatchery influenced, like other populations in the basin, steelhead from the South Fork Skykomish River should be considered of native Puget Sound origin rather than out-of-DPS.

The analysis by WDFW also suggests that summer-run steelhead from the South Fork Skykomish and the North Fork Skykomish Rivers are closely related (Warheit et al. 2021). The population dynamics leading to this low genetic differentiation and the biological significance of the difference is consistent with the low level of Fst across all Puget Sound steelhead as documented in Warheit (2014) and Knapp and Warheit (2016). It is possible that introgression with ESS hatchery-origin summer steelhead released from the Reiter Ponds Hatchery has occurred at different levels during fish spawning in the South- and North Forks in the past, or it may reflect the recent change in management that limited transport of returning ESS hatchery fish to the South Fork Skykomish River upstream of Sunset Falls. To summarize, South Fork Skykomish steelhead may not have had much influence from the Skamania stock because the initial hatchery program included both the natural-origin Skykomish steelhead and hatchery-origin early spawning summer steelhead. The influence was recently reduced through selective transport of natural-origin summer steelhead into the upper South Fork Skykomish River. Furthermore, steelhead from the South Fork Skykomish and the North Fork Skykomish may be more closely related than previously thought.

The implications of these findings for formal population identification (Myers et al. 2015) and recovery planning (NMFS 2019c) are uncertain and being reevaluated. While previous analyses (i.e., (Kassler et al. 2008) have assumed a much larger impact from the Skamania stock, a thorough review of existing documents in light of this updated information is clearly warranted, especially regarding the genetic similarity of South Fork Skykomish summer steelhead and other summer steelhead in the Snohomish basin, to refine the population status and recovery role of South Fork Skykomish summer steelhead within the Puget Sound Steelhead DPS.

Abundance of adult steelhead returning to nearly all Puget Sound rivers has fallen substantially since estimates began for many populations in the late 1970s and early 1980s (NMFS 2015). Since 1980, only half of the 22 populations show evidence of a neutral or increasing trend, and most of these are in the Hood Canal & Strait of Juan de Fuca MPG. Between the two most recent five-year periods for which data have been analyzed (2005-2009 and 2010-2014), the geometric mean of estimated abundance for seven populations in the Northern Cascades MPG, the increase was 3 percent. However, a comparison with the analyses of abundance trends from the 2011 status review (Ford et al. 2011) shows no clear evidence that abundance is increasing or declining or that neutral trends remain common across the DPS. Furthermore, in general, steelhead abundance across the DPS remains well below levels needed to sustain natural production into the future. The intrinsic rate of natural increase has been well below replacement between 2011 and 2015 for at least eight of these DIPs (NWFSC 2015). These include, in the Northern Cascades MPG: Stillaguamish River winter-run and Snoqualmie River winter-run (and, to a lesser extent, Skagit River winter-run and Green River winter-run). That said, some populations are showing signs of productivity above replacement since about 2009. These include Tolt River Summer-run and Pilchuck River winter-run (NMFS 2015).

3.3.2.2 Puget Sound Chinook Salmon

The best available information indicates that the Puget Sound Chinook Salmon ESU is at high risk and is threatened with extinction (NMFS 2015). The Puget Sound ESU encompasses all runs of Chinook salmon from rivers and streams flowing into Puget Sound, including the Strait of Juan de Fuca from the Elwha River eastward, and rivers and streams flowing into Hood Canal, South Sound, North Sound, and the Strait of Georgia in Washington. As of 2016, there are 24 artificial propagation programs producing Chinook salmon that are included as part of the listed ESU (71 FR 20802, April 14, 2014). Hatchery-origin spawners have been present in high percentages in most populations outside the Skagit River Basin, and in many basins, including the Stillaguamish River Basin, the percentages of natural-origin spawners have declined over time (NWFSC 2015). Indices of spatial distribution and diversity have not been developed at the population level, though diversity at the ESU level is declining (NWFSC 2015).

The Snohomish River watershed harbors two Puget Sound Chinook salmon populations – Skykomish and Snoqualmie – which are grouped with eight other independent populations in the Whidbey biogeographical region for Puget Sound Chinook salmon ESU recovery planning purposes (SSPS 2007). Under NMFS recovery and delisting criteria for the listed ESU, two or more populations within the biogeographical region need to be recovered to a low extinction risk status for the ESU to be considered recovered and delisted (NMFS 2007). Hatchery-origin Chinook salmon produced through the Tulalip

Hatchery program (Tulalip Tribes 2012) and the Wallace River Hatchery program (WDFW 2013b) are included with the natural-origin component of the Skykomish Chinook salmon population as part of the ESA-listed ESU (70 FR 37160, June 28, 2005). The Snoqualmie population has no associated hatchery-origin component. The Skykomish population includes summer-timed fish spawning in the Snohomish River mainstem system, the mainstem of the Skykomish, Pilchuck, Wallace, and Sultan rivers; Woods, Elwell, Olney, Proctor, and Bridal Veil creeks; and the North and South Forks of the Skykomish River.

3.3.3 Critical Habitat and Essential Fish Habitat

Critical habitat has been designated for the Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS. Within designated critical habitat, NMFS identifies physical and biological features, such as freshwater spawning and rearing sites, as well as freshwater and estuarine migration and rearing corridors. The analysis area includes designated critical habitat for Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS in freshwater, estuaries, and nearshore marine areas. All the aquatic habitat in the project area described above, including critical habitat for ESA-listed salmon and steelhead species, is part of essential fish habitat (EFH), which is defined under the Magnuson-Stevens Fishery Conservation and Management Act as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” As described by PFMC (2014), the freshwater EFH for Pacific salmon has five habitat areas of particular concern: (1) complex channels and floodplain habitat, (2) thermal refugia, (3) spawning habitat, (4) estuaries, and (5) marine and estuarine submerged aquatic vegetation.

3.3.4 Other populations

The non-ESA-listed salmon and steelhead populations in the analysis area are chum, pink, coho and sockeye salmon. Bull trout is also present, is ESA-listed, and is described in Section 3.4, Other Fish Species.

3.3.4.1 Coho Salmon

The coho salmon populations in the Snohomish River basin are part of the Puget Sound/Strait of Georgia coho salmon ESU (Weitkamp et al. 1995). ESA listing of the ESU was determined by NMFS to be not warranted (75 FR 38776, July 6, 2010), but the ESU remains on the Federal Candidate Species list.

The historical abundance of natural-origin coho salmon produced in the Snohomish River basin before European contact is unknown. Presently, coho salmon are abundant in the Snohomish River basin relative to the status of the species in other Puget Sound regions, and the basin is considered a stronghold for the species in the ESU (NMFS 2017a). Although human developmental actions are threatening lower river tributaries important for natural-origin coho salmon production, the populations in the basin remain relatively healthy and abundant.

3.3.4.2 Chum Salmon

The fall chum salmon stocks in the Snohomish River basin are part of the Puget Sound/Strait of Georgia Chum Salmon ESU (Johnson et al. 1997). The ESU includes all naturally spawned populations of chum salmon from Puget Sound, the Strait of Georgia, and the Strait of Juan de Fuca up to and including the Elwha River, with the exception of summer-run chum salmon from Hood Canal and the Strait of Juan de Fuca. After reviewing the status of chum salmon populations in the region, NMFS determined that ESA listing of the ESU was not warranted on August 10, 1998 (63 FR 11774).

There are three fall chum salmon stocks in the Snohomish River basin that are considered native, natural-origin stocks: Skykomish; Snoqualmie; and Wallace river watershed chum salmon (WDFW 1994; Haring 2002). The native Skykomish and Wallace fall chum stocks are considered healthy in status, and the Snoqualmie stock is of unknown status (WDFW 1994). The historical abundance of fall chum salmon in the basin is unknown. The 2006 return of 278,000 fish - the largest natural-origin Snohomish River basin fall chum return to Puget Sound observed over the 44-year period from 1968 to 2012 - may have approached the potential historical run size (data from A. Dufault, WDFW unpublished data, May 14, 2014). Chum salmon early marine survival, as affected by varying natural productivity conditions in the estuary and ocean, is the primary factor determining the success or failure of each brood year in returning adult chum salmon back to the rivers to spawn (Salo 1991).

3.3.4.3 Pink Salmon

The odd- and even-year pink salmon aggregations in the Snohomish River basin are included as part of the Washington Odd- and Puget Sound Even-Year Pink Salmon ESUs, respectively (Hard et al. 1996). NMFS determined that ESA listing for the two ESUs and their component populations, including the Snohomish populations, was not warranted (60 FR 192, October 4, 1995).

The basin has two native pink salmon stocks: Snohomish odd-year; and Snohomish even-year. There is no hatchery production of the species in the basin. Both native stocks are considered healthy in status (WDFW 1994). Most spawning for odd-year pink salmon takes place in the mainstem Snohomish, Skykomish, and Snoqualmie Rivers, and in larger tributaries such as the Wallace, Sultan, Pilchuck, Beckler, and Tolt Rivers (WDFW and WWTIT 1994). Odd-year pink salmon spawning generally occurs from late September through October in odd-numbered years. Even-year pink salmon spawning occurs in the mainstem Snohomish and lower Skykomish Rivers and possibly in the Snoqualmie River. Even-year pink salmon spawning occurs in September in even-numbered years.

Like chum salmon, juvenile pink salmon emigrate seaward after little or no residency or feeding in freshwater. Odd-year pink salmon fry emigration peaks in early May, and extends from mid-March through the end of May. Even year pink salmon emigrate earlier, with a peak seaward migration timing in early March (Nelson and Kelder 2005). Like chum salmon, early marine survival, as affected by varying natural productivity conditions in the estuary and ocean, is the primary factor determining the success or failure of each brood year in returning adult pink salmon back to the rivers to spawn (Heard 1991).

3.3.4.4 Sockeye Salmon

There is no known persistent sockeye salmon population in the Snohomish River basin. However, low numbers of riverine spawning sockeye salmon are observed in the watershed each year (Gustafson et al. 1997; Snohomish Basin Salmon Recovery Forum 2005). It is unknown whether these fish are a self-sustaining riverine stock, or if they represent strays from adjacent watersheds where self-sustaining sockeye populations are present (e.g., Baker River, Lake Washington, or Fraser River). In its status review of west coast sockeye salmon, NMFS did not delineate any discrete sockeye salmon population in the basin (Gustafson et al. 2007). The presence of riverine sockeye salmon population in the Snohomish River basin is unknown, and this species will not be analyzed in this EA.

3.3.5 Ongoing Effects of the Summer-run Steelhead ESS Hatchery Program and Trap and Haul Program

Hatchery fish that are released from the hatchery program being replaced by the proposed program evaluated in this EA currently interact with other salmon and steelhead within the analysis area once they are released, either as juveniles on their migration to the ocean, or adults as they return to spawn (Table 8).[8] The current use of various facilities that will be analyzed in Chapter 4 also currently interact with salmon and steelhead within the analysis area. The extent of effects (adverse or beneficial) on salmon and

[8] The hatchery fish from the hatchery program being replaced by the proposed program evaluated in this EA are not likely to have a discernible effect on fish in the ocean.

steelhead and their habitat depends on the program design, the condition of the habitat, and the status of the species, among other factors.

Table 8. Potential effects of hatchery programs on natural-origin salmon and steelhead.

Effect	Description of Effect
Genetics	□ Interbreeding with hatchery-origin fish can affect within- and among population genetic diversity □ Hatchery-origin salmon and steelhead can act to preserve the genetic integrity and diversity of depleted natural populations □ Interbreeding with hatchery-origin fish may affect the reproductive performance and viability (fitness) of the local populations. □ Also see "Population Viability" effects
Masking	□ Hatchery-origin fish can increase the difficulty in determining the status of the natural-origin component of a salmon population.
Competition and Predation	□ Hatchery-origin fish can increase competition for food and space with natural-origin fish. □ Hatchery-origin fish can prey on natural-origin fish. □ Juvenile hatchery-origin fish can decrease predation on natural-origin salmon and steelhead by providing an alternative prey source.
Disease	□ Concentrating salmon for rearing in a hatchery facility can lead to an increased risk of amplifying pathogens. When hatchery-origin fish are released from hatchery facilities, they may increase the disease risk to natural-origin salmon and steelhead through pathogen transmission.
Population Viability	□ Abundance: Preserve, increase, or decrease the abundance of a natural-origin fish population. □ Spatial Structure: Preserve, expand, or reduce the spatial structure of a natural-origin fish population □ Genetic Diversity: Increase or decrease within-population genetic diversity of a natural-origin fish population □ Productivity: Maintain, increase, or decrease the productivity of a natural-origin fish population.
Nutrient Cycling	□ Returning hatchery-origin adults can increase the amount of marine-derived nutrients in freshwater systems.

Effect	Description of Effect
Facility Operations	- Hatchery facilities can reduce water quantity or quality in adjacent streams through water withdrawal and discharge. - Weirs for broodstock collection or to control the number of hatchery-origin fish on the spawning grounds can have the following unintentional consequences: o Isolation of formerly connected populations o Limiting or slowing movement of migrating fish species, which may enable poaching or increased predation o Alteration of stream flow o Alteration of streambed and riparian habitat o Alteration of the distribution of spawning within a population o Increased mortality or stress due to capture and handling o Impingement of downstream migrating fish o Forced downstream spawning by fish that do not pass through the weir - Increased straying due to either trapping adults that were not intending to spawn above the weir, or displacing adults into other tributaries
Research, Monitoring, and Evaluation (RM&E)	- Surveying and sampling to assess program objectives and goals may increase the risk of injury and mortality to steelhead that are the focus of the action, or that may be incidentally encountered. - RM&E will also provide information on the status of the natural population

3.3.5.1 Genetics

Hatchery-origin fish can affect natural population productivity and diversity when they interbreed with natural-origin fish. Hatchery-origin steelhead do not interbreed with salmon species, and thus only pose a genetic risk to natural-origin steelhead populations.

In determining genetic risk to steelhead populations posed by hatchery programs, NMFS evaluates three major areas of effects: within-population diversity, outbreeding effects, and hatchery-influenced selection. Distilling the complex phenomenon of genetic change and its consequences into these three somewhat overlapping areas is a simplification done for practical reasons. NMFS' intent is to responsibly consider concerns that have arisen from published scientific papers addressing the genetic risk of hatchery-origin salmon and steelhead on natural-origin fish, and NMFS finds that evaluating hatchery programs on these three "axes" accomplishes that objective. The following material briefly describes these potential effects, all of which could be a concern at some level for natural-origin steelhead populations in the Snohomish Basin that may be influenced by the current segregated ~~Skamania-origin summer-run steelhead~~ESS hatchery program, which is to be terminated, and may be influenced by the proposed program alternatives, all of which focus on integration with natural production.

Within-population genetic diversity is a general term for the quantity, variety, and combinations of genetic material in a population (Busack and Currens 1995). Within-population diversity is gained through mutations or gene flow from other populations and is lost primarily due to genetic drift. To limit genetic drift, the genetically effective population size should at least be in the hundreds (Frankham et al. 2014). Within-population diversity concerns are usually expressed using a metric called effective population size, which is typically considerably smaller than the census population size. Concerns about within-population diversity increase with small effective size. A major concern with hatchery programs is that a large proportion of hatchery-origin fish on the spawning ground that represent relatively few parents can depress the effective size of the natural population by amplifying the genetic contribution of relatively few individuals (Ryman 1991; Ryman et al. 1995; Christie et al. 2012; Waples et al. 2016).

Outbreeding effects are caused by gene flow from other populations. Gene flow occurs naturally among populations within the species of salmon and steelhead, a process referred to as straying (Quinn 1984, 1993, 1997). Natural straying serves a valuable function in preserving diversity that would otherwise be lost through genetic drift and in recolonizing vacant habitat. Straying is considered a risk only when it occurs at unnatural levels or from unnatural sources. Gene flow from straying populations can have two effects, it can increase genetic diversity (Ayllon et al. 2006), but it can also alter established allele frequencies along with coadapted gene complexes and reduce the population's level of "local" adaptation (i.e., outbreeding depression) (Edmands 2007; McClelland and Naish 2007; Eldridge et al. 2009). In general, the greater the geographic separation between the source or origin of hatchery fish and the recipient natural population, the greater the genetic difference between the two populations (ICTRT 2007), and the greater the theoretical potential for outbreeding depression. Experts at a NMFS convened a scientific workshop on the topic in 1995 concluded that gene flow from hatchery fish into another population should be under 5 percent to avoid outbreeding depression (Grant 1997).

Hatchery-influenced selection can occur when hatchery spawning and rearing creates selective regimes that differ from those imposed by the natural environment. For example, fish being reared in hatcheries can have different age-at-length, age at maturity, fecundity, life stage specific mortality, and run timing compared to fish of the same species from natural parents reared naturally. To the extent that these differences are genetically based, the genetic change can be passed on to natural populations through interbreeding with hatchery-origin fish. Selection pressures can be a result of differences in environments (i.e., fish reared in hatchery vs. natural) or a consequence of protocols and practices used by a hatchery program that affects the fish in a way that would not occur in nature (e.g., no allowance for mate selection). Hatchery selection can range from relaxation of natural selection that would normally occur in nature to intentional selection for desired characteristics (Waples 1999).

The typical metric used to describe the domesticating influence of hatchery-origin spawners on the natural population in terms of hatchery-influenced selection is called proportionate natural influence (PNI). This metric is a function of the proportion of natural spawners consisting of hatchery-origin fish (pHOS) and the proportion of the broodstock consisting of natural-origin fish (pNOB). A PNI greater than 50 percent indicates that the influence of natural selection is stronger than the influence of hatchery-influenced selection (HSRG 2009). In other words, the natural environment is influencing the total population (hatchery- and natural-origin fish) genetic diversity more than the hatchery environment. Recommended criteria for PNI have been developed that vary according to type of program, conservation importance, and recovery stage of the affected population. However, NMFS considers higher levels of hatchery influence to be acceptable when a population is at high risk of extinction due to habitat degradation or other factors that limit natural viability (abundance, productivity, diversity, distribution) and the hatchery program is being used to increase abundance and thus reduce extinction risk, in the short-term.

Because of certain unique aspects of programs using highly domesticated steelhead stocks, including the fact that pHOS may be a significant overestimate of gene flow, consultations on early winter-run steelhead programs in Puget Sound (NMFS 2016a, b) used actual gene flow as a metric. Gene flow was estimated by two methods: demographic gene flow (DGF) (Scott and Gill 2008), and proportion of effective hatchery contribution (PEHC)(Warheit 2014).

The Skamania summer-run steelhead stock, derived over 60 years ago from Columbia River Basin steelhead (Washougal and Klickitat rivers) (Crawford 1979) has been released episodically, along with native-derived broodstock, for decades into the Stillaguamish, Snohomish, and Green River watersheds. As noted above, the current summer steelhead hatchery stock used in the Skykomish, called ESS in this document to distinguish from the original Columbia River Skamania steelhead, is a mixture of Skamania and Skykomish fish (Crawford 1979; Warheit et al. 2021). Successful reproduction of ~~Skamania~~ESS steelhead in parts of the Snohomish River Basin has likely put ~~an indelible~~some level of Columbia-basin signature on the genetic profile of the Snohomish River steelhead and more broadly, the genetic diversity patterns within the Puget Sound steelhead DPS (NMFS 2019a). ~~Measurable~~Recent genetic analysis by WDFW (Warheit et al. 2021) suggests that the influence of the ESS hatchery program on Snohomish River Basin steelhead (North Fork and South Fork Skykomish River, Tolt River, Skykomish River, Snoqualmie River, and Pilchuck River) (NMFS 2021c) was overestimated in the past. Nonetheless, measurable Columbia-basin influence on genetic diversity of Snohomish River Basin steelhead may decrease over time due to natural selection and genetic drift, but likely cannot be eliminated from the Snohomish populations without further risking the persistence of the extant natural-origin summer-run steelhead populations—an important and limited life history in the DPS. Thus, some natural-origin summer-run steelhead populations with ~~substantial~~possibly some levels of Skamania lineage will be among the populations contributing to overall DPS viability, and to future hatchery programs. The long-term fitness consequences of the introduction of genetic material from the Columbia basin into the Puget Sound Steelhead DPS are unknown, but the successful self-reproduction of Skamania-lineage fish in the Snohomish basin may indicate that they are not a serious concern for long-term viability of the Puget Sound Steelhead DPS(NMFS 2019a).

The genetic influence of the ~~Skamania~~ESS releases in the Snohomish basin played a central role in development of the proposed new Skykomish summer-run steelhead hatchery program. In 2014, WDFW first analyzed the proportion of effective hatchery contribution (PEHC), a measurement of gene flow between populations, to assess the degree to which natural-origin populations were affected by ESS. In this case, WDFW estimated ~~that Skamania~~the impacts ~~to the~~ of Reiter Ponds ESS from the hatchery program on the natural-origin North Fork Skykomish and Tolt ~~Rivers~~summer~~-run~~ steelhead populations ~~were~~. WDFW's analysis suggested that gene flow between hatchery and natural-origin populations was so large that ~~these~~the two ~~groups~~ natural-origin populations could be considered ~~naturalized populations of Skamania summer-run steelhead (Warheit 2014). The PEHC~~feral populations of ESS-origin summer steelhead (Warheit 2014b).

Subsequent refinements by WDFW to the PEHC analysis estimates produced in the 2014 document have been revised considerably ~~(WDFW 2018b; Warheit et al. 2021)~~, so the "feral population" conclusion now appears to be an overstatement. Nonetheless, impacts from the ESS releases on gene flow remain but the ~~fact remains~~ impact is considerably less than that ~~impacts from Skamania releases have been substantial. The fish~~reported in earlier documents (Warheit 2014). Summer steelhead in the South Fork Skykomish River, which occur almost entirely ~~above~~upstream of Sunset Falls, also display ~~a strong Skamania~~some ESS-origin signature (Warheit et al. 2021). As a measure to reduce gene flow from the Reiter Ponds ~~early summer steelhead~~ESS hatchery program, beginning in 2016, WDFW reduced annual ~~Skamania~~ ESS smolt release levels by 40 percent, from a recent five-year average of 193,000 fish to 116,000 fish (Unsworth 2016), thereby substantially decreasing the number of returning ~~Skamania program~~ ESS adults that could stray into steelhead spawning areas. ~~The Skamania program is being phased out entirely, with~~

~~the last releases of no more than 40,000 fish occurring in 2022, which will be discussed in more detail in Chapter 4.~~

~~The current genetic situation for summer-run steelhead in the Snohomish is a strong genetic signature from Skamania releases in all summer-run steelhead populations in the basin and a gene flow (PEHC) of 24-87% in the North Fork Skykomish, 22-40% in the South Fork Tolt, and 17-27% in the South Fork Skykomish (WDFW and Tulalip Tribes 2019, Table 2.2.2.4B). The Skamania gene flow to the winter-run steelhead populations in the basin before the 2016 reduction in program was on the order of 2-5% per generation (WDFW and Tulalip Tribes 2019, Table 2.2.2.4A), and is currently estimated to be between zero and 2 percent per generation. Summer-run steelhead in the Snohomish basin are generally demographically depressed, with very low natural production in both the North Fork Skykomish River (82 in 2010[9]) and South Fork Tolt River (mean of 76 from 2007 through 2018) summer-run populations (WDFW and Tulalip Tribes 2019, Table 2.2.2.3) . However, summer-run steelhead production is at a higher level in the South Fork Skykomish, numbering in the hundreds[10]. It is larger than formally identified summer-run steelhead populations in the basin and has been only minimally affected by hatchery releases in the last decade (WDFW 2019b) due to limitations on Skamania passage above Sunset Falls (Table 4).~~

For many years, the trap and haul program has passed both Chinook salmon and steelhead above the impassable Sunset Falls on the South Fork Skykomish River. This program has provided direct demographic benefits for both the Chinook salmon and summer-run steelhead of the basin, by allowing them to expand their habitat and numbers. It likely has also provided indirect genetic benefits in that the increase in population size of summer steelhead makes them less susceptible to loss of within-population diversity. In addition, over the last decade, the trap has been used to exclude hatchery-origin summer-run steelhead (i.e., from the current ~~Skamania~~ESS program) from the drainage upstream of the falls, which has created an opportunity for increased local adaptation of the summer-run steelhead spawning above the falls to counter the influence of domestication from the ~~Skamania~~ ESS stock. Currently, the trap serves as a source for natural-origin Chinook salmon to increase PNI in the Wallace River hatchery Chinook salmon program.

~~[9] Only one year of data is available, 2010~~

~~[10] Average for last 5 years is 294 in South Fork Skykomish River vs 49 in South Fork Tolt River; in 2010 South Fork Skykomish River escapement was about four times that of the North Fork Skykomish River.~~

3.3.5.2 Masking

Masking occurs when unmarked or untagged hatchery-origin salmon and steelhead and/or their offspring are included when making population estimates (e.g., abundance, productivity) of natural-origin fish because hatchery-origin salmon and steelhead cannot be distinguished from the natural-origin fish. The inability to distinguish hatchery-origin from natural-origin fish can lead to a variety of problems, including overestimates of the proportion of natural-origin fish in the catch or on the spawning grounds, underestimates of the proportion of hatchery-origin fish collected for broodstock, and overestimates of gene flow from hatchery-origin into the natural spawning population. To minimize masking effects, hatchery-origin fish are often marked or tagged (e.g., adipose fin clips, PIT-tags, CWT, thermal marks). This allows hatchery-origin fish to be distinguished from natural-origin fish. As mentioned previously, these techniques are sometimes not 100% effective because fish either escape clipping or tagging during handling, or tags are lost during the life of the fish.

Most ~~Skamania summer-run steelhead~~ESS currently being released have been externally marked (as discussed in Section 2.2.1.3) to allow for the differentiation of the programs' fish from natural-origin fish as juveniles, in fisheries, and upon adult return.

3.3.5.3 Competition and Predation

Competition and predation effects on natural-origin salmon and steelhead from hatchery-origin steelhead may occur in freshwater at juvenile and adult life stages. Depending on the species and circumstances, competition and predation from hatchery-origin steelhead can lead to reduced growth or increased mortality that affect the abundance and productivity of natural-origin salmonid populations. The likely temporal and spatial overlap between hatchery-origin steelhead and natural-origin salmon and steelhead in estuaries and nearshore marine waters is minimal. Consequently, competition and predation on natural-origin salmon and steelhead juveniles by ~~Skamania~~ESS hatchery-origin steelhead in the estuaries and nearshore marine waters is not likely to have occurred and will not be considered any further in Chapter 3.

In addition, ~~while~~ a portion of hatchery-origin fish currently released may not emigrate and may stay in the stream (i.e., residualize) to compete with or prey upon natural-origin fish. ~~there are no data indicating~~

~~that residualism rates are higher than for their natural counterparts.~~[11] Various factors have been investigated to understand the mechanisms that affect or determine whether a fish will residualize. Tatara et al. (2019) and Hausch and Melnychuk (2012) discuss age at release, size at release, maturation status, and operational characteristics (e.g., whether a fish is volitionally released or forced) as potential factors that could affect residualism. Hausch and Melnychuk (2012) determined that smaller individuals and larger males were more likely to residualize than other fish in the same rearing group. Small individuals may postpone smolting to continue freshwater growth and large males may become precocious and bypass smolting altogether.

Tatara et al. (2019) discuss growth patterns in hatchery rearing that could lead to larger fish that residualize. In nature, steelhead juveniles spend, on average, two to three years in freshwater before migrating to the ocean (Peven et al. 1994). By contrast, for economy of time, space, and expense, most hatchery steelhead are reared on an accelerated growth regime and released to produce seaward migrants (smolts) after a single year. The accelerated growth from this practice can lead to a portion of the male fish that are precocious and residualize after release.

Tatara et al. (2019) suggest three methods of hatchery rearing that can control residualism:

1. Volitional release (also suggested by Hausch and Melnychuk (2012))
2. Sorting of potential residuals based on size and appearance
3. Rearing regimes can be designed to limit the number of residuals (i.e., modulating growth to increase the number of fish exceeding the size threshold necessary to achieve maximum smolt development).

For most steelhead hatchery programs, the estimated residualism rate is less than 10 percent (Hausch and Melnychuk 2012; Snow et al. 2013). Hausch et al. (2012) reviewed 48 estimates of residualism of hatchery-reared steelhead from 16 different studies and found that residualism ranged from 0 percent to 17 percent, averaging 5.6 percent. The occurrence of precocious males (that will residualize) in steelhead

~~[11] For most steelhead hatchery programs, the estimated residualism rate is less than 10 percent Hausch and Melnychuk (2012) (Snow et al. 2013; Tatara et al. 2019) Hausch et al. (2012) reviewed 48 estimates of residualism of hatchery-reared steelhead from 16 different studies and found that residualism ranged from 0 percent to 17 percent, averaging 5.6 percent. The occurrence of precocious males in steelhead released from WDFW hatcheries varies from 1 to 5% (Tipping et al. 2003). NMFS expects that residualism rates for the new integrated hatchery program are likely to be similar to other steelhead programs, and rates exceeding 10 percent would not be expected. The co-managers could reliably estimate the proportion of non-migrating hatchery steelhead by sampling fish during the release period using procedures outlined by Tatara et al. (2019).~~

released from WDFW hatcheries varies from 1 to 5% percent (Tipping et al. 2003). Because the proposed Skykomish summer steelhead hatchery program will be operated as other WDFW steelhead programs, including volitional release and sorting of fish based on size and appearance (Tatara et al. 2019), NMFS expects that residualism rates for the new integrated Skykomish summer steelhead hatchery program are likely to be similar to other WDFW steelhead programs, and rates exceeding 10 percent would not be expected for the new program. The co-managers will be able to estimate the proportion of non-migrating hatchery steelhead by sampling fish during the release period using procedures outlined by Tatara et al. (2019).

Habitat availability above Sunset Falls is abundant, so those fish that are transported above Sunset Falls through the trap and haul program are currently not likely to result in adult competition for any species. Thus, the analysis here is limited to the current ~~Skamania steelhead hatchery~~ESS program.

Appendix A includes general information on competition and predation and a summary of how the Qualitative Evaluation Method (QEM) was used in the analysis to assess the risk level of juvenile competition and predation. The basic premise of the QEM is that the initial default risk level of potential competitive interactions between a hatchery-origin ~~Skamania~~ESS-program steelhead and natural-origin salmon and steelhead juveniles is established in Table 2, Appendix A - which are the default risk levels assigned by Rensel et al. (1984). We then used criteria for competition (Table 4, Appendix A) and for predation (Table 5, Appendix A) by applying site-specific information to assess any appropriate reductions from this default level of risk through a step-by-step process. This approach also allowed for using recent research findings and incorporating the best available information accordingly. This approach only applies to the interaction between outmigrating hatchery-origin fish and natural-origin fish they may encounter.

Chinook Salmon

Juvenile Competition in Freshwater

Considering the default unadjusted high risk level for competition among outmigrating hatchery-origin steelhead and natural-origin Chinook salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted potential risk of competition between outmigrating hatchery-origin ~~Skamania~~ESS-program steelhead and natural-origin Chinook salmon juvenile life-stages in freshwater has been close to none (Table 6, Appendix A). The reduction in risk is primarily due to hatchery-origin steelhead being larger than natural-origin Chinook salmon, low relative abundance of hatchery-origin steelhead, and low temporal overlap between hatchery-origin steelhead and natural-origin Chinook salmon juveniles (Table 6, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin Chinook salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release and pre-sorting of fish by size and appearance, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs.

Juvenile Predation in Freshwater

Considering the default unadjusted unknown risk level for predation on natural-origin Chinook salmon by steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted potential risk of predation on natural-origin Chinook salmon juvenile life-stages by hatchery-origin ~~Skamania~~ESS-program steelhead in freshwater has been small, even if the default risk were high (Rensel et al. 1984). The reduction in risks is primarily due to low relative abundance of hatchery-origin steelhead and low temporal overlap between hatchery-origin steelhead and natural-origin Chinook salmon juveniles (Table 20, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin Chinook salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Adult competition: Spawning site competition

Because there is no temporal overlap between hatchery-origin adult steelhead and natural-origin adult Chinook salmon (Table 30, Appendix A), spawning site competition between hatchery-origin steelhead and natural-origin Chinook salmon has not likely occurred and is discountable.

Adult competition: Redd Superimposition

While there are no data on the exact location of Chinook salmon and steelhead spawning within the Skykomish River, different species have specific preferences for substrate size in which they dig redds, which naturally limits the spatial overlap. Chinook salmon prefer medial spawning substrate size of 1.38 inches, whereas steelhead prefer substrate of 1.02 inches (Kondolf and Wolman 1993). The difference in substrate preferences between the current hatchery-origin ~~Skamania~~ESS-program steelhead that could spawn in the wild and Chinook salmon (Table 31, Appendix A) is likely insufficient to provide for substantial spatial isolation, and therefore, redd superimposition is plausible where there is overlap in the sequential timing of spawning. Different species dig redds of different depth, though the differences in the average redd depths among steelhead and Chinook salmon are not likely to be enough to rule out egg displacement by steelhead (Table 31, Appendix A). However, relative abundance can reduce the risk of redd superimposition, and in this case, the estimated number of ~~Skamania~~ESS fish spawning in the wild (284 fish per year) has been low enough relative to native Chinook salmon (2006-2018 average of 3,273 fish per year) (Table 32, Appendix A) to likely result in minimal redd superimposition with Chinook salmon in the analysis area. Additionally, a large proportion of Chinook salmon fry have emerged from the gravel (Table 18, Appendix A) by the time the ~~Skamania~~ESS-program fish spawn (Table 30, Appendix A). Therefore, the risk level for superimposition of Chinook salmon redds by hatchery-origin ~~Skamania~~ESS-program fish steelhead has been minimal because the relative low abundance of hatchery-origin steelhead spawners compared to Chinook salmon spawners and because a large proportion of Chinook salmon fry have emerged from the gravel by the time hatchery-origin steelhead spawn.

Steelhead

Juvenile Competition in Freshwater

Considering the default unadjusted high risk level for competition among hatchery-origin steelhead and natural-origin steelhead (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted potential risk of competition between hatchery-origin ~~Skamania~~ESS-program yearling smolts and natural-origin steelhead juvenile life-stages in freshwater has been minimal. The reduction in risk is primarily due to hatchery-origin steelhead being larger than natural-origin steelhead, low abundance of hatchery-origin steelhead relative to the abundance of natural-origin steelhead, and low temporal overlap between hatchery-origin steelhead and natural-origin steelhead juveniles (Table 8, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Juvenile Predation in Freshwater

Considering the default unadjusted unknown risk level for predation on natural-origin steelhead by hatchery-origin steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted potential risk of predation on natural-origin steelhead juvenile life-stages by hatchery-origin ~~Skamania~~ESS steelhead in freshwater has been close to none, even if the default risk were high (Rensel et al. 1984). The reduction in risks is primarily due to low abundance of hatchery-origin steelhead relative to natural-origin steelhead and low temporal overlap between hatchery-origin steelhead and natural-origin steelhead juveniles (Table 22, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Adult competition: Spawning site competition

~~It is estimated that the Skamania program overlaps with 19 percent of the summer-run steelhead spawn timing~~It is estimated that spawn timing of the ESS program overlaps with 19 percent of the natural-origin summer-run steelhead's spawn timing~~(Haggerty 2021)~~ (Haggerty 2020a). Because of similarities in spawning site selection and spawning substrate preferences among hatchery-origin and natural-origin steelhead, we assume hatchery-origin steelhead and natural-origin steelhead have spatial overlap. The estimated abundance of returning ~~Skamania~~ESS hatchery-origin steelhead adults (284 fish per year) and the average abundance of returning natural-origin Skykomish summer-run steelhead (2006-2018 average of 360 fish per year) combined is low (Table 32, Appendix A) relative to available spawning habitat. Therefore, ~~Skamania~~ESS hatchery-origin steelhead may currently spawn with natural-origin summer-run steelhead due to chance of encounters, but overall spawner abundance is so low compared to available habitat (reference) that spawning site competition is plausible, but has likely been minimal.

Similarly, it is estimated that the ~~Skamania~~ESS program overlaps with 2 percent of the winter-run steelhead spawn timing NMFS (2016b). The estimated abundance of returning ~~Skamania~~ESShatchery-origin ~~Skamania~~ESS adults (284 fish per year) and the average abundance of returning natural-origin Skykomish winter-run steelhead (2006-2018 average of 1,181 fish per year) combined is low (Table 32,

Appendix A) relative to available spawning habitat. Therefore, ~~Skamania~~ESS hatchery-origin steelhead may currently spawn with natural-origin winter-run steelhead due to chance of encounters, but overall spawner abundance is so low compared to available habitat that spawning site competition is plausible, but has likely been minimal.

Adult competition: Redd Superimposition

Overall spawner abundance is so low compared to available habitat (~~Skamania~~ESS = 284 fish per year, Skykomish Summer-run Steelhead = 353 fish per year) that redd superimposition is not likely to have occurred at measurable levels (Table 32, Appendix A). Therefore, redd superimposition has been possible, but likely has been minimal.

Coho Salmon

Juvenile Competition in Freshwater

Considering the default unadjusted high risk level for competition among hatchery-origin steelhead and natural-origin coho salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted potential risk of competition between hatchery-origin ~~Skamania~~ESS steelhead and natural-origin coho salmon juvenile life-stages in freshwater has been close to none. The reduction in risk is primarily due to hatchery-origin steelhead being larger than natural-origin coho salmon, low abundance of hatchery-origin steelhead relative to coho salmon, and low temporal overlap between hatchery-origin steelhead and natural-origin coho juveniles (Table 10, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin coho salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Juvenile Predation in Freshwater

Considering the default unadjusted unknown risk level for predation on natural-origin coho salmon by hatchery-origin steelhead (Table 3, Appendix A) and applying site-specific factors for the criteria that reduce the risks (Table 5, Appendix A), the adjusted potential risk of predation on natural-origin coho salmon juvenile life-stages by hatchery-origin ~~Skamania~~ESS in freshwater has been minimal, even if the default risk were high (Rensel et al. 1984). The reduction in risk is primarily due to low abundance of hatchery-origin steelhead relative to coho and low temporal overlap between hatchery-origin steelhead and natural-origin coho juveniles (Table 24, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin coho salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Adult competition: Spawning site competition

Adult coho salmon spawn from late October through January, while steelhead spawn from January to March (Table 30, Appendix A). There is only a small temporal overlap among them, and the estimated number of spawning hatchery-origin ~~Skamania~~ESS is low (284 fish per year) relative to coho salmon (2006-2018 average of 92,462 fish per year) (Table 32, Appendix A). Additionally, differences in spawning substrate preferences (0.79 inches for coho salmon, compared to 1.02 inches for steelhead) (Kondolf and Wolman 1993) has contributed to reduction of the risk of spawning site competition between ~~Skamania~~ESS and coho salmon spawning in the wild. As a result, the risk of adult competition with coho salmon is estimated to be discountable.

Adult competition: Redd Superimposition

Redd superimposition for coho salmon has been discountable because the estimated number of potential ~~Skamania~~ESS fish spawning in the wild (284 fish per year) is very low relative to native coho salmon (2006-2018 average of 92,462 fish per year) (Table 32, Appendix A).

Chum Salmon

Juvenile Competition in Freshwater

Considering the default unadjusted low risk level for competition among hatchery-origin steelhead and natural-origin chum salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted potential risk of competition between hatchery-origin ~~Skamania~~ESS and natural-origin chum salmon fry in freshwater has been close to none. The reduction in risk is primarily due to hatchery-origin steelhead being larger than natural-origin chum salmon, low abundance of hatchery-origin steelhead relative to chum salmon, and low temporal overlap between hatchery-origin steelhead and natural-origin chum juveniles (Table 12, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin chum salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Juvenile Predation in Freshwater

Considering the default unadjusted high risk level for predation on natural-origin chum salmon fry by hatchery-origin steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted potential risk of predation on natural-origin chum salmon fry by hatchery-origin ~~Skamania~~ESS in freshwater has been small. The reduction in risk is primarily due to low abundance of hatchery-origin steelhead relative to chum salmon and low temporal overlap between hatchery-origin steelhead and natural-origin chum juveniles (Table 27, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin chum salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Adult competition: Spawning site competition

Because there is absence of temporal overlap among them and the estimated number of spawning hatchery-origin ~~Skamania~~ESS is low (284 fish per year) relative to chum salmon (2006-2018 average of 24,966 fish per year) (Table 32, Appendix A), spawning site competition between hatchery-origin steelhead and natural-origin chum salmon has been discountable.

Adult competition: Redd Superimposition

Redd superimposition for chum salmon is discountable because the estimated number of potential ~~Skamania~~ESS fish spawning in the wild (284 fish per year) is very low relative to native chum salmon (2006-2018 average of 24,966 fish per year) (Table 32, Appendix A).

Pink Salmon

Juvenile Competition in Freshwater

Considering the default unadjusted low risk level for competition among hatchery-origin steelhead and natural-origin pink salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted potential risk of competition between hatchery-origin ~~Skamania~~ESS and natural-origin pink salmon fry in freshwater has been close to none. The reduction in risk is primarily due to hatchery-origin steelhead being larger than natural-origin pink salmon, low abundance of hatchery-origin steelhead relative to pink salmon, and low temporal overlap between hatchery-origin steelhead and natural-origin pink salmon juveniles (Table 14, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin pink salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Juvenile Predation in Freshwater

Considering the default unadjusted high risk level for predation on natural-origin pink salmon fry by hatchery-origin steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted potential risk of predation on natural-origin pink salmon fry by hatchery-origin ~~Skamania~~ESS steelhead in freshwater has been small. The reduction in risks is primarily due to low abundance of hatchery-origin steelhead relative to pink salmon and low temporal overlap between hatchery-origin steelhead and natural-origin pink salmon juveniles (Table 28, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin pink salmon juveniles is low because the residualism rate is expected to be relatively low. The new steelhead program includes volitional release, and thus, it is expected to have similar residualism rates as other WDFW steelhead hatchery programs. Monitoring of the size and appearance of fish will be conducted to determine whether the residual rate is meeting that expectation and, if necessary, result in modification of the program to ensure the residualism rate remains as low as possible.

Adult competition: Spawning site competition

Adult pink salmon spawn in September, while steelhead spawn from January to March (Table 30, Appendix A). Because there is absence of temporal overlap among them and the estimated number of spawning hatchery-origin ~~Skamania~~ESS steelhead is low (284 fish per year) relative to pink salmon (2006-2018 average of 966,962 per year) (Table 32, Appendix A), spawning site competition between hatchery-origin steelhead and natural-origin pink salmon has been discountable.

Adult competition: Redd Superimposition

Redd superimposition in this case is not a concern because the estimated number of potential ~~Skamania~~ESS fish spawning in the wild (284 fish per year) is very low relative to native pink salmon (2006-2018 average of 966,962 fish per year) (Table 32, Appendix A). Therefore, superimposition of pink salmon redds by ~~hatchery-origin Skamania steelhead~~ESS redds has been discountable.

3.3.5.4 Disease

Fish diseases and pathogens can be present in hatchery-origin and natural-origin salmon and steelhead, and interactions between groups of fish in the natural environment can result in transmission of pathogens from afflicted fish. Hatchery-origin steelhead released into the natural environment may pose an increased risk of transferring diseases to natural-origin salmon and steelhead if not released in a disease-free condition. In addition, fish transfers from out-of-basin hatcheries, either in the form of broodstock, eggs, or juveniles, may inadvertently transfer out-of-basin diseases. However, no such transfers currently occur for the ~~steelhead~~ ESS hatchery program in the Skykomish River Basin.

Pathogens are not unique to hatcheries. Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because higher rearing densities of fish in the hatchery may stress fish and lower immune responses. Under certain conditions, hatchery effluent has the potential to transport fish pathogens out of the hatchery, where natural fish may be exposed. These impacts are currently addressed by rearing the steelhead at low densities, within widely recognized guidelines (Piper et al. 1986), and by continuing well-developed monitoring, diagnostic, and treatment programs already in place (WWTIT and WDFW 2006). Table 9 lists the pathogens, the time period these were observed and the treatment that was applied, if any, for all facilities considered in this EA

Table 9. Past disease occurrence at the facilities considered in this EA.

Facility	Pathogen	Occurrence	Treatment
Reiter Ponds	*Sessile ciliates*	March 2018-2019	No treatment
Wallace River Hatchery	*Ichthyobodo*	May 2019	Formalin
	Trichodina	May 2019, July 2018	KMnO4, no treatment
	Flavobacterium psychrophilum	April 2019, May 2018-2019	Chloramine T, Aquaflor medicated feed
	Ichthyophthirius multifiliis	July 2017-2019, Oct 2018	Formalin, salt
	Flavobacterium columnare	Aug 2017-2019, Sept 2019	KMnO4, Chloramine T, TM200 medicated feed
Tokul River Hatchery	*Ichthyobodo*	June-July 2018,2019	Formalin (1)
	Ichthyophthirius multifilis	Aug.-Sept.2018, 2019	Formalin (1)
	Gyrodactylus	Feb-April 2017, 2018	no treatment
	F. psychrophilum	July-Aug. 2017,2019	medicated feed (1 in 2019)

3.3.5.5 Population Viability

Salmon and steelhead population viability is determined through a combination of four parameters, which include abundance, productivity, spatial structure, and diversity (McElhany et al. 2000). As part of ESA status reviews and recovery planning for threatened and endangered populations, NMFS defines population performance measures for these key parameters and then estimates the effects of hatchery programs at the population scale on the survival and recovery of an entire ESU or DPS. NMFS has established population viability criteria for the Puget Sound Chinook Salmon ESU and the Puget Sound Steelhead DPS. Because coho, chum, and pink salmon populations in the analysis area are not listed under ESA, NMFS has not developed specific population viability criteria for these populations.

The effects of hatchery programs on the status of Puget Sound Chinook Salmon ESU or Puget Sound Steelhead DPS "will depend on which of the four key attributes are currently limiting the ESU, and how the hatchery fish within the ESU affect each of the attributes" (70 FR 37204, 37215, June 28, 2005).

One aspect of population viabililty is fitness, for which productivity can serve as a surrogate. One factor that plays a role in productivity is reproductive success. Most of the empirical evidence of fitness depression due to hatchery-influenced selection comes from studies of species that are reared in the hatchery environment for an extended period – one to two years – prior to release (Berejikian and Ford 2004). In addition, one of the basic tenets of an integrated hatchery program is to increase the likelihood that reproductive success of subsequent generations will improve because natural-origin genes are continually being incorporated into the population.

Hatchery programs may have both beneficial and negative effects on these parameters. However, the current ~~Skamania summer-run steelhead hatchery~~ESS program in the Skykomish River Basin has no conservation objectives and is not intended to provide population viability benefits to any species (e.g., see Section 3.3.5.1 Genetics for risks to genetic diversity). Because the program uses a highly domesticated non-native stock, NMFS indicated that the current program has negative population viability effects for Puget Sound Steelhead DPS and needs to change in order to avoid current detrimental effects (Thom 2017).

The current Sunset Falls trap and haul operation has been benefitting the population viability for both Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS for many years. Transporting fish above Sunset Falls provides additional habitat for these fish, thereby benefiting the species' abundance, productivity, and spatial structure. In addition, while transporting hatchery-origin fish presents a genetic risk (see 3.3.5.1, Genetics), NMFS considers the risk to be outweighed by the population viability benefits (i.e., abundance and spatial distribution) provided by enhancing natural production, which limits hatchery genetic impacts.

3.3.5.6 Nutrient Cycling

Steelhead can be important transporters of marine-derived nutrients into the freshwater and terrestrial systems through the decomposition of carcasses of adults returning from the ocean (Cederholm et al. 2000). Naturally spawning hatchery-origin fish from the ongoing hatchery programs can also contribute to increased nutrient cycling in the natural environment.

Phosphorous is one example of a marine-derived nutrient that is currently added to natural systems from salmonid carcasses. Estimating the quantity of phosphorous added to the natural environment from hatchery programs is one method to estimate nutrient transport. Increased phosphorus currently benefits salmonids because phosphorus is typically a limiting nutrient for the growth of prey sources (e.g., *Daphnia* spp., a prey item for juvenile salmonids).

Currently, the decreased abundance of natural-origin salmon and steelhead in the analysis area likely translates into a reduction of nutrient availability from the marine environment into freshwater and terrestrial ecosystems. Because natural-origin steelhead abundance is so low (relative to historical populations in the Skykomish River Basin), hatchery-origin steelhead increases nutrient availability in areas where they return and are not removed from the system. Thus, the current ~~summer-run steelhead~~ESS hatchery program does not make a substantial contribution of marine-derived nutrients to the freshwater ecosystem because not many spawn naturally (and subsequently die and decompose), and unlike salmon, steelhead are iteroparous so some may not die after spawning naturally. The ~~Skamania~~ESS program currently contributes around 0.01 to 0.09 percent of the total phosphorous contribution by spawning salmon and steelhead in the Snohomish River Basin (Patino 2020).

3.3.5.7 Facility Operations

Because water quantity and water quality are assessed as separate resources in Sections 3.1, Water Quantity and 3.2, Water Quality, the discussion of the current and ongoing effects of facility operations on salmon and steelhead in this section is restricted to the operation of weirs and traps for juveniles and adults, water intake structures, and facility maintenance activities. The facilities (or related activities) that may currently affect salmon and steelhead species include:

- Wallace River Hatchery
- Reiter Ponds
- Sunset Falls Fishway
- Tokul Creek Hatchery

Operating hatchery facilities can affect instream fish habitat in the following ways: (1) reduction in available fish habitat due to water withdrawals, (2) operation of instream structures (e.g., water intake structures, fish ladders, and weirs), or (3) maintenance of instream structures (e.g., protecting banks from erosion or clearing debris from water intake structures). The following describes the on-going pertinent facility and operational features described in Chapter 2 and their effects on natural-origin salmon and steelhead.

Full river-spanning weirs are operated at the Wallace River Hatchery on the mainstem Wallace River and in May Creek, which seasonally block access to upstream spawning areas. The May Creek weir is a permanent weir that is operated from June through ~~mid-December~~March 15. When trapping is not occurring, the removable panels are removed to allow upstream passage. The Wallace River weir is a temporary weir and is placed and operated from June through September each year. Chinook salmon are passed upstream above the Wallace River weir to seed natural habitat with naturally spawning fish, and migration and blockage effects are minimized at the weir through timely handling of trapped fish (NMFS 2017a). The use of weirs for broodstock collection or to control the number of hatchery-origin fish on the spawning grounds can have unintentional consequences, such as increased mortality or stress due to capture and handling and forced downstream spawning by fish that do not pass through the weir.

Volunteer traps are used at Reiter Ponds and Tokul Creek Hatchery. Summer-run steelhead voluntarily enter the Reiter Pond trap from June 1 through January 31 of each year. No listed Chinook salmon have been observed at the trap during the collection period. Any listed Chinook salmon that would enter the trap would be returned to the river. A trap is used at Tokul Creek Hatchery to collect early winter-run hatchery-origin steelhead broodstock without a weir and minimizes~~does not present any~~ biological risks to natural-origin fish ~~populations.~~ that are migrating up Tokul Creek. Trapping at Sunset Falls Fishway consists of a ladder and a trap. The ladder is currently open from July 1 through December 31 each year, and various species of salmon and steelhead voluntarily migrate up the ladder into a trap, allowing them to be transported above the falls. After the fish enter the trap, the operation uses trucks to haul the fish above Sunset Falls.

A ladder and the truck could have negative impacts on migrating salmon and steelhead by diverting fish from upstream spawning areas. However, the ladder at Sunset Falls does not have this concern because these fish would otherwise be blocked by the impassable natural barrier. The operation has been causing temporary handling stress, but the stress is minimized through following handling protocols.

Although the hatchery water intake screens in the Wallace River and May Creek are in compliance with state and federal guidelines (NMFS 1995, 1996), they do not meet the newest NMFS Anadromous Salmonid Passage Facility Design Criteria (NMFS 2011). Intake screens on both tributaries affected by Wallace River Hatchery are scheduled by WDFW for rebuild by fall ~~2020~~2023 to bring the screens into compliance with current NMFS criteria. The intake structures at Reiter Ponds are gravity fed, which minimizes the likelihood of entrainment and impingement. In addition, Austin Creek and Hogarty Creek are not known to contain anadromous fish, so these intake structures are not likely to pose a risk to listed species. The water intake at the Tokul Creek Hatchery was updated in 2016 to add a fish ladder and to be in compliance with the current NMFS criteria.

There are no in-water construction activities proposed for the hatchery actions under consideration in this EA. Terrestrial construction would not affect salmon and steelhead or their habitat. Construction will not be analyzed further.

3.3.5.8 Research, Monitoring, and Evaluation

Snohomish-region hatchery programs include extensive monitoring, evaluation and adaptive management, and many other actions to monitor and address potential risks to natural-origin juvenile and adult fish. The co-managers conduct numerous ongoing monitoring programs under existing ESA coverage[12], including catch, escapement, marking, scale and otolith sampling, genetic sampling, CWT and otolith tagging, fish health testing and an extensive post-release juvenile monitoring program in freshwater, the estuary, and in marine areas.

~~Research, Monitoring, and Evaluation (RM&E) activities related to the summer-run steelhead program under current conditions, which are the same as the Proposed Action Alternative, include:~~

- Marking (adipose clip) and tagging (BWT, PIT) juvenile ~~hatchery-origin~~ Skykomish hatchery summer-run steelhead prior to release.

- Examination of ~~juvenile and adult~~ Skykomish hatchery summer-run steelhead, both juveniles and adults (e.g., observed through snorkel surveys) ~~(observed in snorkel surveys or collected with hook and line or electrofishing gear)~~ for an adipose clip and ~~checking clipped fish~~ for the presence of a tag (BWT, PIT).

~~[12] These include the following: a) Section 7(a)(2) WCR-2019-00381 Annual, 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; b) 4(d) limit 7 authorization ("Snohomish and Stillaguamish watersheds annual salmonid biological sampling"), Annual WDFW Research and Monitoring; c) Section 10(a)(1)(A) 1345-9A, Warmwater Fish Species Monitoring; d) limit 6 determination ("Joint Hatchery and Genetic Management Plans for Bernie Kai-Kai Gobin Salmon Hatchery "Tulalip Hatchery" Subyearling Summer Chinook Salmon, Tulalip Bay Hatchery Coho Salmon, Tulalip Bay Hatchery Chum Salmon, Wallace River Hatchery Summer Chinook Salmon, Wallace River Hatchery Coho Salmon, and Everett Bay Net-Pen Coho Salmon"), Tulalip Tribes smolt trap operations in the lower mainstem of the Skykomish River; and e) Evaluation and Recommended Determination of a Tribal Resource Management Plan Submitted for Consideration Under the Endangered Species Act's Tribal Plan Limit for the Period January 1, 2017 – December 31, 2021 (WCR-2016-5800).~~

- Obtaining tissue samples from broodstock in the South Fork Skykomish River and from juveniles in the North Fork Skykomish River to genetically monitor diversity and assist in verification of steelhead population structure (Warheit et al. 2021).

In addition, the work group of co-managers that will be formed to determine whether outplanting will occur in the North Fork Skykomish River, as discussed as part of the proposed action in the biological opinion (NMFS 2021b), will be relying on information obtained through the various monitoring programs.

Current RM&E activities related to the Sunset Falls trap and haul program include:

- Enumerating trapped migrating fish by species and origin (natural versus hatchery based on differential marks and/or tagging).
- Collecting biological samples and PIT tagging (or otherwise externally marking) these fish.
- Monitoring of Chinook salmon, steelhead, and other fish species as needed, as part of a basin-wide monitoring program.

RM&E activities that are directly related to hatchery programs are currently implemented using well established (Galbreath et al. 2008) methods and protocols. Because the intent of RM&E for all programs is to improve the understanding of salmon and steelhead populations, the information gained outweighs the risks to the populations, based on the small proportion of fish encountered. Incidental effects resulting from tagging, such as injury to salmon and steelhead, are also considered minimal.

Ongoing collection of adults at traps delays individuals in their upstream migration. Individuals may also suffer stress or mortality during tagging or tissue sampling. Mortality from tagging could be both acute (occurring during or soon after tagging) and delayed (occurring long after the fish have been released into the environment). However, counts of live fish at Sunset Falls are essential to estimating annual escapement and run reconstruction for ESA-listed Skykomish Chinook salmon and steelhead, as well as other non-listed anadromous fish mentioned above.

NMFS has developed general guidelines to reduce impacts when collecting listed adult and juvenile salmonids (NMFS 2000, 2008). Because hook-and-line and electrofishing are targeted toward steelhead, they are likely to experience stress from handling and tagging; all other species encountered through angling and electrofishing may experience temporary stress from being released from the hook or being stunned by the shock. Low mortality, if at all, is expected from electrofishing. Hook-and-line may cause around 5% release mortality, though the extent of impacts may depend on various factors, such as temperature and use of a bait (NMFS 2019d).

3.4 Other fish species

The analysis area for the Other Fish Species resource is the Snohomish River watershed and estuary, immediately adjacent nearshore marine areas, and independent tributaries to those immediately adjacent nearshore areas encompassed by Snohomish County. The analysis area is not considered as one of the geographical areas occupied by the ESA-listed southern DPS of Pacific eulachon (76 FR 65324, October 20, 2011), and eulachon will not be discussed further in this document.

3.4.1 Other fish species affected by the hatchery operation

Many fish species in the Snohomish River basin and adjacent nearshore marine areas have a relationship with steelhead as prey, predators, or competitors (Table 10). The following species may eat steelhead eggs and fry: Pacific lamprey, Western brook lamprey, river lamprey, coast range sculpin, prickly sculpin, rainbow trout, kokanee, bull trout, cutthroat trout, brook trout, smallmouth bass, minnows, suckers, Pacific staghorn sculpin, rockfish[13], starry flounder, and spiny dogfish. All fish species in the Snohomish River basin may be prey for steelhead at some life stage. Additionally, all fish species in the Snohomish River basin compete with steelhead for food and space. Further, facility operations can affect other fish species by potentially entraining or impinging fish.

In addition to Chinook salmon and steelhead, bull trout in the Snohomish River basin are also listed as a threatened fish species under the ESA. The basin harbors four discrete populations that are included as part of the "Snohomish/Skykomish core area" for the listed Puget Sound/Washington Coastal bull trout DPS: North Fork Skykomish River; Salmon Creek; South Fork Skykomish River; and Troublesome Creek (USFWS 2015a).

The Snohomish River basin includes habitat designated as critical for bull trout (75 FR 63898, October 18, 2010). Bull trout critical habitat includes primary constituent elements considered essential for the conservation of bull trout, and may require special management considerations or protection. Such elements include adequate migration, spawning, and rearing habitat, including maintained connectivity,

[13] Canary rockfish, bocaccio, and yelloweye rockfish are ESA-listed in Puget Sound. The effects on these listed species have been analyzed in (NMFS 2020a). Critical habitat for canary rockfish was removed in 2017. Critical habitat for bocaccio and yelloweye rockfish are in the deepwater marine habitat in Puget Sound, but NMFS (2020a) found that hatchery programs in Puget Sound would not have adversely affect critical habitat.

sufficient water quality and quantity, low levels of piscivorous (i.e., fish eating) or competing species, and an abundant food base.

Bull trout predominantly spawn in headwater sections of streams and tributaries that overlap with steelhead. These two species are commonly found in tributaries throughout the Pacific Northwest and are thought to have co-evolved life histories to minimize competition by partitioning habitat and resources upon which both rely (Underwood et al. 1995). Nonetheless, steelhead may compete with bull trout for spawning, rearing, and foraging resources, although the number of bull trout affected is likely very low. Current population surveys suggest that bull trout are approximately four times more abundant than natural-origin summer-run steelhead in the North Fork Skykomish watershed (WDFW 2020c). Typically, resident (rainbow trout) or anadromous (steelhead) *Oncorhynchus. mykiss* are far more abundant than bull trout in the Pacific Northwest (Underwood et al. 1995; Brenkman et al. 2008).

Pacific lamprey and Western brook lamprey are Federal "species of concern" and are Washington State "monitored species" (Table 10). In marine areas, several species of rockfish are listed as threatened under the ESA. Pacific herring (a forage fish for steelhead) is a Federal species of concern and a State candidate species. All species in Table 10 have a range that includes the Snohomish River basin or nearby marine areas where they may be affected by the current ~~Skamania~~ESS program under current conditions. However, none of these species is located exclusively in the Snohomish River basin or nearby marine waters, and in most cases, these areas are a very small percentage of their total range.

Table 10. Range and status of other fish species that may interact with Snohomish River basin salmon and steelhead.

Species	Range in Snohomish River Basin	Federal/State Listing Status	Type of Interaction with Salmon
Freshwater -			
Pacific Lamprey, Western Brook Lamprey, and River Lamprey	Pacific and River Lamprey: basin reaches accessible to anadromous fish. Western Brook Lamprey: entire basin above and below barriers to anadromous fish migration.	Pacific and Western Brook Lamprey: Federal Species of Concern; Washington State Monitored Species. River Lamprey: Federal Species of Concern, State Candidate Species	Predator of salmon eggs and fry Potential prey item for adult salmon May compete with salmon for food and space May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Coast Range and Prickly Sculpin	Entire basin above and below barriers to migration. Prickly sculpin habitat extends into tidally influenced areas	None	Predator of salmon eggs and fry Potential prey item for adult salmon May compete with salmon for food and space

Species	Range in Snohomish River Basin	Federal/State Listing Status	Type of Interaction with Salmon
			May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Three-spine stickleback	Basin reaches downstream of impassable barriers; estuarine and nearshore marine areas	None	May compete with juvenile salmon for food and space Potential prey item for salmon May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Mountain Whitefish	Entire basin above and below barriers to migration.	None	Predator of salmon eggs and fry Potential prey item for adult salmon May compete with salmon for food and space May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Rainbow Trout (resident form)	Entire basin below, and potentially above barriers to anadromous fish migration.	None – the resident form of *O. mykiss* is not included as part of the listed Puget Sound steelhead DPS	Predator of salmon eggs and fry Potential prey item for salmon May compete with salmon for food and space May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Kokanee	Lake Roesiger (in the Woods Creek watershed) and in Lake Stevens (in the Stevens Creek watershed).	None	Predator of salmon eggs and fry Potential prey item for salmon May compete with salmon for food and space
Bull Trout	Basin reaches downstream of impassable barriers, and South Fork Skykomish above Sunset Falls; also, estuarine and nearshore marine areas	Listed as threatened under the Federal ESA	Predator of salmon eggs and fry Potential prey item for salmon May compete with salmon for food and space May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Cutthroat Trout	Basin reaches upstream (resident form) and downstream (resident and sea-run forms) of impassable barriers; also, estuarine and nearshore marine areas (sea-run form)	None	Predator of salmon eggs and fry Potential prey item for salmon May compete with salmon for food and space May benefit from additional marine-derived nutrients provided by hatchery-origin fish
	Griffin Creek, and areas downstream (may not have persisted after initial hatchery plants)	None	Potential predator of salmon eggs and fry Potential prey item for salmon May compete with salmon for food and space
Smallmouth Bass	Basin lakes, ponds, and sloughs	None	Potential predator of juvenile salmon
Minnows (sp.), including	Entire basin below, and potentially above barriers to anadromous fish migration.	None	Potential predators of salmon eggs and juveniles Potential prey items for salmon

Species	Range in Snohomish River Basin	Federal/State Listing Status	Type of Interaction with Salmon
Northern Pikeminnow			May compete with salmon for food and space
Suckers (sp.)	Entire basin below, and potentially above barriers to anadromous fish migration.	None	Potential predator of salmon eggs and fry Potential prey item for salmon May compete with salmon for food and space
Marine Areas -			
Pacific Staghorn Sculpin	Lower Snohomish River brackish and estuarine areas; adjacent nearshore marine areas	None	Predator of salmon fry and smolts Potential prey item for adult salmon May compete with salmon for food and space
Rockfish	Rocky reef habitats in certain areas of Puget Sound including North Puget Sound and the San Juan Islands areas	Several species are federally listed as threatened and/or have State Candidate listing status[14]	Predators of juvenile salmon Juvenile rockfish are prey for juvenile and adult salmon May compete with salmon for food
Forage Fish	Most marine waters within Puget Sound	Pacific herring is a Federal species of concern and a State candidate species	Prey for juvenile and adult salmon May compete with salmon for food
Shiner Perch	Most marine waters within Puget Sound	None	Prey for juvenile and adult salmon May compete with salmon for food
Starry Flounder	Brackish, nearshore, and marine waters within Puget Sound	None	Predator of juvenile salmon Juvenile flounders are prey for juvenile and adult salmon May compete with salmon for food
Spiny Dogfish	Most marine waters within Puget Sound	None	Predator of juvenile salmon May compete with salmon for food

Sources: (NMFS 2017b)

3.4.2 Other fish species affected by the Trap and Haul program

The trap and haul program at Sunset Falls has been transporting bull trout, cutthroat trout, and mountain whitefish above the falls, providing these species with access to additional habitat. Table 11 presents data on the trap and haul program at Sunset Falls from 2009 to 2018 (WDFW 2014a, 2015c, 2016a, 2017, 2019a, 2020b, a).

[14] Georgia Basin bocaccio DPS - Federally listed as endangered and state candidate species; Georgia Basin yelloweye rockfish DPS - Federally listed as threatened and state candidate species; Georgia Basin canary rockfish DPS. Federally listed as threatened and state candidate species; Black, brown, China, copper, green-striped, quillback, red-stripe, tiger, and widow rockfish are state candidate species

Table 11. ~~Information on days of operation and the~~The number of trout transported by the trap and haul program at Sunset Falls. NC = Not counted.

Year	Bull trout	Cutthroat trout	Mountain Whitefish
2009	52	1	NC
2010	97	-	NC
2011	60	1	NC
2012	55	1	NC
2013	46	2	247
2014	67	1	251
2015	23	1	381
2016	34	1	431
2017	9	-	437
2018	10	-	82
Ave.	**45**	**1**	**305**

3.5 Wildlife

The analysis area for the Wildlife resource is the Snohomish River watershed and estuary adjacent nearshore marine areas, independent tributaries to adjacent nearshore areas, and other marine waters encompassed by Snohomish County. In general, hatchery operations in the Snohomish River basin have potentially affected local wildlife species by changing the total abundance of steelhead in aquatic and marine environments, which serve as a food source for various wildlife species and can affect these individuals of these species through predator/prey interactions. Many wildlife species also feed on steelhead carcasses in the Snohomish River basin and subsequently bring marine derived nutrients from the steelhead into the terrestrial ecosystem (i.e., nutrient cycling). Steelhead hatchery operations may therefore provide additional prey availability to wildlife species that use steelhead as a food source. In addition, the hatcheries could affect wildlife through transfer of toxic contaminants from hatchery-origin fish to wildlife (Boxall et al. 2004), the operation of weirs (which could block or entrap wildlife, or conversely, make salmon and steelhead easier to catch through their corralling effect). These effects are at individual levels and are not considered to affect populations of wildlife, as the wildlife under consideration ranges broadly and is not documented to be food limited by steelhead availability in the area of analysis.

The analysis area supports a variety of birds, large and small mammals, amphibians, and invertebrates that may eat or be eaten by steelhead, compete with steelhead for food and space, and scavenge on steelhead (Table 12).

Table 12. Wildlife species that may interact with Snohomish River basin salmon and steelhead.

Species	Status	Habitat [1]			Relationship with Steelhead			
		Fresh-water	Estuary	Marine	Predator	Competitor	Prey	Scavenger
Bald eagle	Federally protected under Bald Eagle and Golden Eagle Protection Act State threatened species	X	X	X	X			X
Golden eagle	Federally protected under Bald Eagle and Golden Eagle Protection Act State candidate species	X	X	X	X		~~X~~	X
Marbled Murrelet	Federal threatened species		X	X	X			
Pacific fisher	Federal candidate species	X						X
Peregrine falcon	Federal species of concern	X	X					
Gulls and cormorants	None	X	X	X	X	X		X
Great blue heron	State Monitored Species	X	X		X	X		
Duck (species)	None	X	X	X	X			
Beaver	None	X				X		
Black bear	None	X	X		X			
River otter	None	X	X		X			X
Mink and weasels	None	X	X		X			X
Bats	Varies by species[2]	X				X		
Amphibians (e.g., salamanders & frogs)	Varies by species[3]	X			X	X	X	
Aquatic/terrestrial / riparian zone invertebrates (e.g., insects and snails)	Varies by species[4]	X	X				X	X
Southern Resident Killer Whale	Federal Endangered Species			X	X			

		Habitat [1]			Relationship with Steelhead			
Species	Status	Fresh-water	Estuary	Marine	Predator	Competitor	Prey	Scavenger
Harbor seal	Protected under MMPA[5]		X	X	X	X		
Steller sea lion	Protected under MMPA; Western DPS ESA-listed endangered		X	X	X	X		
California sea lion	Protected under MMPA		X	X	X	X		
Harbor porpoise (Inland Washington and Oregon-Washington Coastal stocks	Protected under MMPA; State species of concern			X	X	X		
Dall's porpoise (California /Oregon/Washington stock)	Protected under MMPA			X	X	X		
Marine invertebrates (e.g., zooplankton; crab)	None		X	X			X	X

Sources: Listed and Proposed Endangered and Threatened Species and Critical Habitat; Candidate Species; And Species of Concern in Snohomish County. As Prepared by The U.S. Fish and Wildlife Service Washington Fish and Wildlife Office. (Revised March 15, 2012; Washington State Species of Concern Lists: http://wdfw.wa.gov/conservation/endangered/lists/search.php?searchby=simple&search=black+bear&orderby=AnimalType percent2CCommonName

State threatened and monitored species are so designated under the Washington State Endangered, Threatened, and Sensitive Species Act.

Notes:

[1] Includes those habitats most relevant for evaluating interactions with salmon and steelhead; does not include all habitats used by each species.

[2] Applicable listed species include Long-eared myotis (Federal sensitive species); Long-legged myotis (Federal sensitive species); and Pacific Townsend's big-eared bat (state and Federal candidate species).

[3] Applicable listed species include federally listed sensitive species (Cascades frog (State Monitored); Olympic torrent salamander; Tailed frog (State Monitored); Van Dyke's salamander; and Western toad.

[4] Applicable listed species include federally listed snails (Bliss Rapids snail (federally threatened), Banbury Springs lanx (federally endangered), Snake River physa snail (federally endangered), Utah valvata (federally endangered).

[5] Marine Mammal Protection Act. Enacted by Congress in 1972, the MMPA prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

Steelhead eat invertebrates and amphibians, which may include insects and frogs. Steelhead predators include several species of birds, black bear, river otter, mink, weasels, and some amphibians. Some bird species, including bald and golden eagles (protected under the Bald and Golden Eagle Protection Act) and cormorants, scavenge on salmon and steelhead carcasses, as do minks, weasels, and several invertebrate species. Other wildlife species compete with steelhead for food or habitat (e.g., gulls). The ~~summer-run steelhead~~ESS hatchery program is relatively small compared to other programs in the analysis area and natural production. The ~~Skamania~~ESS ~~summer-run steelhead~~ interact with wildlife but represent only a small proportion of the total hatchery-origin and natural-origin salmonids available for such interactions.

Within the analysis area, there are several wildlife species listed under the ESA. The marbled murrelet is listed as endangered and are found in Snohomish County, Washington (USFWS and WFWO 2013), the county encompassing the majority of the analysis area. Other ESA-listed wildlife species in Snohomish County are the yellow-billed cuckoo, Canada lynx, gray wolf, and grizzly bear. Federal candidate wildlife species within the action area are the fisher, North American wolverine, and Oregon spotted frog. The bald and golden eagle, Beller's ground beetle, Cascades frog, long-eared myotis, long-legged myotis, olive-sided flycatcher, Pacific Townsend's big-eared bat, peregrine falcon, tailed frog, and western toad are present in the action area and are designated by the U.S. Fish and Wildlife Service as "species of concern." Southern Resident killer whales are also observed in marine waters of Puget Sound proximate to the analysis area. Marine mammals are protected under the federal Marine Mammal Protection Act (MMPA) (16 U.S.C. 1361, Marine Mammal Protection Act). Harbor seals, sea lions, harbor porpoises and Dall's porpoises are commonly present in Puget Sound and nearshore marine areas immediately adjacent to where Snohomish region hatchery-origin adult steelhead return.

Although Southern Resident killer whales, harbor porpoises, and Dall's porpoises are not found in the Snohomish River Basin (harbor seals and sea lions may range into upper estuarine areas), they may intercept adult steelhead in the analysis area when feeding in the estuary and adjacent marine waters. Harbor seals may also be important predators of Snohomish River Basin-origin salmon and steelhead smolts transiting the Salish Sea in more seaward areas (Moore et al. 2010; Moore et al. 2015). Harbor seals and sea lions have been observed in nearshore areas preying on salmon produced by the proposed Skykomish summer steelhead hatchery programs. No other marine mammals are likely to prey on Snohomish River basin-origin steelhead in the analysis area.

Based on currently available data, the Southern Resident killer whale diet in Salish Sea marine waters during the summer months consists mainly of salmon, with Chinook salmon being the preferred species, making up approximately 80 percent of all salmon species consumed (Hanson et al. 2010; Hilborn et al. 2012; Ford et al. 2016). These same studies have shown that coho, sockeye, and chum salmon are also prey for the whales in Puget Sound during the summer and fall months.

Adult steelhead returning from the hatchery program in the Skykomish River Basin are not high-priority components of the Southern Resident killer whale prey base (Hanson et al. 2010; Hilborn et al. 2012; Ford et al. 2016). Additionally, the numbers of hatchery-origin fish released from this river basin are low (production levels of up to 116,000 total hatchery-origin steelhead) compared to the total number of hatchery releases throughout Puget Sound (approximately 168 million salmon and steelhead released)).

Southern Resident killer whales have been observed near marine areas on either side of the Snohomish River Basin mouth, where steelhead would gather prior to migrating up the Snohomish River to spawn. Although steelhead from the hatchery program in the Skykomish River Basin co-occur with Southern Resident killer whales in Puget Sound along with many other hatchery-origin and natural-origin salmon originating from other Puget Sound river basins, it is likely that fish from the current ~~summer-run steelhead~~ESS hatchery program constitute a non-substantive contribution to the diet of Southern Resident killer whales based on research suggesting salmon make up a much larger proportion of their diet (Chasco et al. 2017a; Chasco et al. 2017b).

None of the facilities supporting the current ~~Skamania~~ESS program under baseline conditions rely on hazing wildlife to prevent them from eating fish being raised in the hatchery facilities. Instead, the hatchery facilities use nets over their raceways and rearing ponds to exclude predators, and this practice is not considered to adversely affect any wildlife populations (WDFW 2015a, 2016 2017 2018 ; Antipa 2019a, b, c). A low number of birds are reported dead at Wallace River Hatchery, Reiter Ponds, and Tokul Creek Hatchery each year, some of which die from drowning in the pond or entangling in the net. For example, in 2015 two blue herons, one mallard duck, and one crow were found dead at Wallace River Hatchery. In 2018, one blue heron, one crow, and one belted kingfisher were found dead at Wallace River Hatchery and Tokul Creek Hatchery, each.

Currently, the transfer of pathogens to wildlife associated with the hatchery program is unlikely to contribute to their presence/load in wildlife due to the regulation of hatchery operations through the NPDES permit and the applicants' fish health policies (WWTIT and WDFW 2006). Weirs and traps used for collection of fish may impede individual wildlife movement and/or benefit individual wildlife by restricting migration of fish and thereby enhancing predation efficiency.

The trap and haul program transports up to 30,000 salmon, steelhead and trout above Sunset Falls, an impassable barrier to migrating adult salmonids. As a result of the operation of this program, the habitat above the falls is seeded with spawning adults and the resulting productivity in this habitat benefits many of the wildlife species in this section of the analysis area, though population level impacts are unlikely.

3.6 Socioeconomics

The analysis area for the Socioeconomics resource is the Skykomish River and Snohomish River watershed and estuary. In addition to providing fish for harvest, hatchery programs directly affect socioeconomic conditions in the regions where the hatchery facilities operate. Hatchery facilities generate economic activity (personal income and jobs) by providing employment opportunities and through local procurement of goods and services for hatchery operations. The trap and haul program at Sunset Falls Fishway program also provides employment in that region.

The evaluation of the Snohomish River Basin steelhead hatchery program effects and the trap and haul program on socioeconomics focuses on the contribution of hatchery-origin fish to local and regional economies and natural-origin fish above Sunset Falls to local and regional economies. This section describes the baseline contribution of hatchery-origin Skykomish River Basin steelhead to commercial and recreational socioeconomic values and to the communities where the hatchery facilities operate. This section also describes the baseline contribution of natural-origin Skykomish River Basin steelhead passes above the Sunset Falls to recreational socioeconomic values and to the communities where the fisheries targeting these fish occur.

3.6.1 Employment and Operations

In addition to providing fish for harvest and conservation, the summer-run steelhead hatchery program and the trap and haul program directly affect socioeconomic conditions within the communities where these facilities operate. These facilities provide employment opportunities and procure goods and services for their operations. Direct hatchery-related expenditures for labor and procurement of supplies also generate secondary economic activity, both locally and in more distant areas. WDFW operates Wallace River Hatchery, using four full-time employees to perform operation and maintenance duties (WDFW and Tulalip Tribes 2019). Steelhead production is only a small proportion of the fish produced at Wallace River Hatchery.

Reiter Ponds is operated using 1.5 full-time employees to perform operation and maintenance duties with an annual operating cost of $150,450 (WDFW and Tulalip Tribes 2019). The annual operation cost of the Sunset Falls program is $120,450, with 2 full time staff for 6 months (Eleazer 2020).

3.6.2 Fisheries

The analysis area for the Fisheries resource is the Skykomish River and Snohomish River watershed and estuary, and adjacent marine areas 8A and 8D (Washington Administrative Code (WAC) 220-301-030; Figure 2). Fisheries contribute to local economies through the purchase of supplies such as fishing gear, camping equipment, consumables, and fuel at local businesses. All these expenditures help to support local businesses, but it is unknown how dependent these businesses are on fishing-related expenditures. Recreational anglers also contribute to the economy through payments for fishing outfitters, guides, and charter fees.

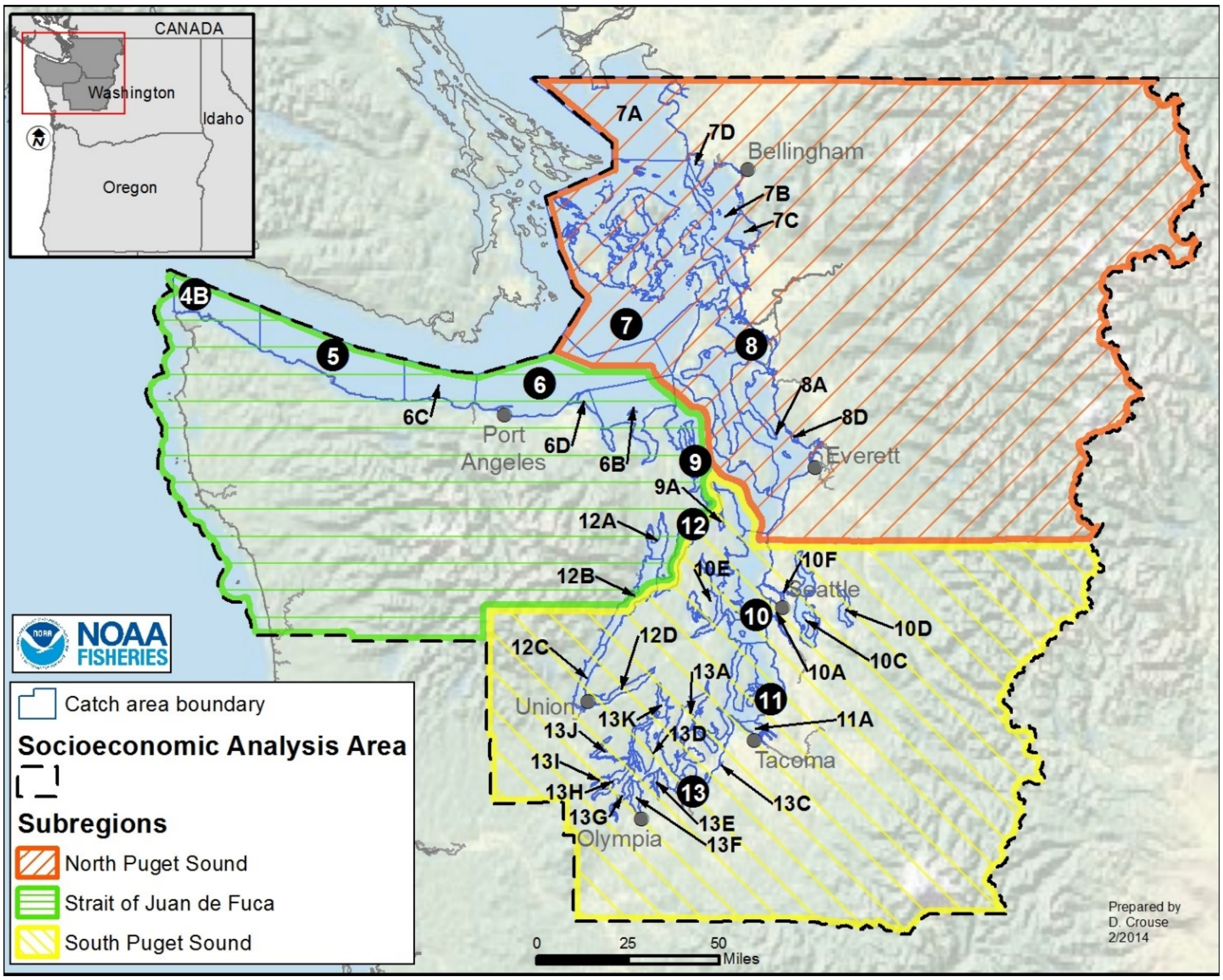

Figure 2. Map illustrating WDFW fishery marine areas, including marine area 8A and 8D.

Annual average releases of hatchery-origin ~~Skamania~~ESS smolts were reduced from a recent five-year average of 193,000 fish to the current target of up to 116,000, and the first year of adult returns after this reduction was 2019. Assuming the smolt-to-adult survival rate and harvest rate for summer-run steelhead was the same as before the reduction, the estimated recreational catch was a minimum of 1,307 summer-run steelhead in the Snohomish Basin. No related economic data are available for 2020, but based on $160 in angler expenditures per trip, an economic impact multiplier of 1.33 (Gislason et al. 2017), and average catch rates, the estimated economic value from recreational fisheries under these conditions would have been $2.3 million in 2019 (Scott 2019)[15].

Salmon and steelhead fishing has been a focus for tribal economies, cultures, lifestyles, and identities for many millennia (Gunther 1950). Further discussions of tribal fisheries will be in section 3.7 Cultural Resources.

3.7 Cultural Resources

The analysis area for Cultural Resources is the Snohomish River watershed and estuary, adjacent nearshore marine areas, tributaries to Tulalip Bay, and marine waters encompassed by Tulalip Bay, Port Susan, and Everett Bay. Impacts on cultural resources typically occur when an action disrupts or destroys cultural artifacts, disrupts cultural use of natural resources, or disrupts cultural practices. This hatchery program and the operation of the trap and haul program do not include activities that could disrupt or destroy cultural artifacts. However, the hatchery program and the Sunset Falls trap and haul program are operated can affect the ability of Native American tribes to use salmon and steelhead in their cultural practices. The Sunset Falls trap and haul program, in particular, has been benefitting salmon and steelhead population viability for many years, as discussed in Section 3.3.5.5, which has contributed to enhacing the cultural resourcs for the tribes.

The Tulalip Tribes are federally recognized and have a reservation adjacent to the marine waters of Port Susan and Possession Sound (which includes Port Gardner) and north of the Snohomish River. The reservation was reserved for use and benefit of Indian tribes and bands that were signatories to the Treaty of Point Elliott, which included the Snohomish, Snoqualmie, Skagit, Suiattle, Sammamish, and Stillaguamish Tribes and allied bands living in the region (Tulalip Tribes 2018d). The Tulalip Tribes have 4,533 enrolled tribal members, primarily from the Snohomish, Snoqualmie, and Skykomish tribes, with 2,500 of these members residing on the reservation (Tulalip Tribes 2018c). Since the Treaty of Point

[15] While this analysis is for the economic impact of the recreational fisheries, it is important to note that this steelhead fishery is one of the largest remaining steelhead recreational fisheries in Puget Sound. Many families have fished for steelhead in the Snohomish River for many years.

Elliott, the Swinomish, Upper Skagit, Sauk-Suiattle, and Stillaguamish Tribes have established federally recognized reservations separate from the Tulalip Reservation.

Salmon and steelhead represent an important cultural resource to the Tulalip Tribes, who manage, protect, and conserve those natural resources that are required to sustain healthy populations of fish, shellfish, and wildlife within the tribes' usual and accustomed fishing areas (Tulalip Tribes 2018b). The tribes establish and enforce laws and regulations for conducting and managing commercial, subsistence, and/or ceremonial harvest by tribal members (Tulalip Tribes 2018a)

The Tulalip Tribes, like other Puget Sound treaty tribes, regularly consume salmon and steelhead, which is served at gatherings of elders and to guests at feasts and traditional dinners. Salmon and steelhead are a core symbol of tribal identity, individual identity, and the ability of Native American cultures to endure (NMFS 2004, 2005). The survival and well-being of salmon and steelhead are inextricably linked to the survival and well-being of Native American people and tribal culture. Salmon and steelhead are an important component of the Salmon Ceremony organized by the Tulalip Tribes.

Tribal ceremonial and subsistence uses of salmon and steelhead pertain to fish that are caught non-commercially by members of Puget Sound treaty tribes, including the Tulalip Tribes, for purposes of maintaining cultural viability and providing a valuable food resource, among other traditional foods, in tribal ceremonies. Examples of ceremonies that use traditional foods include winter ceremonies, first salmon ceremonies (Amoss 1987), naming ceremonies, giveaways, feasts, and funerals (Resources 1999). Subsistence refers to ways in which Native Americans use environmental resources like salmon and steelhead to meet the nutritional needs of tribal members.

Harvest of steelhead generally occurs within a tribe's usual and accustomed fishing areas when forecasted returns of hatchery-origin and natural-origin steelhead are sufficient to provide for both a fishery and escapement for natural reproduction. The Tulalip Tribes' "usual and accustomed" fishing area, as defined by the federal court, includes the entire Snohomish River basin and marine waters extending from the Canadian border to mid-Puget Sound, including Possession Sound, Port Susan, and Port Gardner Bay.

Members of the Tulalip Tribes prioritize their ceremonial and subsistence needs over commercial sales, though no data are available regarding how many fish are caught for each of the three purposes. Tribes may not commercially sell fish caught for ceremonial and subsistence purposes, but they are allowed to use fish harvested as part of commercial harvest for subsistence purposes. Adult fish returning from the ~~Skamania~~ESS program in the Skykomish River Basin are currently used for ceremonial and subsistence purposes, which could have the potential to provide substantial benefits to Tulalip Tribes. However, many tribes feel their subsistence needs are not met by the available abundances of natural-origin and hatchery-origin fish. While 14,545 steelhead were caught in 1986, there has been a sharp decline in the number of steelhead caught by the Tulalip Tribes from 230 in 2000 to 11 in 2019. (J. Gobin, pers. comm., Tulalip Tribes, Fish and Wildlife Director, May 12, 2020). Steelhead has been an important food source for the Puget Sound tribes since time immemorial.

3.8 Environmental Justice

The analysis area for Environmental Justice includes Snohomish River Basin and Snohomish County where the steelhead hatchery program and trap and haul program analyzed in this EA operate. Harvest of steelhead produced by the hatchery program occurs primarily in the Snohomish and Skykomish River and marine areas 8A and 8D (WAC 220-301-030; Figure 2).

Environmental justice analysis considers whether adverse human health or environment effects of a program would be disproportionately borne by minority and low-income populations (Executive Order 12898). Hatcheries and trap and haul programs, such as the ones subject to this EA, have the potential to affect the extent of fish available for subsistence, cultural, and economic purposes for minority and low-income populations.

Aside from tribal fisheries and cultural practices, there are no data regarding fishing specific to minority and low-income communities and there is no information to suggest that disproportionate effects to these communities from the proposed action seem likely, so only tribes will be further analyzed for environmental justice impacts.

Native American Tribes

The environmental justice evaluation for Native American tribes includes:

- Ceremonial and subsistence uses
- Tribal commercial fisheries
- Economic value to tribes from hatchery and trap and haul operations

Ceremonial and subsistence use and tribal fisheries are described in Section 3.7, Cultural Resources. Environmental justice analysis will focus on the potential for the proposed action and alternatives to disproportionately affect the tribal communities of the Tulalip Tribes. All the hatchery facilities for the

Skykomish steelhead hatchery program and the Sunset Falls Fishway (where the trap and haul program would operate) are currently operated by the WDFW, and these do not directly benefit tribal members with jobs. Thus, there is no potential for disproportionate effects to economic value of the hatchery and trap and haul programs to tribes, so this will not be analyzed for effects. Instead, the analysis will focus on the ceremoninal and subsistence uses and the tribal commercial fisheries.

4 ENVIRONMENTAL CONSEQUENCES

This chapter describes the analysis of the direct and indirect environmental effects associated with the four alternatives on the eight resource categories. The positive and negative effects of Alternative 1, No Action, are compared to the current conditions where those conditions continue into the future unchanged. The No Action alternative is ramping down the ~~Skamania~~ESS program in the Skykomish River because this ramping down is required under settlement agreement; thus, if NMFS took no action, this program would be phased out. The positive and negative effects of the other alternatives are described relative to Alternative 1, No Action. The relative magnitude of impacts is described using the following terms:

- Undetectable – The impact would not be detectable.
- Negligible – The impact would be at the lower levels of detection.
- Low – The impact would be slight, but detectable.
- Medium – The impact would be readily apparent.
- High – The impact would be severe.

The aspects of critical habitat as defined by the ESA that may be affected include (1) adequate water quantity and quality, and (2) freedom from excessive predation. Potential effects on habitat are analyzed in this EA in the discussion of impacts on habitat in Sections 4.1, Water Quantity; 4.2, Water Quality; 4.3, Salmon and Steelhead; 4.4, Other Fish Species; and 4.5, Wildlife. Because all of the habitat in the area of analysis is critical habitat under ESA and essential fish habitat (EFH) under MSA, the enumerated sections of the EA address effects to critical habitat and EFH. Physical attributes of critical habitat and EFH are not expected to be affected because no new construction, traps, weirs, or other items will be added to the system as part of this action, though further considerations of effects to these physical environments will be made in the Biological Opinion and the EFH consultation associated with the Section 4(d) Limit 6 determination.

4.1 Water Quantity

This section discusses the effects of the alternatives on water quantity (Table 7). All water withdrawals under all alternatives would be non-consumptive, returned to the source within a short distance of the point of withdrawal, and remain within permitted water rights (Table 7). The effects on water quantity under each of the alternatives are summarized in Table 13.

Table 13. Summary of effects on water quantity.

Resource	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Water Quality	Negligible positive	Negligible negative	Negligible negative	Negligible negative

4.1.1 Alternative 1 (No Action/Termination)

Under Alternative 1, the effects on water quantity at Tokul Creek Hatchery would be the same as current conditions because all operations at Tokul Creek Hatchery would remain the same. Because the quantity of water currently used by the ~~Skamania~~ESS program overlaps with other water uses (e.g., for the Chinook program) at Wallace River and Reiter Ponds for other salmonid production out of the scope on the analysis in this EA, the effects on water quantity from Alternative 1 would be only minorly less than under current conditions for these two facilities, consistent with phasing out and eliminating the ~~Skamania~~ESS program after 2022.

Broodstock collection for the ~~Skamania~~ESS program and the trap and haul program's portion of the Sunset Falls Fishway operations would be terminated under Alternative 1, but the facility would continue to be used for other purposes outside of the scope of the proposed action. The operation would continue for a limited duration for trapping the returning hatchery fish from the ~~Skamania~~ESS program until the returns from the last release year are captured. Operations for capturing broodstock for the Chinook and coho salmon programs annually through September would continue under hatchery programs assessed in NMFS (2017a). The shortening of trapping duration and elimination of the trap and haul portion of the program's operation would only minorly reduce water withdrawals at Sunset Falls Fishway facility under Alternative 1, compared to current conditions.

Water withdrawals would be affected only at lower levels of detection, so Alternative 1 would have a negligible beneficial effect on water quantity.

4.1.2 Alternative 2 (Proposed Action)

Compared to Alternative 1, the quantity of water used under Alternative 2 would be minorly higher at Wallace River Hatchery and Reiter Ponds because, while the existing ~~Skamania~~ESS program would be phased out and eliminated (as it would be for Alternative 1). A new summer-run steelhead program would be developed (absent in Alternative 1) that would have water quantity effects similar to current conditions at these two facilities. The additional amount of water needed to operate this new program under Alternative 2 would result in only a small increase in the total amount of the water that would be used at these facilities under Alternative 1 because other ongoing hatchery programs would continue to withdraw water regardless of whether there is a ~~Skamania~~ESS program.

The Sunset Falls Fishway would increase the water usage relative to Alternative 1 because it would be operated the same as current conditions. The trap operation would be the same as Alternative 1 during the years when the adults from the ~~Skamania~~ESS steelhead program continue to return. After that, the trap operation would be longer by roughly 3 months relative to Alternative 1 to capture steelhead as broodstock, in addition to the Chinook and coho salmon captured under Alternative 1. In addition, this alternative would allow the hauling of various species of fish above Sunset Falls, which would use a small, but additional, amount of water in the tanks.

Water withdrawals would be affected only at lower levels of detection under Alternative 2 compared to Alternative 1, so Alternative 2 would have a negligible negative effect on water quantity.

4.1.3 Alternative 3 (Use of Tolt River steelhead as alternate for broodstock)

As described in Section 2.3, Tokul Creek Hatchery would be used to collect brood, incubate eggs, rear and release summer-run steelhead juveniles onsite and into Tolt River during phase one of Alternative 3, which would not occur under Alternative 1 and Alternative 2. Compared to Alternative 1, the quantity of additional water that would be used at Tokul Creek Hatchery under phase one of Alternative 3 would be a minor increase from what is currently occurring at this facility for hatchery production, as analyzed in (NMFS 2016b) (Table 7). Under phase one of Alternative 3, water withdrawals at Wallace River Hatchery and Reiter Ponds would decrease to levels similar to Alternative 1.

During phase two under Alternative 3, the new summer-run steelhead hatchery program would move to the Skykomish River, and water withdrawals at Tokul Creek Hatchery would decrease to levels similar to Alternative 1, Alternative 2, and current conditions. During phase two under Alternative 3, the quantity of water that would be used at Wallace River Hatchery and Reiter Ponds would be a minor increase compared to Alternative 1 because a new summer-run steelhead program of similar size as current conditions would be developed at these facilities.

Under Alternative 3, the Sunset Falls Fishway would operate the same as current conditions and Alternative 2.

Water withdrawals would be affected only at lower levels of detection under Alternative 3 compared to Alternative 1, so Alternative 3 would have a negligible negative effect on water quantity.

4.1.4 Alternative 4 (Reduced Production)

Alternative 4 is a reduced steelhead production alternative that otherwise does not differ from Alternative 2. Fewer hatchery releases will result in a very small reduction in water use compared to Alternative 2 but not sufficient difference to change the level of impact, which would be negligible negative for Alternative 4 compared to Alternative 1.

4.2 Water Quality

This section discusses the effects of the alternatives on water quality. All discharge under all alternatives would continue to contain fish, fish food, chemicals, and pharmaceuticals used for production of other salmonids not considered in this EA, so elimination of this program would not eliminate these discharges. The pollutant discharges, with or without the ~~Skamania~~ESS program, would be limited in accordance with NPDES permits. These facilities would continue to comply with applicable Federal, state, and tribal water quality and groundwater standards. Other chemicals not regulated by the NPDES permit (e.g., therapeutic chemicals) are not likely to have a detectable effect on water quality because they are used at a level lower than the therapeutic level approved by the U.S. Food and Drug Administration and in accordance with the labeled instructions. The effects on water quality under each of the alternatives are summarized in Table 14.

The Sunset Falls Fishway trap and haul program has no effect on water quality under all alternatives.

Table 14. Summary of effects on water quality.

Resource	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Water Quality	Negligible positive	Negligible negative	Negligible negative	Negligible negative

4.2.1 Alternative 1 (No Action)

Under Alternative 1, the water quality would minorly improve at Wallace River Hatchery and Reiter Ponds relative to existing conditions, consistent with phasing out and eliminating the current

~~Skamania~~ESS program, eventually declining to zero from this program by 2023 when the production would be fully phased out. Based on decrease and ultimate cessation of the small amount of effluent at lower levels of detection under Alternative 1 compared to the existing conditions, Alternative 1 would have a negligible positive effect on water quality.

4.2.2 Alternative 2 (Proposed Action)

Compared to Alternative 1, water quality would minorly decline under Alternative 2 at Wallace River Hatchery and Reiter Ponds because while the existing ~~Skamania~~ESS program would be phased out and eliminated (as it would be for Alternative 1), a new summer-run steelhead program would be developed (absent in Alternative 1) that would have water quality effects similar to current conditions at these two facilities. The additional amount of effluent discharge related to the new program under Alternative 2 would be minorly greater than the amount produced at these two facilities under Alternative 1. Based on the small amount of increased effluent at lower levels of detection under Alternative 2 compared to Alternative 1, Alternative 2 would have a negligible negative effect on water quality.

4.2.3 Alternative 3 (Use of Tolt River steelhead as alternate for broodstock)

Compared to Alternative 1, the new summer-run steelhead program would increase production at Tokul Creek Hatchery under phase one of Alternative 3, meaning the related pollutant discharge at this facility would minorly add to the discharge under Alternative 1 (Table 1). Under phase one of Alternative 3, summer-run steelhead production would be phased out at Reiter Ponds and Wallace River hatchery, decreasing pollutant discharge at these facilities to the same levels as under Alternative 1.

During phase two under Alternative 3, the new summer-run steelhead hatchery program would move to the Skykomish River, and pollutant discharges at Tokul Creek Hatchery would decrease to the same levels as under Alternative 1 and current conditions. During phase two under Alternative 3, the pollutant discharge at Wallace River Hatchery and Reiter Ponds would be at the same level as Alternative 2 and minorly higher compared to Alternative 1 because a new summer-run steelhead program similar to existing conditions would be developed and implemented at these facilities.

Based on the small amount of increased effluent at lower levels of detection under Alternative 3 compared to Alternative 1, Alternative 3 would have a negligible negative effect on water quality.

4.2.4 Alternative 4 (Reduced Production)

Because the production level under Alternative 4 is about half of the production level under Alternatives 2 and 3, the water quality impacts attributed to this program are minorly less than that under Alternatives 2 and 3. As for Alternatives 2 and 3, the small amount of increased effluent at lower levels of detection under Alternative 4 compared to Alternative 1 would have a negligible impact on water quality.

4.3 Salmon and Steelhead

The analyses of salmon and steelhead focus on effects of the alternatives on natural-origin salmon and steelhead in the analysis area (Section 3.3). Chinook, coho, chum, and pink salmon are included in the evaluation because they may be affected by the alternatives. Types of effects are described in Table 8. In addition, the effects of monitoring directly associated with salmon hatchery operations and performance are also evaluated. The effects on salmon and steelhead from other factors (e.g., habitat restoration, climate change) are described in Chapter 5, Cumulative Effects.

4.3.1 Genetics

In this section, only effects on steelhead and Chinook salmon are analyzed below because those two species are the only species that would be at risk of genetic effects through the Skykomish summer steelhead hatchery program or the Sunset Falls trap and haul program. The Skykomish summer steelhead hatchery program is not expected to affect Chinook genetically because the two species do not interbreed.

Under all alternatives, adult ~~Skamania~~ESS are expected to return to the basin through 2025, though some would be removed by fisheries, at the hatchery racks, or at the Sunset Falls Fishway trap and not allowed to spawn in the wild. The genetic influence from the ~~Skamania~~ESS program through gene flow on the natural-origin steelhead populations in the analysis area would continue until the program is terminated (discussed in more detail under Alternative 1), though lessening over time as ~~Skamania~~ESS release numbers are reduced.

4.3.1.1 Alternative 1 (No Action/Termination)

As described above, under Alternative 1, the hatchery would discontinue use ~~Skamania~~ESS steelhead stock. As a result, not all adult ~~Skamania~~ESS hatchery fish would be removed (i.e., minor straying is likely), so genetic influence from the current ~~Skamania~~ESS program on the winter-run and summer-run natural-origin steelhead populations in the analysis area would continue through 2025, though lessening over time as release numbers are reduced. After 2025, once adult hatchery-origin ~~Skamania~~ESS stop returning to the basin, interbreeding with the ~~Skamania~~ESS stock fish would not occur, though the substantial ~~Skamania~~ESS genetic signature ~~in the DNA~~ of the natural summer-run steelhead populations resulting from the past use of ~~Skamania~~ESS broodstock will persist.

Under Alternative 1, the operation of Sunset Falls trap would be limited to the goal of trapping Chinook salmon for the Chinook salmon hatchery program.[16] ~~The hauling of fish~~WDFW would no longer transport fish above the falls ~~would terminate~~. Because trapping of Chinook salmon broodstock would continue, the PNI benefit to Chinook (i.e., using the trapping operation to increase pNOB) of the operation would continue, but overall, the genetic and demographic health of Chinook salmon would be reduced due to the reduced amount of habitat that would not be available to the population. Reducing available habitat would constrain the population production, and the smaller size of the naturally produced component of the population would proportionately increase pHOS and potentially decrease effective population size.

Summer-run steelhead would be affected similarly to Chinook salmon because of reduced available habitat, but the genetic situation in terms of domestication would worsen on a short-term basis, as returning ~~Skamania~~ESS fish would no longer be removed from the population at Sunset Falls.

Therefore, compared to current conditions, genetic effects on Chinook salmon would be slight but detectable, resulting in Alternative 1 having low negative genetic effects on the Chinook salmon population because the negative effect of ceasing the trap and haul operation outweighing the continued benefit of being able to trap natural-origin fish for broodstock. Also, relative to current conditions, Alternative 1 is expected to have readily apparent positive effects on steelhead, resulting in an overall medium positive genetic effect on steelhead populations in the analysis area because negative effects of the ESS hatchery programs would no longer be ongoing, which would outweigh the negative impacts of natural origin steelhead not having access to habitat above Sunset Falls.

4.3.1.2 Alternative 2 (Proposed Action)

The new Skykomish summer steelhead hatchery program in Alternative 2 would supplement both the South Fork and North Fork summer steelhead populations with fish considerably less genetically influenced by the ~~Skamania~~ESS and likely considerably more locally adapted than the current North Fork

[16] The current use of the Sunset Falls trap by the Chinook salmon hatchery program was analyzed in (NMFS 2017a).

population. The Skykomish summer steelhead hatchery program proposed under Alternative 2 would use natural-origin South Fork Skykomish summer-run steelhead as broodstock. In addition, ~~once~~if agreed-to in the ~~program is established (i.e., during phase two)~~workgroup consisting of the co-managers and NMFS, the applicants can begin transplanting 250 Skykomish summer steelhead hatchery-origin fish annually into the North Fork Skykomish River~~with the potential for transplanting a maximum of 500 steelhead if appropriate after evaluating effects on bull trout~~[17], effectively supplementing this depressed population.

~~The expected high gene flow through deliberate supplementation releases from integrated and locally adapted broodstock should lessen domestication impacts of past Skamania returns in the North Fork Skykomish River population compared to Alternative 1. This benefit stems from both increased gene flow from the presumably less-domesticated South Fork Skykomish steelhead population as broodstock, and from increased population size, which should allow natural selective forces to work more effectively. Once it becomes established, very low gene flow would be expected between the new summer-run steelhead hatchery program, and the Pilchuck winter-run, Snoqualmie winter-run, and Tolt summer-run steelhead populations because of lack of spatial overlap. The~~If outplanting Skykomish summer steelhead hatchery-origin adult steelhead to the North Fork Skykomish River occurs, NMFS anticipates that there would potentially be both positive and negative genetic effects, including similar effects as discussed for the hatchery program below. In the biological opinion for this Skykomish summer steelhead hatchery program (NMFS 2021b), NMFS used effective population size as a metric to understand whether the Skykomish summer steelhead hatchery program would depress effective size. Using modeling, NMFS concluded that with outplanting, the effective population size increased between 19 percent and 48 percent (Section 2.5.2.2 in the biological opinion). Based on these results, NMFS concluded that the proposed program will not depress the effective population size of Skykomish summer steelhead, either the South Fork or the South Fork-North Fork composite.

In addition, as stated above, NMFS and co-managers anticipate that the use of natural-origin fish in the new Skykomish summer steelhead hatchery program will likely allow for local adaptation compared to the ESS program because of its history, where Columbia Basin steelhead were introduced. Therefore, the

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[17] ~~There is an ongoing Section 7 ESA consultation by the USFWS for effects of the proposed action on bull trout.~~ USFWS finalized a Section 7 ESA consultation for effects of the proposed action on bull trout in April 2021 (USFWS 2021).

new program that would operate under Alternative 2 would be a demographic and genetic benefit to summer-run steelhead for the reasons above.

In the 2021 biological opinion (NMFS 2021c), NMFS estimated past and future gene flow for winter-run steelhead in Pilchuck River and summer-run fish in the Tolt, and North Fork Skykomish River. The estimates were based on potential gene flow from the new Skykomish summer steelhead hatchery program to the other populations through straying, and also estimated the gene flow from the potential outplanting portion of the program. For Pilchuck River winter steelhead, the level of gene flow is expected to be less than that into the Snohomish/Skykomish winter steelhead population because these populations have similar numbers of natural-origin spawners and similar spawn timing and would have smaller numbers of hatchery-origin spawners (due to the distance from the release site) compared to the Snohomish/Skykomish winter population. NMFS estimated pHOS for the Tolt River and North Fork Skykomish River summer-run populations at 0.02 and 0.16, respectively (Table 12 from (NMFS 2021b)). In addition, PNI for the South Fork Skykomish River summer-run steelhead would be greater than 0.67 under the new Skykomish summer steelhead hatchery program.

In the biological opinion (NMFS 2021b), NMFS evaluated different scenarios of the program and estimated PNI for the South Fork Skykomish population. Based on those findings, NMFS expects the PNI to range from 0.57 to 0.70 for the program. Because the PNI is primarily a function of pHOS and pNOB, hatchery operations can be adjusted to reach a PNI level of 0.67 (or greater) by adjusting the number of natural-origin steelhead incorporated into the broodstock and/or removing hatchery-origin steelhead at Sunset Falls. If Skykomish summer steelhead hatchery-origin fish are selectively removed at the Sunset Falls trap, with only enough transported upstream of Sunset Falls to replace the natural-origin fish removed for broodstock, and pNOB is 50%, the PNI will increase to 0.65.

During years of low return (as defined by having less than 250 natural-origin summer steelhead predicted to reach Sunset Falls), the program would be managed to allow up to 250 summer steelhead (natural- and hatchery-origin combined) to be passed above Sunset Falls, while maximizing the natural-origin broodstock (up to 30 percent of the returns to Sunset Falls). To buffer against the gene flow effects from these low return years, PNI will be managed to achieve a value higher than 0.67 during the years of good returns.

There is potential for gene flow from the Skykomish summer steelhead hatchery program to the Snohomish/Skykomish winter-run population due to possible spatial and temporal overlap during spawning. The new program could have a negative genetic effect on Skykomish winter-run steelhead because it is likely to increase gene flow from summer-run steelhead into that population relative to that which would occur under Alternative 1, possibly increasing from the recent level of 2% up to 5%, based on our DGF modeling ~~(Haggerty 2020b).~~(Haggerty 2020b; NMFS 2021b). Because the new program should have a more natural spawning timing than the artificially advanced timing of the ~~Skamania~~ESS stock, gene flow from the program into the Snohomish/Skykomish winter steelhead population may be higher compared to the previous ESS program. At present it is unknown what natural gene flow levels are between steelhead run-timing ecotypes, but research is underway in several labs on the genetic basis of steelhead run timing (Ford et al. 2020), so more realistic gene flow guidelines may be forthcoming as the program develops. Gene flow from the new program into the winter steelhead population would be monitored by tissue sampling as part of a larger WDFW steelhead genetic monitoring plan (Warheit et al. 2021).

Similar to Alternative 1, the genetic ~~Skamania~~ESS footprint from past gene flow would continue despite expected low contemporary levels of gene flow under Alternative 2.

Under Alternative 2, the Sunset Falls trap and haul program would continue to operate, collect broodstock, ~~pass~~transport fish upstream, and remove hatchery-origin steelhead as necessary. For Chinook salmon, the current genetic and demographic condition of the population in terms of upstream occupancy would continue, in addition to the PNI benefits of the ~~trapping~~trap and haul operation. For steelhead, the ~~trapping~~trap and haul operation would allow collection of broodstock for the new Skykomish summer steelhead hatchery program, which should genetically benefit Skykomish summer-run steelhead throughout the basin (as described above). As with Alternative 1, Alternative 2 would have a substantial genetic benefit from continuing to remove the returning ~~Skamania~~ESS fish, limiting additional gene flow from this domesticated stock.

The proposed program would initially use only natural-origin broodstock collected from Sunset Falls Trap and Haul Fishway, with strict limitations on the proportion of the natural-origin ~~run~~summer steelhead that can be used, but once Skykomish summer steelhead hatchery-origin fish begin returning the broodstock will be a mixture of natural-origin and hatchery-origin fish. ~~Once the program is established,~~

~~the PNI[18] resulting from the hatchery program and the Sunset Falls trap and haul program under Alternative 2 is expected to be approximately 51 percent if no hatchery-origin fish in excess of broodstock needs are removed at Sunset Falls (Haggerty 2020b). If concerns about fish handling can be solved by improved trapping protocols to allow additional hatchery-origin fish to be removed at Sunset Falls, our modelling indicates that PNI could rise to 65 percent.~~

Compared to Alternative 1, Alternative 2 is expected to have low positive genetic effect on natural-origin Chinook salmon relative to Alternative 1 because the trap and haul program can potentially benefit Chinook salmon abundance and distribution. Compared to Alternative 1, Alternative 2 is expected to have low positive effects on summer-run steelhead genetics derived from supplementing the demographically depressed ~~and presumed highly domesticated~~ North Fork Skykomish steelhead population with integrated, locally-adapted fish, although there may be negative impacts to the Snohomish/Skykomish winter steelhead population from higher levels of gene flow with integrated Skykomish summer steelhead.

4.3.1.3 Alternative 3 (Tolt River Source)

Alternative 3 is identical to Alternative 2 except that the original broodstock source would be Tolt River summer-run steelhead rather than the South Fork Skykomish summer-run steelhead, and phase 1 rearing and release would be from the Tokul Creek hatchery.

The genetic impacts of Alternative 3 are a mix of positive and negative effects compared to Alternative 1. Under phase one of Alternative 3, the program would collect natural-origin broodstock from the Tolt summer-run steelhead population, and potentially collect eggs by redd pumping if insufficient broodstock were available. The Tolt population is small, and further reducing a small population poses genetic risk through low effective size as well as demographic risk to the Tolt population that Alternative 1 does not. On the other hand, the returning hatchery fish that spawn naturally may provide benefits of population increase due to supplementation and the lessening of ~~Skamania~~ESS influence to the Tolt summer-run steelhead population, which would not occur under Alternative 1. However, because of the new hatchery

~~[18] In a previous biological opinion on salmon hatchery programs in the Snohomish basin ((NMFS 2017a)), we discussed two PNI metrics, PNI_D and PNI_C. The former is computed using a demographic estimate of pHOS, whereas the latter adjusts demographic pHOS by the reproductive success of hatchery-origin fish relative to natural-origin fish (e.g., Withler et al. (2018)). In this document, all presented PNI values are demographically based, so can be considered PNI_D.~~

program, gene flow from summer-run steelhead into the depressed Snoqualmie winter-run steelhead program would increase over the levels that would occur under Alternative 1.

Under phase two of Alternative 3, the hatchery operation would be moved to facilities on the Skykomish River, and the program would be operated identically to Alternative 2. As in the case of Alternative 2, the demographic and genetic change caused by the hatchery program could have a negative genetic effect on Skykomish winter-run steelhead in that it is likely to increase gene flow from summer-run steelhead into that population relative to what would occur under Alternative 1. However, the continuing impact would be less than the initial impact occurring under phase 1 because the returning Tolt-origin hatchery fish would be mixed in broodstock with South Fork Skykomish fish collected at Sunset Falls.

The negative genetic impacts to steelhead under phase 2 of Alternative 3 would be greater than phase 2 of Alternative 2 in three respects because of the use of Tolt steelhead as the founders of the program:

1. Because the Tolt population has been ~~moreheavily~~ impacted more by Skamania releases compared to the South Fork Skykomish population (i.e., donor under Alternative 2), the program under Alternative 3 would have less of the beneficial effect of reducing domestication caused by past influx of Skamania genes compared to the new proposed program under Alternative 2.
2. The North Fork Skykomish and Tolt summer-run steelhead populations, which inhabit different major tributaries of the Snohomish basin (Skykomish and Snoqualmie, respectively) are considered to be two separate demographically independent populations (Hard et al. 2015). The release of Tolt-origin steelhead into the North Fork Skykomish under Alternative 3 would reduce the genetic distinction between the two populations and may outweigh any demographic benefit from ~~supplementation~~outplanting to the North Fork Skykomish population, which would not be the case under Alternative 2.
3. The Tolt summer-run steelhead population likely interacts very little under present conditions with the Skykomish winter-run steelhead population, so using Tolt summer-run steelhead as the donor population would increase the gene flow from the Tolt summer-run steelhead population to the Skykomish winter-run steelhead population compared to natural conditions.

Under Alternative 2, very low gene flow would be expected between the new Skykomish summer-run steelhead hatchery program and the Pilchuck winter-run, Snoqualmie winter-run, and Tolt summer-run steelhead populations during phase 2. The previously mentioned gene flow impact on the Skykomish winter-run steelhead population would continue but would be lessened relative to phase 1 due to the blending of the Tolt based hatchery stock with the South Fork Skykomish summer-run steelhead population.

Under phase 1 of Alternative 3, the Sunset Falls trap and haul program, removal of hatchery-origin fish as necessary and collection of Chinook salmon as broodstock would continue. Under phase two, the trapping would also include natural-origin steelhead for broodstock. Under both phases, the hauling of salmon and steelhead would continue. As such, the effect of the trap and haul program would be the same as Alternative 2 for Chinook salmon. For steelhead, the trap and haul program allows for a similar genetic benefit as Alternative 2 (i.e., more beneficial than Alternative 1); however, the benefit is slightly less because the source of hatchery-origin fish (i.e., Tolt River) is more heavily influenced than the fish from the South Fork Skykomish River, as discussed above.

Compared to Alternative 1, Alternative 3 is expected to have low positive genetic effects on Chinook salmon because the trap and haul program benefits Chinook salmon abundance and distribution. When the negative genetic effect on the North Fork Skykomish steelhead population potentially interbreeding with hatchery steelhead of Tolt River origin and the positive abundance and distribution effects effect that may occur on the other steelhead populations or from the trap and haul program are integrated, the overall effect on steelhead is low positive under Alternative 3.

4.3.1.4 Alternative 4 (Reduced Production)

Under Alternative 4, the current ~~Skamania~~ESS program would be phased out similar to Alternative 1, and a new reduced South Fork Skykomish River summer-run steelhead hatchery program would be developed. Comparison of the genetic consequences of the reduced program relative to those of the full program (Alternative 2) is complicated. Because of the reduced production, the expected gene flow impact on other populations in the basin would be approximately 45 percent of that expected under Alternative 2. In particular, the expected gene flow into the Snohomish/Skykomish winter steelhead would likely not exceed 2.5 percent. However, under Alternative 4, the genetic benefit in terms of increased population size creating greater opportunity for adaptation for the North Fork Skykomish summer steelhead population expected under Alternative 2 would be similarly decreased. On the positive side, the reduced program itself would have a smaller domesticating influence on the North Fork Skykomish population. Whereas under Alternative 2 the expected PNI would range from ~~51~~57 percent to ~~65~~70 percent, depending on the number of Skykomish summer steelhead hatchery-origin fish removed at the Sunset Falls trap, the reduced program would be expected to achieve a PNI of 75 to 79 percent

(Haggerty 2020a) because the reduced production requirement would allow the broodstock to consist only of natural-origin fish.

The genetic impacts of the Sunset Falls trap and haul program operation on Chinook salmon would be the same as Alternative 2 because the program would operate the same as Alternative 2. However, because less hatchery steelhead would be produced under Alternative 4, there would be less hatchery steelhead being passed up above Sunset Falls; therefore, the genetic risk and the population increase benefits from ~~supplementation~~the potential outplanting portion of the program would be less than that described under Alternative 2 for steelhead.

In summary, Alternative 4 is expected to have low positive genetic effects on Chinook salmon compared to Alternative 1 because the benefits of operation of the trap and haul program would be similar to Alternative 2. Alternative 4 would have negligible positive genetic effects on steelhead relative to Alternative 1 because the trap and haul program would continue to haul natural-origin and hatchery-origin steelhead above Sunset Falls. However, this benefit is smaller than that compared to Alternative 2 because there would be no benefits from the ~~supplementation~~potential outplanting of fish into the North Fork Skykomish River and a reduced production level for the hatchery program provides a smaller benefit compared to Alternative 2.

4.3.2 Masking

As described in Section 3.3.5.2, Masking, there is effectively no potential for masking effects from the ~~Skamania~~ESS programs in the analysis area under current conditions because fish are marked and thus distinguishable from natural-origin fish.

Similarly, no masking effect would occur under any of the alternatives because Skykomish summer steelhead hatchery-origin steelhead would be marked.

4.3.3 Competition and Predation

Discountable Effects

The analysis of competition and predation impacts focuses on identifying risks of these impacts because the actual impacts themselves are not measurable. A high risk of competition or predation occurring does not necessarily result in a high level of impacts to populations, depending on the population abundance and resilience to these stressors. When risk of these stressors is mitigated by a lack of temporal or spatial overlap between natural-origin fish and hatchery-origin fish, or other factors like orders of magnitude differences in relative abundance between hatchery-origin (low abundance) and natural-origin (high abundance) fish, the potential effects of competition or predation may be discountable.

~~In the case of Skykomish hatchery-origin steelhead, hatchery-origin juvenile fish would be volitionally released, meaning the fish would only leave the hatchery if it is ready to out-migrate and travel quickly downstream toward the ocean. Thus, risks from the hatchery-origin fish residualizing in the river to compete and prey with natural-origin juvenile fish are minimal, and the effect of juvenile competition and predation from the hatchery-origin fish that do not out-migrate would likely be discountable.~~

For adult competition, hatchery-origin steelhead that spawn in the wild may create spawning site competition or redd superimposition effects on Chinook salmon and summer-run and winter-run steelhead, but these effects are discountable for coho, chum, and pink salmon for the types of reasons stated in Chapter 3. Adult competition effects on Chinook salmon and summer-run and winter-run steelhead are limited to effects from the hatchery program because adult competition above Sunset Falls (trap and haul program) and the North Fork Skykomish River (potential outplanting program) is not likely due to the ample availability of spawning habitat, relative number of spawners, and species composition in these areas.

See Chapter 3, Section 3.3.5.3, Competition and Predation, and Appendix A - Competition and Predation Literature Summary and Qualitative Evaluation Method for specific information about differences in spatial and temporal patterns, relative abundances, and spawning habitat preference differences that result in the discountability of spawning site and redd superimposition effects for the Alternatives considered in this EA. Because they are otherwise discountable, spawning site competition and redd superimposition will not be discussed further in Chapter 4 for coho, chum, and pink salmon.

Qualitative Evaluation Method

The application of the Qualitative Evaluation Method (QEM) criteria for juvenile competition and predation analysis for each species under each of the alternatives is described in Appendix A, Section 3, Evaluation Method. Risk levels of competition and predation analyzed in Appendix A cannot necessarily be directly translated as impact levels because a large risk may not translate to much impact on populations and a small risk, depending on the population dynamics. Instead, risk levels are interpreted in this section relative to the anticipated impacts, per the definitions provided at the beginning of Chapter 4.

For the same reasons as described in Chapter 3, competition and predation on natural-origin salmon and steelhead juveniles by hatchery-origin steelhead in the estuaries and nearshore marine waters is not likely to occur and will not be considered any further in Chapter 4 (See Appendix A - Competition and Predation Literature Summary and Qualitative Evaluation Method for additional information on competition and predation in nearshore and marine waters).

Under Alternatives 2, 3, and 4, hatchery-origin steelhead smolts would be released volitionally ~~and for the purpose of the analysis here, the assumption is that up to ten percent of the juveniles reared each year would not leave the hatchery to incorporate the effects of 2-year-old smolts; these smolts would be held over an additional year and released as 2-year-olds at a larger size. As explained in Appendix A, Section 3.1.3 (Temporal Overlap), hatchery steelhead would be volitionally released;~~because there is little information on how quickly they may leave the rearing ponds during the release period, this analysis includes two scenarios. Scenario A assumes all fish leave at once, at the beginning of the release period (i.e., April 15). Scenario B assumes they all leave at once, at the end of the release period (i.e., May 31). The most likely scenario is between these two extremes, so the average risk reduction between the two scenarios is applied in the risk reduction exercise in the QEM (Appendix A - Competition and Predation Literature Summary and Qualitative Evaluation Method).

4.3.3.1 Chinook Salmon

Alternative 1 (No Action)

Under Alternative 1, ongoing juvenile competition and predation risks listed in Section 3.3.5.3, Competition and Predation and described in Appendix A - Competition and Predation Literature Summary and Qualitative Evaluation Method would completely cease by 2023 as the program gets phased out. Ongoing adult competition and redd superimposition between hatchery-origin steelhead and natural-origin Chinook salmon would also cease after the last adult return under Alternative 1. The termination of the hatchery program would provide a low beneficial impact for Chinook salmon under Alternative 1 because it will eliminate the small adverse impacts for juvenile predation and competition and minimal adverse impacts from redd superimposition in Section 3.3.5.3 Competition and Predation.

Alternative 2 (Proposed Action)

Juvenile Competition in Freshwater

Considering the default unadjusted high risk level for competition among outmigrating hatchery-origin steelhead and natural-origin Chinook salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted risk level of competition between hatchery-origin steelhead and natural-origin Chinook salmon juvenile life-stages in freshwater under Alternative 2 would be ~~close to none~~minimal (Table 7, Appendix A). The reduction in risk from the default unadjusted risk level is primarily due to hatchery-origin steelhead being larger than natural-origin Chinook salmon, low relative abundance of hatchery-origin steelhead, and low temporal overlap between hatchery-origin steelhead and natural-origin Chinook salmon juveniles (Table 7, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin Chinook salmon juveniles is low because the residualism rate is expected to be low (see footnote 11).

Juvenile Predation in Freshwater

Considering the default unadjusted unknown risk level for predation on natural-origin Chinook salmon by steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted risk level of predation on natural-origin Chinook salmon juvenile life-stages by hatchery-origin steelhead in freshwater under Alternative 2 would be minimal, even if the default risk level were high. The reduction in risk is primarily due to low relative abundance of hatchery-origin steelhead, and low temporal overlap between hatchery-origin steelhead and natural-origin Chinook salmon juveniles (Table 21, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin Chinook salmon juveniles is low because the residualism rate is expected to remain low (see footnote 11).

Adult Competition: spawning site competition

As discussed in Appendix A - Competition and Predation Literature Summary and Qualitative Evaluation Method, factors to consider in determining spawning site competition risks include spatial and temporal overlap, relative abundance, and habitat availability. Because hatchery-origin steelhead and Chinook salmon would not overlap in spawn timing under Alternative 2, spawning site competition would not occur between these two species.

Adult competition: redd superimposition

Factors to consider in determining redd superimposition risks include spatial overlap, the sequential timing of spawning, relative abundance, and habitat availability. As discussed in Appendix A - Competition and Predation Literature Summary and Qualitative Evaluation Method, the difference in substrate preferences between the steelhead that could spawn in the wild and Chinook salmon (Table 31, Appendix A) is likely insufficient to provide for substantial spatial isolation, and therefore redd superimposition is plausible due to the sequential timing of spawning (Table 31, Appendix A). However, the number of returning Skykomish summer steelhead hatchery-origin adults are expected to be similar to the current program, which would result in less than 1,000 Skykomish summer steelhead hatchery-origin adults in the analysis area including those transplanted in North Fork Skykomish River. Even during the years with the transplanted adults, the relative abundance of hatchery-origin steelhead (less than 1,000 hatchery-origin adults) compared to natural-origin Chinook salmon (2006-2018 average of 3,273) (Table 32, Appendix A) is likely not high enough to result in substantial redd superimposition with Chinook salmon in the analysis area. Additionally, a large portion of the Chinook salmon fry would have emerged from the gravel (Table 18, Appendix A) by the time steelhead show up to spawn (Table 30, Appendix A).

Summary

When competition and predation effects are considered in combination with life history, abundance, and habitat availability, compared to Alternative 1, Alternative 2 would result in a low adverse effect on the competition and predation risk level for Chinook salmon based on minimal to small juvenile competition and predation risks and minimal adult competition risks.

Alternative 3 (Tolt River Broodstock)

Under phase one Alternative 3, release of juvenile summer-run steelhead at Reiter Ponds and Wallace River Hatchery would cease as under Alternative 1, and there would be release of up to 28,000 smolts at Tokul Creek Hatchery. In considering juvenile competition and predation using the QEM, relative size and the temporal overlap are expected to be the same as Alternative 2. But because only up to 28,000 smolts would be released under Phase one of Alternative 3, the relative abundance of hatchery-origin steelhead (less than 1,000 hatchery-origin adults) compared to the expected abundance of natural-origin Chinook salmon juvenile would be even lower than under Alternative 2, thus reducing the competition and predation risk. In addition, the population that would primarily be affected under phase one is Snoqualmie River population because of the release location.

For adult competition (spawning site competition and redd superimposition) in phase one, the factors considered under Alternative 2 apply, though the Snoqualmie River Chinook population would primarily be affected because the hatchery-origin fish are expected to mostly return to the Tolt River. In addition, because the number of smolts released under phase one is substantially lower than Alternative 2, the relative abundance of hatchery-origin steelhead (fewer than 1,000 hatchery-origin adults) compared to natural-origin Chinook salmon is low enough to rule out spawning site competition and redd superimposition with Chinook salmon during phase one.

Under phase two of Alternative 3, the competition and predation effects resulting from juvenile and adult hatchery steelhead described under phase one would cease because smolts would not be released from Tokul Creek Hatchery. Instead, the releases and the adult transplanting would occur at Reiter Ponds and the North Fork Skykomish River, respectively, as described under Alternative 2. Therefore, juvenile competition and predation effects and adult competition under phase two of Alternative 3 would be the same as under Alternative 2.

Because phase one of Alternative 3 is limited in duration (i.e., 8 years), while phase two is of unlimited duration, the effects described under phase two are the long-term effects that inform the consequences of this alternative. Therefore, compared to Alternative 1, Alternative 3 would result in a low adverse effect on the competition and predation risk level for Chinook salmon based on the estimated minimal to small risk level of hatchery-origin juveniles competing with and preying on juvenile Chinook salmon and the minimal likelihood of adult competition.

Alternative 4 (Reduced Production)

Under Alternative 4, summer-run steelhead hatchery production would reach up to 56,000 smolts (i.e., little less than half of the production of Alternative 2). Although the outcome of applying the criteria that reduce juvenile competition and predation risks for Chinook salmon under Alternative 4 are the same as Alternative 2, the magnitude of competition and predation effects under Alternative 4 would decrease by an amount of about half of that under Alternative 2 because the number of juveniles released under this alternative is roughly half of that released under Alternative 2. For the same reason, the returning adults are likely to be about half of that returning under Alternative 2. Compared to Alternative 1, juvenile competition and predation and adult competition effects between hatchery-origin steelhead and natural-origin Chinook salmon under Alternative 4 would be about half of that under Alternative 2, resulting in a negligible adverse effect for Chinook salmon relative to Alternative 1.

4.3.3.2 Steelhead

Alternative 1 (No Action)

Under Alternative 1, ongoing juvenile competition and predation risks described in Section 3.3.5.3, Competition and Predation would completely cease by 2023, as the program gets phased out. Ongoing adult competition between hatchery-origin steelhead and natural-origin steelhead would also cease after the last adult return under Alternative 1. Therefore, the termination of the steelhead hatchery program under Alternative 1 would result in low beneficial impacts on steelhead because it will eliminate the small adverse impacts on the risk level for juvenile competition and predation and minimal adverse impacts on the risk level of redd superimposition described in Section 3.3.5.3, Competition and Predation.

Alternative 2 (Proposed Action)

Juvenile Competition in Freshwater

Considering the default unadjusted high-risk level for competition among outmigrating hatchery-origin steelhead and natural-origin steelhead (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted risk level of competition between hatchery-origin steelhead and natural-origin steelhead juvenile life-stages in freshwater under Alternative 2 would be minimal. This adjusted risk level of competition is minimal because of a reduction of risk level category due primarily to hatchery-origin steelhead being larger than natural-origin steelhead, low relative abundance of hatchery-origin steelhead, and low temporal overlap between hatchery-origin steelhead and natural-origin steelhead juveniles (Table 9, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to remain low (see footnote 11).

Juvenile Predation in Freshwater

Considering the default unadjusted unknown risk level for predation on natural-origin steelhead by outmigrating hatchery-origin steelhead (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 4, Appendix A), the adjusted risk level of predation on natural-origin steelhead juvenile life-stages by hatchery-origin steelhead in freshwater under Alternative 2 would be close to none, even if the default risk level were high. This adjusted predation risk level is close to none because of a reduction of risk level category due primarily to ~~lack of size differences between yearling/2-year-old steelhead and other life-stages,~~ low relative abundance of hatchery-origin steelhead, and low temporal overlap between hatchery-origin steelhead and natural-origin steelhead juveniles (Table 23, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to remain low (see footnote 11).

Adult Competition: spawning site competition and redd superimposition

As discussed in Appendix A, Section 4.3, factors to consider in determining adult competition risks include spatial and temporal overlap, the sequential timing of spawning, relative abundance, and habitat availability. While natural-origin steelhead and Skykomish summer steelhead hatchery~~-origin summer-run steelhead~~ adults would likely overlap substantially, the hatchery-origin steelhead are intended to spawn in the wild to provide a demographic boost to the native summer-run steelhead population in the Skykomish River Basin. Therefore, the competition that may occur is not considered to be a risk for the summer-run steelhead population because the level is not above what is expected from the natural steelhead competing with each other.

Because natural-origin winter-run steelhead and Skykomish summer steelhead hatchery~~-origin summer-run steelhead~~ adults would likely only minimally overlap, adult competition between hatchery-origin steelhead and winter-run natural-origin steelhead is also only minimal under Alternative 2.

Summary

When competition and predation effects are considered in combination with described life history, abundance, and habitat use and availability, compared to Alternative 1, Alternative 2 would result in a low adverse effect on the competition and predation risk level for steelhead, based on the minimal risk from Skykomish summer steelhead hatchery-origin juveniles competing with and close to no risk of preying on juvenile steelhead and minimal adult competition with winter-run steelhead.

Alternative 3 (Tolt River Broodstock)

Under phase one Alternative 3, release of juvenile summer-run steelhead at Reiter Ponds and Wallace River Hatchery would cease as under Alternative 1, and there would be release of up to 28,000 smolts at Tokul Creek Hatchery. In considering juvenile competition and predation using the QEM, relative size and the temporal overlap are expected to be the same as Alternative 2. But because only up to 28,000 smolts would be released under Phase one of Alternative 3, the relative abundance of hatchery-origin steelhead compared to the expected abundance of natural-origin steelhead juveniles would be lower than under Alternative 2. In addition, the population that would primarily be affected under phase one is Tolt River summer-run population because of the release location.

For adult competition (spawning site competition and redd superimposition) in phase one, the factors considered under Alternative 2 apply, though the Tolt River steelhead population would primarily be affected because the hatchery-origin fish are expected to mostly return to the Tolt River. In addition, because the number of smolts released under phase one is substantially lower than Alternative 2, the relative abundance of hatchery-origin steelhead compared to natural-origin summer-run steelhead adults is low enough to rule out result in spawning site competition and redd superimposition with steelhead during phase one.

Under phase two of Alternative 3, the competition and predation effects resulting from juvenile and adult hatchery steelhead described under phase one would cease because smolts would not be released from Tokul Creek Hatchery. Instead, the releases and the adult transplanting would occur at Reiter Ponds and the North Fork Skykomish River, respectively, as described under Alternative 2. Therefore, juvenile competition and predation effects and adult competition under phase two of Alternative 3 would be the same as under Alternative 2. Because phase one of Alternative 3 is limited in duration (i.e., 8 years), while phase two is of unlimited duration, the effects described under phase two are the long-term effects that inform the consequences of this alternative. Therefore, compared to Alternative 1, Alternative 3 would result in a low adverse effect on the competition and predation risk level for steelhead based on the minimal risks from hatchery-origin juveniles competing with and preying on juvenile steelhead and the minimal likelihood of adult competition.

Alternative 4 (Reduced Production)

Under Alternative 4, summer-run steelhead hatchery production would reach up to 56,000 smolts (i.e., little less than half of the production of Alternative 2). Although the criteria that reduce juvenile competition and predation risk for steelhead under Alternative 4 are the same as Alternative 2, the magnitude of competition and predation effects under Alternative 4 would decrease by an amount of about half of that under Alternative 2 because the number of juveniles released under this alternative is roughly half of that released under Alternative 2. For the same reason, the returning adults are likely to be about half of that returning under Alternative 2. Therefore, compared to Alternative 1, juvenile competition and predation and adult competition effects between hatchery-origin steelhead and natural-origin steelhead under Alternative 4 would be about half of that under Alternative 2, resulting in a negligible adverse effect on the competition and predation risk level for steelhead relative to Alternative 1

4.3.3.3 Coho Salmon

Alternative 1 (No Action)

Under Alternative 1, ongoing juvenile competition and predation risks described in Section 3.3.5.3, Competition and Predation would completely cease by 2023 as the program gets phased out. Ongoing adult competition between hatchery-origin steelhead and natural-origin coho salmon would also cease after the last adult return under Alternative 1. Therefore, the termination of the steelhead hatchery program under Alternative 1 would result in a low beneficial impact on the risk level of competition and predation for coho salmon because it will eliminate the small adverse impacts on the risk level for juvenile competition and predation described in Section 3.3.5.3, Competition and Predation.

Alternative 2 (Proposed Action)

Juvenile Competition in Freshwater

Considering the default unadjusted high risk level for competition among outmigrating hatchery-origin Skykomish summer steelhead and natural-origin coho salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted risk level of competition between hatchery-origin steelhead and natural-origin coho salmon juvenile life-stages in freshwater under Alternative 2 would be close to none. This adjusted risk level of competition is close to none because of a reduction of risk level category due primarily to the hatchery-origin steelhead being larger than coho salmon, low relative abundance of hatchery-origin steelhead, and small temporal overlap between hatchery-origin steelhead and natural-origin coho juveniles (Table 11, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to remain low (see footnote 11).

Juvenile Predation in Freshwater

Considering the default unadjusted unknown risk level for predation on natural-origin coho salmon by outmigrating hatchery-origin steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted risk level of predation on natural-origin coho salmon juvenile life-stages by hatchery-origin steelhead in freshwater under Alternative 2 would be small, even if the default risk level is unknown (Rensel et al. 1984). The adjusted risk level of predation is small because of a reduction in risk level category attributed to low relative abundance of hatchery-origin steelhead and small temporal overlap (Table 25 Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to remain low (see footnote 11).

Summary

When competition and predation effects are considered in combination with the described life history, abundance, and habitat use and availability, compared to Alternative 1, Alternative 2 would result in a low adverse effect on the competition and predation risk level for coho salmon based on close to none to small risks from Skykomish summer steelhead hatchery-origin juveniles competing with and preying on juvenile coho salmon.

Alternative 3 (Tolt River Broodstock)

Under phase one Alternative 3, release of juvenile summer-run steelhead at Reiter Ponds and Wallace River Hatchery would cease as under Alternative 1 and there would be release of up to 28,000 smolts at Tokul Creek Hatchery. In considering juvenile competition and predation using the QEM, relative size and the temporal overlap are expected to be the same as Alternative 2. But because only up to 28,000 smolts would be released under phase one of Alternative 3, the relative abundance of hatchery-origin steelhead compared to the expected abundance of natural-origin coho salmon juveniles would be lower than under Alternative 2. In addition, coho salmon in the Snoqualmie River would primarily be affected under phase one because of the release location.

Under phase two of Alternative 3, the competition and predation effects resulting from juvenile and adult hatchery steelhead described under phase one would cease because smolts would not be released from Tokul Creek Hatchery. Instead, the releases and the adult transplanting would occur at Reiter Ponds and the North Fork Skykomish River, respectively, as described under Alternative 2. Therefore, juvenile competition and predation effects under phase two of Alternative 3 would be the same as under Alternative 2. Because phase one of Alternative 3 is limited in duration (i.e., 8 years), while phase two is of unlimited duration, the effects described under phase two are the long-term effects that inform the consequences of this alternative. Therefore, compared to Alternative 1, Alternative 3 would result in a low adverse effect on the competition and predation risk level for coho salmon based on close to none to small risks from hatchery-origin juveniles competing with and preying on juvenile coho salmon.

Alternative 4 (Reduced Production)

Under Alternative 4, summer-run steelhead hatchery production would reach up to 56,000 smolts under Alternative 4 (i.e., a little less than half of the production of Alternative 2). Although the criteria that reduce juvenile competition and predation risks for coho salmon under Alternative 4 are the same as Alternative 2, the magnitude of competition and predation effects under Alternative 4 would decrease by about half of that under Alternative 2 because the number of juveniles released under Alternative 4 is roughly half of that released under Alternative 2. Therefore, compared to Alternative 1, juvenile competition and predation effects between hatchery-origin steelhead and natural-origin coho under Alternative 4 would be about half of that under Alternative 2, resulting in a negligible adverse effect on the competition and predation risk level for coho salmon relative to Alternative 1.

4.3.3.4 Chum Salmon

Alternative 1 (No Action)

Under Alternative 1, ongoing juvenile competition and predation risks described in Section 3.3.5.3, Competition and Predation, would completely cease by 2023 as the program gets phased out. Ongoing adult competition between hatchery-origin steelhead and natural-origin chum salmon would also cease after the last adult return under Alternative 1. Therefore, the termination of the steelhead hatchery program under Alternative 1 would result in low beneficial impact on the risk level of competition and predation for steelhead because it will eliminate the small adverse impacts on the risk level for juvenile competition and predation described in Section 3.3.5.3, Competition and Predation.

Alternative 2 (Proposed Action)

Juvenile Competition in Freshwater

Considering the default unadjusted low risk level for competition among outmigrating hatchery-origin Skykomish summer steelhead and natural-origin chum salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted potential risk of competition between hatchery-origin steelhead and natural-origin chum salmon fry in freshwater under Alternative 2 would be close to none. This adjusted risk of competition is close to none because of a reduction of risk level category due primarily to hatchery-origin steelhead being larger than chum salmon, low relative abundance of hatchery-origin steelhead, and small temporal overlap between hatchery-origin steelhead and natural-origin chum juveniles (Table 13, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to be low.

Juvenile Predation in Freshwater

Considering the default unadjusted high risk level for predation on natural-origin chum salmon fry by outmigrating hatchery-origin Skykomish summer steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted potential risk of predation on natural-origin chum salmon fry by hatchery-origin steelhead in freshwater under Alternative 2 would be minimal, because of small temporal overlap and low relative abundance of hatchery-origin steelhead (Table 27, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to be low.

Summary

When competition and predation effects are considered in combination with described life history, abundance, and habitat use and availability, compared to Alternative 1, Alternative 2 would result in a negligible adverse effect on the competition and predation risk level for chum salmon based on close to none to small risks from hatchery-origin juveniles competing with and preying on juvenile chum salmon.

Alternative 3 (Tolt River Broodstock)

Under phase one Alternative 3, release of juvenile summer-run steelhead at Reiter Ponds and Wallace River Hatchery would cease as under Alternative 1, and there would be release of up to 28,000 smolts at Tokul Creek Hatchery. In considering juvenile competition and predation using the QEM, relative size and the temporal overlap are expected to be the same as Alternative 2. But because only up to 28,000 smolts would be released under phase one of Alternative 3, the relative abundance of hatchery-origin steelhead compared to the expected abundance of natural-origin chum salmon juvenile would be lower than under Alternative 2. In addition, chum in the Snoqualmie River would primarily be affected under phase one because of the release location.

Under phase two of Alternative 3, the competition and predation effects resulting from juvenile and adult hatchery steelhead described under phase one would cease because smolts would not be released from Tokul Creek Hatchery. Instead, the releases and the adult transplanting would occur at Reiter Ponds and the North Fork Skykomish River, respectively, as described under Alternative 2. Therefore, juvenile competition and predation effects under phase two of Alternative 3 would be the same as under

Alternative 2. Because phase one of Alternative 3 is limited in duration (i.e., 8 years), while phase two is of unlimited duration, the effects described under phase two are the long-term effects that inform the consequences of this alternative. Therefore, compared to Alternative 1, Alternative 3 would result in a negligible adverse effect on the competition and predation risk level for chum salmon based on risks (ranging from small to close to none) from hatchery-origin juveniles competing with and preying on juvenile chum salmon.

Alternative 4 (Reduced Production)

Under Alternative 4, summer-run steelhead hatchery production would reach up to 56,000 smolts under Alternative 4 (i.e., a little less than half of the production of Alternative 2). Although the criteria that reduce juvenile competition and predation risks for chum salmon under Alternative 4 are the same as Alternative 2, the magnitude of competition and predation effects under Alternative 4 would decrease by about half of that under Alternative 2 because the number of juveniles released under Alternative 4 is roughly half of that released under Alternative 2. Therefore, compared to Alternative 1, juvenile competition and predation effects between hatchery-origin steelhead and natural-origin chum under Alternative 4 would be about half of that under Alternative 2, resulting in a negligible adverse effect on the competition and predation risk level for chum salmon relative to Alternative 1.

4.3.3.5 Pink Salmon

Alternative 1 (No Action)

Under Alternative 1, ongoing juvenile competition and predation risks described in Section 3.3.5.3, Competition and Predation, would completely cease by 2023 as the program gets phased out. Ongoing adult competition between hatchery-origin steelhead and natural-origin pink salmon would also cease after the last adult return under Alternative 1. Therefore, the termination of the steelhead hatchery program under Alternative 1 would result in negligible beneficial impact on the risk level of competition and predation for steelhead because it will eliminate the small adverse impacts on the risk level for juvenile competition and predation described in Section 3.3.5.3, Competition and Predation.

Alternative 2 (Proposed Action)

Juvenile Competition in Freshwater

Considering the default unadjusted low risk level for competition among outmigrating hatchery-origin Skykomish summer steelhead and natural-origin pink salmon (Table 2, Appendix A) and applying site-specific information for the criteria that reduce the competition risks (Table 4, Appendix A), the adjusted potential risk of competition between hatchery-origin steelhead and natural-origin pink salmon fry in freshwater under Alternative 2 would be close to none. This adjusted risk of competition is close to none because of a reduction of risk level category due primarily to hatchery-origin steelhead being larger than pink salmon, low relative abundance of hatchery-origin steelhead, and small temporal overlap between hatchery-origin steelhead and natural-origin pink salmon juveniles (Table 15, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to be low.

Juvenile Predation in Freshwater

Considering the default unadjusted high risk level for predation on natural-origin pink salmon fry by outmigrating hatchery-origin Skykomish summer steelhead (Table 3, Appendix A) and applying site-specific information for the criteria that reduce the risks (Table 5, Appendix A), the adjusted potential risk of predation on natural-origin pink salmon fry by hatchery-origin steelhead in freshwater under Alternative 2 would be minimal because of small temporal overlap and low relative abundance of hatchery-origin steelhead (Table 29, Appendix A). In addition, the risk from residualized hatchery-origin steelhead to natural-origin steelhead juveniles is low because the residualism rate is expected to be low.

Summary

When competition and predation effects are considered in combination with described life history, abundance, and habitat use and availability, compared to Alternative 1, Alternative 2 would result in a negligible adverse effect on the competition and predation risk level for pink salmon based risks (ranging from small to close to none) from hatchery-origin juveniles competing with and preying on juvenile pink salmon.

Alternative 3 (Tolt River Broodstock)

Under phase one Alternative 3, release of juvenile summer-run steelhead at Reiter Ponds and Wallace River Hatchery would cease as under Alternative 1, and there would be release of up to 28,000 smolts at Tokul Creek Hatchery. In considering juvenile competition and predation using the QEM, relative size and the temporal overlap are expected to be the same as Alternative 2. But because only up to 28,000 smolts would be released under phase one of Alternative 3, the relative abundance of hatchery-origin steelhead compared to the expected abundance of natural-origin pink salmon juvenile would be lower than under Alternative 2. In addition, pink salmon in the Snoqualmie River would primarily be affected under phase one because of the release location.

Under phase two of Alternative 3, the competition and predation effects resulting from juvenile and adult hatchery steelhead described under phase one would cease because smolts would not be released from Tokul Creek Hatchery. Instead, the releases and the adult transplanting would occur at Reiter Ponds and the North Fork Skykomish River, respectively, as described under Alternative 2. Therefore, juvenile competition and predation effects under phase two of Alternative 3 would be the same as under Alternative 2. Because phase one of Alternative 3 is limited in duration (i.e., 8 years), while phase two is of unlimited duration, the effects described under phase two are the long-term effects that inform the consequences of this alternative. Therefore, compared to Alternative 1, Alternative 3 would result in a negligible adverse effect on the competition and predation risk level for pink salmon based on close to none to small risks from hatchery-origin juveniles competing with and preying on juvenile pink salmon.

Alternative 4 (Reduced Production)

Under Alternative 4, summer-run steelhead hatchery production would reach up to 56,000 smolts under Alternative 4 (i.e., little less than half of the production of Alternative 2). Although the criteria that reduce juvenile competition and predation risks for pink salmon under Alternative 4 are the same as Alternative 2, the magnitude of competition and predation effects under Alternative 4 would decrease by an amount of about half of that under Alternative 2 because the number of juveniles released under this alternative is roughly half of that released under Alternative 2. Therefore, compared to Alternative 1, juvenile competition and predation effects between hatchery-origin steelhead and natural-origin pink under Alternative 4 would be about half of that under Alternative 2, resulting in a negligible adverse effect on the competition and predation risk level for pink salmon relative to Alternative 1.

4.3.4 Disease

Under all alternatives, health monitoring and the implementation of best management practices would take place as described in Chapter 3. The disease effects on salmon and steelhead under each of the alternatives are summarized in Table 15.

Table 15. Summary of disease effects on salmon and steelhead.

	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Salmon and Steelhead	Negligible positive	Negligible negative	Negligible negative	Negligible negative

Under Alternative 1, ~~Skamania~~ESS production would be phased out at Wallace River Hatchery and Reiter Ponds, but all other hatchery production in the analysis area would continue to operate as under current conditions. The ~~Skamania~~ESS production is only a small proportion of all hatchery fish produced in the analysis area, but the elimination of the program would reduce the likelihood of disease amplification in the natural-origin salmon and steelhead populations; therefore, there would be a negligible positive disease effect on natural-origin salmon and steelhead under Alternative 1 at Wallace River Hatchery and Reiter Ponds compared to current conditions.

Under Alternative 2, ~~Skamania~~ESS production would be phased out at Wallace River Hatchery and Reiter Ponds, but a new program of the same size as current conditions would be phased in. The disease risks are marginally higher than Alternative 1 because up to 116,000 more fish would be reared under this alternative. However, because Alternative 2 represents a small fraction of total hatchery production in the analysis area and because of the continuation of well-developed monitoring, diagnostic, prevention, and treatment programs already in place (WWTIT and WDFW 2006), it would result in negligible negative disease effect on natural-origin salmon and steelhead compared to Alternative 1.

Under phase one of Alternative 3, production would increase at Tokul Creek Hatchery compared to Alternative 1 but would be the same as Alternative 1 for Reiter Ponds and Wallace River Hatchery. Therefore, disease risks are greater at Tokul Creek Hatchery during phase one (8-year duration), though the risk is minimal through implementation of best management practices. Under phase two of Alternative 3 (long term), production would be the same for Tokul Creek Hatchery compared to Alternative 1 but would increase for Reiter Ponds and Wallace River Hatchery. Phase two of Alternative 3 would have the same disease risks as Alternative 2. Phase 2 of Alternative 3 is used to represent the effects of Alternative 3 because it is representative of long-term effects (after 8 years of phase one). Therefore, Alternative 3 would have a negligible negative disease effect on natural-origin salmon and steelhead compared to Alternative 1, which is the same as for Alternative 2.

Under Alternative 4, ~~Skamania~~ESS production would be phased out at Wallace River Hatchery and Reiter Ponds, but a new reduced program would be implemented. The disease risks are marginally higher under

Alternative 4 than under Alternative 1 because up to 56,000 more fish would be reared under this alternative. However, because Alternative 4 represents a very small fraction of total hatchery production in the action area, it would result in negligible negative disease effect on natural-origin salmon and steelhead compared to Alternative 1.

4.3.5 Population Viability

The ~~Skamania~~ESS program is not intended to provide viability benefits to any of the steelhead populations in the analysis area, as it is phased out under all alternatives. The population viability effects on steelhead under each of the alternatives are summarized in Table 16.

Table 16. Summary of population viability effects on salmon and steelhead.

	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Puget Sound Chinook Salmon ESU	Medium Negative	Medium Positive	Medium Positive	Medium Positive
Puget Sound Steelhead DPS	Low Positive	Medium Positive	Medium Positive	Low Positive

Under Alternative 1, the termination of the ~~Skamania~~ESS program would stop any continuation of past negative effects on population viability of Puget Sound Steelhead DPS in the analysis area relative to current conditions, and those past effects are expected to fade over time. However, the termination of the Sunset Falls trap and haul program would eliminate the benefit to population viability for both the Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS. Therefore, Alternative 1 would have a medium-negative effect for the Puget Sound Chinook Salmon ESU compared to current conditions because of the negative impacts resulting from the termination of the Sunset Falls trap and haul program. However, Alternative 1 would have a low positive population viability effect on the Puget Sound Steelhead DPS, compared to current conditions, because the positive impact of terminating the ~~Skamania~~ESS program would outweigh the negative impact of terminating the Sunset Falls trap and haul program.

Under Alternative 2, an integrated summer-run steelhead program would result in a benefit to Puget Sound Steelhead DPS population viability because the new steelhead hatchery program is intended to replace the negative past impacts of ~~Skamania~~ESS production with a program that would supplement natural production potentially increasing abundance and improving spatial structure. Under Alternative 2, the operation of the trap and haul program would have a positive effect on the viability of Chinook salmon and summer-run steelhead populations because providing additional spawning and rearing habitat for natural-origin fish is an overall benefit to population viability (i.e., abundance, spatial structure, diversity, and productivity), as discussed in Section 3.3.5.5, Population Viability In addition, steelhead population increase from the potential Skykomish summer steelhead hatchery production ~~supplementation~~outplanting into the North Fork Skykomish River may enhance the natural genetic diversity (i.e., an element of population viability) relative to Alternative 1 by increasing effective population size. It may also indirectly increase productivity in the North Fork Skykomish population by increasing ~~population size.~~abundance. Therefore, Alternative 2 would have medium-positive population viability effects on Puget Sound Chinook salmon compared to Alternative 1 because of the operation of the trap and haul program, and medium-positive for Puget Sound Steelhead DPS compared to Alternative 1 because of the operation of the trap and haul program and the potential of outplanting~~of~~ hatchery-origin summer-run steelhead into the North Fork Skykomish River.

Under phase one of Alternative 3, the hatchery production may increase the risk to genetic diversity, and therefore the risk to population viability, for the Tolt River steelhead population, though such risk is small. Under phase two of Alternative 3, the hatchery production would have nearly the same beneficial effect on Puget Sound Steelhead DPS population viability as Alternative 2. The difference would be the outbreeding effects from the initial use of the Tolt population. The operation of the Sunset Falls trap and haul program would also provide the same benefit as Alternative 2 to Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS. Therefore, Alternative 3 would have medium-positive and medium-positive population viability effects respectively for Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS compared to Alternative 1, which is the same as Alternative 2.

Under Alternative 4, an integrated summer-run steelhead program of reduced size would result in a benefit to Puget Sound Steelhead DPS population viability, though the benefit is smaller than Alternative 2 because of the size of the program. The program would not result in excess steelhead being outplanted into the North Fork Skykomish River, thereby limiting the benefit to abundance, productivity, and spatial structure in that population. In addition, population increase and genetic effects, positive and negative, from ~~supplementation~~the potential outplanting of adults into the North Fork Skykomish River, would be reduced compared to Alternative 2, though it is still an overall benefit compared to Alternative 1. The operation of the Sunset Falls trap and haul program would also provide the same benefit as Alternative 2 to Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS. Therefore, Alternative 4 would have medium-positive population viability effects for both the Puget Sound Chinook Salmon ESU and the Puget Sound Steelhead DPS, compared to Alternative 1, which is the same for Chinook salmon and less for steelhead than under Alternative 2.

4.3.6 Nutrient Cycling

The nutrient cycling effects on salmon and steelhead under each of the alternatives are summarized in Table 17.

Table 17. Summary of nutrient cycling effects.

Resource	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Salmon and Steelhead	Negligible negative	Negligible positive	Negligible positive	Negligible positive

Under Alternative 1, the termination of the summer-run steelhead program would reduce the number of carcasses in the analysis area compared to current conditions. The current contribution of 0.01 to 0.09 percent of phosphorus would eventually become zero, as the hatchery production ceases. In addition, ceasing the trap and haul program would prevent additional nutrients from being transported to areas above Sunset Falls. Therefore, Alternative 1 would have a negligible negative effect on nutrient cycling compared to current conditions because of a reduction in nutrient cycling.

There would be a minor incremental increase in nutrient cycling effects under Alternative 2 compared to Alternative 1 because release numbers and potential adult returns would be similar to current conditions. The distribution of the nutrients may vary from year to year[19], but the returning adults at the full production level are expected to contribute around 0.03 to 0.21 percent of phosphorus compared to all of the phosphorus contributed by salmon and steelhead in the Snohomish Basin (Patino 2020). Therefore, Alternative 2 would have low positive nutrients cycling effects compared to Alternative 1 because of an increase in nutrient cycling.

[19] The program would allow up to 250 adults to be outplanted annually ~~for eight years~~ in the North Fork Skykomish River ~~from 2025 to 2032.~~ if the work group that will be formed by the co-managers and NMFS agree that the North Fork steelhead population would benefit from the outplants. During ~~those 8~~ the years of outplanting, the North Fork Skykomish River would benefit from additional nutrients. After those eight years, a similar amount of phosphorus is expected to be contributed to the Snohomish Basin because the fish that would have been outplanted to the North Fork Skykomish River would be released above Sunset Falls through the trap and haul program.

Under phase one of Alternative 3, there would be additional nutrient cycling effects for Tokul Creek compared to Alternative 1 because of the initial production of steelhead at Tokul Hatchery and the potential increase in natural spawner abundance through hatchery supplementation. Under phase one of Alternative 3, nutrient cycling effects in the Skykomish River would be the same as under Alternative 1, because there would not be steelhead production in that basin. Under phase two of Alternative 3, nutrient cycling effects for Tokul Creek would be the same as under Alternative 1 because steelhead would not be released at Tokul Hatchery. Under phase two of Alternative 3, nutrient cycling effects in the Skykomish River would be the same as that described in Alternative 2. Therefore, Alternative 3 would have low positive nutrient cycling effects in the analysis area compared to Alternative 1, which is the same as under Alternative 2.

Under Alternative 4, summer-run steelhead production levels would be up to 56,000, which is roughly half of the current production, so these returning adults would contribute about half of the marine derived nutrients in the analysis area compared to current conditions. There would not likely to be enough hatchery-origin adults returning under this Alternative to plant up to 250 adults into the North Fork Skykomish River; therefore, this alternative would not have the beneficial nutrient cycling effects in the North Fork Skykomish River that is described under Alternatives 2 and 3. Compared to Alternative 1, Alternative 4 would have a negligible positive effect on nutrient cycling because there would still be an increased level of nutrients being contributed by the returning hatchery-origin adults.

4.3.7 Facility Operations

The facility operation effects on salmon and steelhead under each of the alternatives are summarized in Table 18. The discussion of ongoing effects of hatchery facility operations on salmon and steelhead in this section is restricted to the operation of weirs and traps for juveniles and adults, water intake structures, and facility maintenance activities. The effects also includes the effects of trapping and hauling salmon and steelhead.

Table 18. Summary of facility operation effects on salmon and steelhead.

	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Facility Operations	Negligible positive	Negligible negative	Negligible negative	Negligible negative

Under Alternative 1, the ~~Skamania~~ESS program and the trap and haul program at Sunset Falls would be terminated. However, the facility operations at Wallace River Hatchery and Reiter Ponds are likely to remain at similar levels as current conditions because the Chinook salmon and winter-run steelhead programs would continue unaffected. Therefore, the stress or mortality due to capture and handling, the forced downstream spawning of fish that do not pass through the weir, and the entrainment and injury of juvenile fish in water intake and discharge screens would not decrease substantially compared to current conditions. However, the minimal effects of hauling fish above Sunset Falls would terminate under Alternative 1 compared to current conditions. Therefore, Alternative 1 would have a negligible positive effect on salmon and steelhead in the analysis area compared to current conditions because of the benefits of the existing trap and haul program would be lost.

Under Alternative 2, production levels and facility operations effects would be the same as current conditions for Wallace River Hatchery and Reiter Ponds and the trap and haul program at Sunset Falls would continue to operate. Because the operation of Wallace River Hatchery and Reiter Ponds would include operation for the summer-run steelhead program, facility effects discussed in Section 3.3.5.7, Facility Operation would be marginally more negative than under Alternative 1. The trap and haul program would have the same minimal handling stress as described in Section 3.3.5.7. The negative effects of hauling the fish above Sunset Falls and facility operations of Wallace River Hatchery and Reiter Ponds lead to negligible negative effect on salmon and steelhead in the analysis area under Alternative 2, compared to Alternative 1.

Under phase one of Alternative 3, facility operations effects would be the same as Alternative 1 for Wallace River Hatchery and Reiter Ponds and greater for Tokul Creek due to the production of more smolts at Tokul Creek Hatchery. Under phase two of Alternative 3, facility operations effects would be the same as current conditions for Wallace River Hatchery, Reiter Ponds, and Tokul Creek Hatchery due to the production of the same number of smolts at Wallace River Hatchery and Reiter Ponds and none at Tokul Creek Hatchery. Under both phases of Alternative 3, the trap and haul program would continue, and its benefits would be greater than under Alternative 1. Therefore, Under Alternative 3,[20] facility operation effects on natural-origin salmon and steelhead would be greater at Wallace River Hatchery and Reiter Ponds and to a lesser degree at Tokul Creek hatchery compared to Alternative 1. While facilities

[20] Because phase two of Alternative 3 represents the long term for that alternative (after the first 8 years), our analysis is of effects of Alternative 3 is based on the specifics of phase two.

being operated under phase one of this alternative are different than facilities under Alternative 2, the same facilities would be used under phase two of Alternative 3 and Alternative 2; therefore, the long term impacts of these two alternatives are the same. The trap and haul program would have the same minimal handling stress as described in Section 3.3.5.7. The negative effects of hauling the fish above Sunset Falls and facility operations of Wallace River Hatchery and Reiter Ponds lead to a negligible positive effect on salmon and steelhead in the analysis area under Alternative 2, compared to Alternative 1.

Compared to Alternative 1, under Alternative 4, the proposed summer-run steelhead program would release up to 56,000 more steelhead smolts and the trap and haul program at Sunset Falls would operate. The facility operations are likely to be at the same level as Alternative 2. Therefore, Alternative 4 would have the same impact as Alternative 2, resulting in a negligible negative effect on salmon and steelhead in the analysis area compared to Alternative 1.

4.3.8 Research Monitoring and Evaluation

As described in Section 3.3.5.8, Research Monitoring and Evaluation, RM&E activities have resulted in stress and low levels of mortality of natural-origin salmon and steelhead in the analysis area under current conditions, though the information gained through RM&E activities outweighs the risks to the populations. The RM&E effects on salmon and steelhead under each of the alternatives are summarized in Table 19.

Table 19. Summary of research monitoring and evaluation effects on salmon and steelhead.

	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
RM&E	Low negative	Low positive	Low positive	Low positive

Under Alternative 1, RM&E activities associated with the ~~Skamania~~ESS program and the Sunset Falls trap and haul program would cease. The RM&E activities would no longer cause stress to encountered fish. However, the termination of the RM&E associated with the Sunset Falls program would reduce the amount of data available for all species. Termination of RM&E would be especially problematic for estimating annual escapement and run reconstruction for ESA-listed species, creating more uncertainty in management of ESA-listed species. Because the benefits of RM&E outweigh the negative effects, termination of RM&E under Alternative 1 would have a low negative effect on salmon and steelhead in the analysis area compared to current conditions.

Under Alternatives 2, 3, and 4, marking of juvenile fish and sampling juvenile and adult fish would take place through the new summer-run steelhead program and the Sunset Falls trap and haul program, which would stress encountered fish more than Alternative 1. However, the RM&E would provide data for all species and essential data for estimating annual escapement and run reconstruction for ESA-listed species. Therefore, Alternatives 2, 3, and 4 would have a low positive effect on salmon and steelhead in the analysis area compared to Alternative 1 because the beneficial benefits on the information obtained through the RM&E program outweigh its negative effects related to sampling and handling stress for encountered fish.

4.4 Other Fish Species

The proposed Skykomish summer steelhead hatchery program and the Sunset Falls program may have some similar effects on other fish species as those effects described in Section 3.3, Salmon & Steelhead. Predators, prey base, and competitors of steelhead might be affected by the proposed hatchery program. Predators, such as ESA-threatened bull trout, may be positively affected to the extent they prey on hatchery-origin steelhead released from the Skykomish summer steelhead hatchery program. Species of other fish that are prey of steelhead may be negatively affected by hatchery-origin steelhead released from the Skykomish summer steelhead hatchery program. In addition, facility operations can affect other fish species by potentially entraining or impinging fish.

Other species of fish that compete with steelhead may be negatively affected by hatchery-origin steelhead released from the Skykomish summer steelhead hatchery program. Under existing conditions, current releases of ~~Skamania~~ESS contribute to a relatively small portion of the prey base for the other fish species because of other hatchery releases, natural salmon and steelhead, trout, and aquatic insects that are important prey items in the analysis area. Under existing conditions, the trap and haul program provides access to otherwise unutilized habitat for bull trout and, to a lesser degree, to cutthroat trout. The analysis here first discusses the impacts of the hatchery program on other fish species generally, then discusses additional impacts on cutthroat trout and on bull trout. The effects on other fish species under each of the alternatives are summarized in Table 20.

Table 20. Summary of effects on other fish species.

Resource	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Other Fish Species	Negligible negative	Negligible positive	Negligible positive	Negligible positive
Bull trout	Low negative	Negligible positive	Negligible positive	Low positive
Cutthroat trout	Negligible negative	Negligible positive	Negligible positive	Negligible positive
Mountain whitefish	Negligible negative	Negligible positive	Negligible positive	Negligible positive

4.4.1 Alternative 1 (No Action/Termination)

Effect of the hatchery operation on other fish species generally

Under Alternative 1, up to 116,000 summer-run steelhead juveniles would not be released and would not be available as prey, predators, or competitors for other fish species compared to current conditions. However, 116,000 steelhead juveniles not released under Alternative 1 would be only a small fraction of other prey, predators, or competitors (i.e., natural and hatchery origin prey and competitors) of other fish species in the analysis area under current conditions. Facility operation effects, such as potential entrapment or impinging, would not necessarily decrease under Alternative 1 because weirs and traps would continue to be used for the operation of these same facilities for hatchery production of other species unrelated to this EA. The effect of terminating the hatchery program would be negligible negative on other fish species generally under Alternative 1 compared to existing conditions because the negative effects from the continued operation of the facilities for other hatchery activities and a small decrease in available prey outweighs the positive effect of ceasing competition and predation under this alternative.

Effects on bull trout, cutthroat trout, and mountain whitefish

The termination of the hatchery program would have the same effect on bull trout, cutthroat trout, and mountain whitefish as that described above for other fish species generally.

The lack of transport of bull trout, cutthroat trout, and mountain whitefish above Sunset Falls under Alternative 1 would prevent access to the South Fork Skykomish River upstream of Sunset Falls to an average of 46 bull trout, one cutthroat trout, and 305 mountain whitefish annually, compared to existing conditions. While the termination of the trap and haul program would alleviate stress to individual fish caused by the transport, the termination would have a negative effect on the bull trout, cutthroat trout, and mountain whitefish populations because they would lose access to good habitat above the falls. The termination of this program would impair migratory connectivity of bull trout, currently listed as threatened, and potential cessation of the trap and haul program is listed as one of the primary threats to the bull trout in this Snohomish/Skykomish watershed (USFWS 2015b). Therefore, the effect of terminating the hatchery program (negligible negative, as discussed above) and the trap-and-haul program would be medium negative on bull trout, as a substantial portion of the local population would lose access to high quality spawning and rearing habitat necessary to maintain viability for this local population. The effect on cutthroat trout and mountain whitefish under Alternative 1 compared to existing conditions would be negligible negative because of the number of fish that would not get transported above Sunset Falls to otherwise unavailable habitat.

4.4.2 Alternative 2 (Proposed Action)

Effect of the hatchery operation on other fish species generally

Under Alternative 2, up to 116,000 summer-run steelhead juveniles would be released and would be available as prey, predators or competitors for other fish species that would not be released under Alternative 1. However, 116,000 steelhead juveniles released under Alternative 2 would be only a small fraction of other hatchery releases and natural abundance of other fish species that could be prey, be predators or competitors of hatchery-origin summer-run steelhead in the analysis area under Alternative 1. Facility operation effects, such as potential entrapment or impinging, would be similar to Alternative 1 because the production of summer-run steelhead does not alter the yearly operation of weirs and traps. Therefore, the effect of operating the new Skykomish summer steelhead hatchery program would be negligible positive on other fish species generally under Alternative 2, compared to Alternative 1 because the positive effect of prey availability outweighs the negative effects of the facility operation effects and competition predation effects.

Effect on bull trout, cutthroat trout, and mountain whitefish

The new Skykomish summer steelhead hatchery program would have the same effect on bull trout, cutthroat trout, and mountain whitefish under Alternative 2 as that described above for other fish species generally, except for the additional potential for redd superimposition on bull trout redds, discussed below. The cutthroat trout population is large enough that redd superimposition is discountable. There are no redd superimposition concerns from hatchery-origin steelhead on mountain whitefish because mountain whitefish do not create redds.

The transport of bull trout, cutthroat trout, and mountain whitefish above Sunset Falls under Alternative 2 would continue to provide access to the South Fork Skykomish River upstream of Sunset Falls to an average of 46 bull trout, one cutthroat trout, and 305 mountain whitefish annually, compared to no access under Alternative 1. While the operation of the trap and haul program would cause stress due to the transport to individual fish, the transport would have a positive effect on the bull trout, cutthroat trout, and mountain whitefish populations because they would continue to gain access to good habitat above the falls. The effect of the new Skykomish summer steelhead hatchery program (negligible negative, as described above) and the trap-and-haul program would be negligible positive on cutthroat trout and mountain whitefish under Alternative 2 compared to Alternative 1 because of the benefits of the trap-and-haul program. While the trap-and-haul program has a positive impact on the bull trout population, the amount of benefit is reduced by the negative effect of redd superimposition, discussed below.

~~Once~~If agreed upon within the work group comprised of co-managers and NMFS, and if the new Skykomish summer steelhead hatchery program has a sufficient number of adult returns, the operators would ~~initially transplant~~outplant up to 250 hatchery-origin fish annually into the North Fork Skykomish River ~~for eight years with the potential to transplant up to 500 fish upon agreement on additional RM&E among the co-managers, NMFS, and the USFWS, which can have additional effects on bull trout.[21] In the recovery plan for Puget Sound steelhead, NMFS identified this level of supplementation as compatible with shared recovery objectives for numerous species, including bull trout.~~ The expected increase in spawners in the North Fork Skykomish River through ~~deliberate supplementation releases would likely~~ the proposed outplanting may result in more redd superimposition for bull trout from hatchery-origin steelhead than occurs from natural-origin bull trout. Because bull trout share about 60 percent of spawning habitat with summer-run steelhead in the North Fork Skykomish River, approximately 40 percent of this local population would be unaffected (NMFS 2020c). ~~[22]~~ Other differences in spawn timing and microhabitat preference are likely to further decrease potential interactions for spawning habitat

~~[21] Cutthroat trout are not likely to be affected by the outplanting because cutthroat trout are abundant, and the outplanting for a limited amount of time would only affect them temporarily. Mountain whitefish would not be affected because they do not create redds.~~

between summer steelhead and bull trout (NMFS 2020c). Additional juvenile steelhead produced from hatchery adults will increase the amount of forage for adult bull trout. Therefore, the effect of the new Skykomish summer steelhead hatchery program ~~and~~ the ~~trap~~Sunset Falls Trap-and-Haul program (negligible positive, as described above) and the ~~transplant~~potential outplanting of up to 250 hatchery-origin steelhead into the North Fork Skykomish River would result in negligible positive effects on bull trout under Alternative 2 compared to Alternative 1 because the benefit of the trap-and-haul program outweighs the risks the hatchery program and of redd superimposition concerns for bull trout.

4.4.3 Alternative 3 (Tolt River Source)

Effect of the hatchery operation on other fish species generally

Under phase one of Alternative 1 there would be impacts to other fish species that are prey, predators, or competitors with steelhead in the Tolt River, but these would be in the short-term. Phase two of Alternative 3 would have the same long-term impacts as Alternative 2, including the effects of facility operations. Therefore, the effect of operating the new hatchery program would be negligible positive on other fish species generally under Alternative 3 (same as Alternative 2) compared to Alternative 1.

Effect on bull trout, cutthroat trout, and mountain whitefish

The new hatchery program would have the same effect on bull trout, cutthroat trout, and mountain whitefish under Alternative 3 as for Alternative 2. The effect of the transplanting of up to 250 hatchery-origin steelhead into the North Fork Skykomish River and the trap-and-haul program would be the same as Alternative 2 because these programs would be operated the same as described under Alternative 2, resulting in negligible positive on bull trout, cutthroat trout, and mountain whitefish under Alternative 3 compared to Alternative 1 because of benefits in abundance and distribution.

4.4.4 Alternative 4 (Reduced Production)

Effect of the hatchery operation on other fish species generally

Under Alternative 4, up to 56,000 summer-run steelhead juveniles would be released and would be available as prey, predators or competitors for other fish species that would not be released under Alternative 1. However, up to 56,000 steelhead juveniles released under Alternative 4 would be only a small fraction of other hatchery releases and natural abundance of other fish species that could be prey, be predators or competitors of hatchery-origin summer-run steelhead in the analysis area under

Alternative 1. Facility operation effects, such as potential entrapment or impinging, would be similar to Alternative 1 because the production of summer-run steelhead does not alter the yearly operation of weirs and traps. The effect of operating the new hatchery program under Alternative 4 would be negligible positive on other fish species generally under Alternative 4 (same as Alternatives 2 and 3) compared to Alternative 1.

Effect on bull trout, cutthroat trout, and mountain whitefish

The new hatchery program would have the same effect on bull trout and cutthroat trout under Alternative 4 as that described above for other fish species generally.

The transport of bull trout, cutthroat trout, and mountain whitefish above Sunset Falls under Alternative 4 would be the same as under Alternative 2, and the effects on cutthroat trout and mountain whitefish would be the same as Alternative 2 (negligible positive compared to Alternative 1). However, there would be no transplant of hatchery-origin steelhead into the North Fork Skykomish River under Alternative 4 because the expected adult returns would not be high enough to have fish to transplant. Therefore, the effect of operating the new hatchery program of reduced size and the trap-and-haul program would be low positive on bull trout under Alternative 4 compared to Alternative 1; the positive effect on bull trout under Alternative 4 is greater than Alternative 2 because the negative effects of redd superimposition that could result from the potential outplanting of hatchery-origin summer-run steelhead in the North Fork Skykomish would be eliminated.

4.5 Wildlife

Under all alternatives hatchery-origin summer-run steelhead interact with wildlife but represent only a small proportion of other hatchery-origin and natural-origin salmonids interacting with wildlife. In addition, hatchery-origin steelhead under all alternatives would constitute an insubstantial contribution to the diet of Southern Resident killer whales because steelhead has not been identified as a preferred prey of Southern Resident killer whales (Hanson et al. 2010; Hilborn et al. 2012; Ford et al. 2016).

The effects on wildlife under each of the alternatives are summarized in Table 21.

Table 21. Summary of effects on wildlife.

Resource	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Wildlife	Negligible negative	Negligible positive	Negligible positive	Negligible positive

4.5.1 Alternative 1 (No Action/Termination)

Under Alternative 1, up to 116,000 summer-run steelhead juveniles would not be released and would not be available as prey or be a predator for wildlife compared to current conditions. However, 116,000 steelhead juveniles not released under Alternative 1 would be only a small fraction of other salmonids available as prey or predators of wildlife under current conditions, including as prey for Southern Resident killer whales, for which steelhead has not been identified as a preferred prey (Hanson et al. 2010; Hilborn et al. 2012; Ford et al. 2016).

The trap and haul program annually transports and releases more than 30,000 adult salmon, steelhead and trout into wildlife habitat that would not have this number of adult fish and carcasses without the trap and haul program at Sunset Falls. While many fish are transported above Sunset Falls, those fish could potentially disperse among a habitat area of 69 miles (111 kilometers), so wildlife species above Sunset Falls are not likely to be heavily reliant on the trap and haul program for prey availability. Terminating the operation of the trap and haul program is likely to have a very small reduction in prey availability for wildlife species.

Overall, compared to current conditions, the effects on wildlife under Alternative 1 would be negligible negative from decreases in prey availability related to the elimination of the summer-run steelhead program and the decrease in availability of prey and carcasses above Sunset Falls.

4.5.2 Alternative 2 (Proposed Action)

Under Alternative 2, up to an additional 116,000 summer-run steelhead juveniles would be released and would be available as prey predators for wildlife compared to Alternative 1. However, an increase of 116,000 steelhead juveniles released under Alternative 2, compared to Alternative 1 would be only a small fraction of other salmonids available as prey or predators for wildlife, including prey for Southern Resident killer whales, for which steelhead has not been identified as a preferred prey (Hanson et al. 2010; Hilborn et al. 2012; Ford et al. 2016). The effect of all hatchery releases in Puget Sound on Southern Resident Killer whales was analyzed in (NMFS 2020d) and found to not jeopardize the species.

For wildlife species in the South Fork Skykomish River basin above Sunset Falls under Alternative 2, the trap and haul program offers a very small positive effect through distribution of over 30,000 adult salmon, steelhead, and trout above Sunset Falls.

Overall, compared to Alternative 1, the effects on wildlife under Alternative 2 would be negligible positive based on increases in prey availability from the new Skykomish summer steelhead hatchery program releasing juveniles and the trap and haul program transporting salmon, steelhead, and trout above Sunset Falls.

4.5.3 Alternative 3 (Tolt River Source)

While the short-term impacts on wildlife under phase one of Alternative 3 would be in the Tolt River basin, the long-term impacts on wildlife under phase two would be the same as Alternative 2 because the same number of fish would be released from the same locations and the trap and haul program would operate the same. Therefore, the effects on wildlife under Alternative 3 would be negligible positive compared to Alternative 1.

4.5.4 Alternative 4 (Reduced Production)

Under Alternative 4, up to an additional 56,000 summer-run steelhead juveniles would be released and would be available as prey or predators for wildlife compared to Alternative 1. However, an increase of up to 56,000 steelhead juveniles released under Alternative 4, compared to Alternative 1, would be only a small fraction of other salmonids that could be available as prey or predators for wildlife, including as prey for Southern Resident killer whales, for which steelhead has not been identified as a preferred prey (Hanson et al. 2010; Hilborn et al. 2012; Ford et al. 2016).

The trap and haul program would have the same beneficial effect as Alternatives 2 and 3.

Overall, compared to Alternative 1, the effects on wildlife under Alternative 4 would be negligible positive because of increases in prey availability related to the continuation of a reduced summer-run steelhead program at half the size as current conditions, and the increase in availability of prey because of the continuing operation of the trap and haul program that would transport more than 30,000 salmon, steelhead, and trout above Sunset Falls each year.

4.6 Socioeconomics

The following analysis discusses the effects of the alternatives on socioeconomics. As described in Section 3.8, Socioeconomics, the ~~Skamania~~ESS program provides employment opportunities and procures goods and services for hatchery operations under existing conditions. In addition, harvest of summer-run steelhead produced in the analysis area hatcheries provides economic benefits to the local and regional economies. Tribal summer-run steelhead fisheries may include some commercial harvest in addition to ceremonial and subsistence harvest, and the effects of this harvest on culture are discussed in Section 3.7, Cultural Resources. Data regarding tribal commercial harvest are not available. Also, the hatchery production contributes to a large recreational fishery targeting summer-run steelhead from the Skykomish River Basin, which has resulted in a positive benefit to local socioeconomics under existing conditions. The effects on socioeconomics under each of the alternatives are summarized in Table 22.

Table 22. Summary of effects on socioeconomics.

Resource	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Socioeconomics	Medium negative	Medium positive	Medium positive	Low positive

4.6.1 Alternative 1 (No Action/Termination)

Under Alternative 1, the ~~Skamania~~ESS program would gradually reduce juvenile releases until it ceases to operate in 2022, and the trap and haul program would cease to operate. Consequently, returning hatchery-origin adult steelhead would not be available for recreational harvest (estimated economic value of $2.3 million; see Section 3.6), and the economic contributions from hatchery and fishway operations and employment of staff would also be foregone under Alternative 1 compared to existing conditions. Because ~~Skamania~~ESS hatchery production directly contributes to one of the biggest summer-run steelhead recreational fisheries in Washington, Alternative 1 would result in a medium negative effect on socioeconomics compared to existing conditions.

4.6.2 Alternative 2 (Proposed Action)

Under Alternative 2, the hatchery production would continue to allow for recreational harvest of summer-run steelhead, though the magnitude of the fishery would depend on the survival rate of the hatchery fish. Economic contributions from hatchery and fishway operations and employment of staff would be gained under Alternative 2 compared to Alternative 1. Because the economic contributions from employment and the recreational fishery would continue under this alternative, Alternative 2 would result in a medium positive effect on socioeconomics compared to Alternative 1.

4.6.3 Alternative 3 (Tolt River Source)

Hatchery production under Alternative 3 would contribute to recreational fisheries in the same way as Alternative 2. Economic contributions from hatchery and fishway operation and employment of staff would also be at the same level as Alternative 2, though there may be a difference in staff location (Tokul Creek Hatchery vs. Wallace River Hatchery) under phase one. Consequently, Alternative 3 would result in a medium positive effect on socioeconomics compared to Alternative 1.

4.6.4 Alternative 4 (Reduced Production)

Under Alternative 4, hatchery production would continue to contribute to recreational harvest, though the smaller production number would reduce the availability of fish for recreational harvest. Economic contributions from reduced hatchery and fishway operations and reduced employment of staff would likely be at a similar level as Alternative 2. Alternative 4 would result in low positive effect on socioeconomics compared to Alternative 1

4.7 Cultural Resources

The following section discusses the effects of the alternatives on cultural resources. The survival and well-being of Native American people and tribal culture are inextricably linked to the survival and well-being of salmon and steelhead. The total number of adult steelhead returning to the Snohomish River Basin is limited and has impacted the tribes' ability to harvest. Furthermore, some tribes believe that the abundance of fish under existing conditions is inadequate to meet their subsistence needs (Section 3.7, Cultural Resources). As described in Section 3.7, Cultural Resources, steelhead produced by the ~~Skamania~~ESS program and the population viability benefits to salmon and steelhead from the Sunset Falls trap and haul program provide an important cultural benefit to the Tulalip Tribes. The effects on cultural resources under each of the alternatives are summarized in Table 23.

Table 23. Summary of effects on cultural resources.

Resource	Alternative 1 – No Action	Effect of Alternative relative to Alternative 1		
		Alternative 2 – Proposed Action	Alternative 3 – Tolt River Source	Alternative 4 – Reduced Production
Cultural Resources	Medium negative	Medium positive	Medium positive	Low positive

4.7.1 Alternative 1 (No Action/Termination)

Under Alternative 1, the ~~Skamania~~ESS program would gradually reduce juvenile releases until it ceases to operate in 2022 without it being replaced, and the Sunset Falls trap and haul program would terminate. Consequently, up to 116,000 summer-run steelhead juveniles would not be released and returning hatchery-origin adult steelhead would not be available for tribal harvest. The loss of summer-run steelhead production would reduce the number of adult steelhead returning to the Snohomish River Basin and diminish the potential for long-term harvest of summer-run steelhead for uses by the Tulalip Tribes because tribes are only allowed to harvest hatchery steelhead in this basin. No other summer-run steelhead hatchery programs exist to provide harvestable steelhead, and steelhead harvest occurs during a season in which other salmon speices are not available for harvest. In addition, the termination of the Sunset Falls trap and haul program would cease to provide additional habitat access to Chinook, chum, coho, and pink salmon, thereby reducing salmon abundance and contributing to a loss of cultural resources. As a result, impacts to tribal culture will be readily apparent, so under Alternative 1, there would be a medium negative effect on cultural resources compared to current conditions in which ~~Skamania~~fish from the ESS program are still available for harvest and the Sunset Falls trap and haul program contributes to additional salmon and steelhead availability.

4.7.2 Alternative 2 (Proposed Action)

Contrary to Alternative 1, under Alternative 2, up to 116,000 summer-run steelhead juveniles would be annually released, and a portion of those released would return to the Snohomish River Basin. This would be the only hatchery-origin summer-run steelhead available for tribal harvest in the Snohomish River Basin during the time when salmon species are not available for harvest. Thus, Skykomish summer steelhead hatchery production would maintain the potential for long-term tribal harvest of summer-run steelhead by the Tulalip Tribes. In addition, the Sunset Falls trap and haul program would continue to provide additional habitat for salmon and steelhead, thus providing additional benefits to these species and to the cultural resources. This will result in impacts to tribal culture that will be readily apparent, resulting in a medium positive effect on cultural resources for Alternative 2 compared to Alternative 1.

4.7.3 Alternative 3 (Tolt River Source)

Under Alternative 3, the long-term hatchery operation would look the same as Alternative 2, switching only the broodstock source, resulting in a medium positive effect on cultural resources compared to Alternative 1.

4.7.4 Alternative 4 (Reduced Production)

Under Alternative 4, up to 56,000 summer-run steelhead juveniles would be released. Because of the small production number, the availability of fish for tribal harvest purposes may be limited compared to Alternatives 2 and 3, but greater than under Alternative 1. Therefore, under Alternative 4, there would be a low positive effect on cultural resources compared to Alternative 1 because of the more limited availability of hatchery-origin summer-run steelhead for tribal harvest compared to Alternatives 2 and 3.

4.8 Environmental Justice

This section assesses if there would be disproportionately high adverse human health or environmental effects from the summer-run steelhead hatchery and trap and haul program under the alternatives on minority and low-income environmental justice populations. In Section 3.8, Environmental Justice, Native American tribes (particularly the Tulalip Tribes) were identified as the potentially affected environmental justice population. The analysis of environmental justice effects is different from the analysis of effects on the other resources in Chapter 4, Environmental Consequences. The analysis first determines whether effects on the resources analyzed in the EA are adverse under any alternative, and if so, whether such adverse effects would be disproportionately high to the identified environmental justice populations. Effects of the alternatives on water quantity, water quality, salmon and steelhead, other fish species, and wildlife would not disproportionately affect environmental justice populations or communities. The effects analyzed in Section 4.7, Socioeconomics, also did not pertain to tribal harvest.

As described in Section 3.8, Environmental Justice, the availability of fish for tribal harvest use provides an important cultural resource value to Native American tribes. The current ~~Skamania~~ESS program provides steelhead for tribal harvest.

Alternative 1 (No Action/Termination)

Under Alternative 1, the ~~Skamania~~ESS program would gradually reduce juvenile releases until it ceases to operate in 2022 without being replaced. Under this Alternative, returning hatchery-origin adult steelhead would not be available for tribal harvest. The adverse effects on cultural resources under Alternative 1 would be disproportionately high to the Tulalip Tribes because the steelhead entering their usual and accustomed fishing areas will diminish as a result of the hatchery production being eliminated, while other tribes continue to benefit from other hatchery programs in other basins.

Alternative 2 (Proposed Action)

Under Alternative 2, returning hatchery-origin adult steelhead would be available for tribal harvest. Because positive cultural resource effects are anticipated under Alternative 2, no disproportionate adverse effects are anticipated.

Alternative 3 (Tolt River Source)

Alternative 3 would have the same effect on cultural resources as Alternative 2, so no disproportionate adverse effects are anticipated.

Alternative 4 (Reduced Production)

Under Alternative 4, hatchery production would continue to contribute to tribal harvest, though the smaller production number may limit the availability of fish for tribal harvest. As a result, there would be minimal beneficial effects on cultural resources important to the Tulalip Tribes under Alternative 2 Consequently, no disproportionate adverse effects are anticipated.

5 CUMULATIVE IMPACTS

This chapter discusses the cumulative impacts of the alternatives described in Chapter 2, Alternatives, and analyzed in Chapter 4, Environmental Consequences, along with other past, present, and reasonably foreseeable future actions, considered against the existing condition of the affected environment (Chapter 3, Affected Environment). Cumulative impact "is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). For this EA, the actions analyzed include both hatchery-related and other actions potentially affecting the resources and environmental justice communities and groups described in Chapter 3, Affected Environment. Actions are included only if they are tangible and specific and if effects overlap temporally and geographically with the Proposed Action.

The cumulative impacts analysis area for each resource is described in Chapter 3, Affected Environment, at the beginning of each section, which includes the project area described in Section 1.2, Project and Analysis Area. The temporal scope of past and present actions is the temporal context within which affected resources are described in Chapter 3, Affected Environment, whereby existing conditions are a result of prior and ongoing actions in the project area. The temporal scope for reasonably foreseeable future actions affecting resources and environmental justice is 15 years to account for approximately three generations of salmon and steelhead (one generation takes about 5 years), which is the minimum number of generations needed to reasonably observe changes in response to management actions in salmon and steelhead populations. Considering this timeframe, the cumulative impacts analysis provides expected trends but recognizes that comprehensive data are generally lacking to definitively determine the magnitude of effects.

5.1 Past, Present, and Reasonably Foreseeable Actions and Conditions

Chapter 3, Affected Environment, describes existing conditions for each resource and environmental justice and reflects the effects of past actions and present conditions. Past actions that contributed to the present condition of resources considered in this EA primarily include rural and urban development, restoration, hatchery practices, and fisheries. NMFS (2019a) identified that loss of habitat as one of the main stressors to Puget Sound steelhead. In particular, it identified habitat quantity, riparian conditions, perhipheral and transitional habitats, channel form/structure, sediment conditions, and water quantity as the main ecological concerns for the Snohomish/Skykomish River population and the North Fork Skykomish River population. Although restoration actions and some hatcheries provide beneficial impacts, the net result of past actions has been the loss and degradation of aquatic habitat, changes in salmon and steelhead genetic structure, and fisheries over-exploitation, which in turn have led to declines in salmon and steelhead populations in the Snohomish River Basin.

Climate change, rural and urban development, habitat restoration, hatchery production, and fisheries are the primary factors currently contributing to the cumulative impacts on the resources and environmental justice communities considered in this EA. The following sections describe the reasonably foreseeable actions and conditions related to these factors.

5.1.1 Climate Change

The changing climate is recognized as a long-term trend that is occurring throughout the world. Within the Pacific Northwest, Ford et al. (2011) summarized expected climate changes in the coming years as leading to the following physical and chemical changes (certainty of occurring is in parentheses):

- Increased air temperature (high certainty)
- Increased winter precipitation (low certainty)
- Decreased summer precipitation (low certainty)
- Reduced winter and spring snowpack (high certainty)
- Reduced summer stream flow (high certainty)
- Earlier spring peak flow (high certainty)
- Increased flood frequency and intensity (moderate certainty)
- Higher summer stream temperatures (moderate certainty)
- Higher sea level (high certainty)
- Higher ocean temperatures (high certainty)
- Intensified upwelling (moderate certainty)
- Delayed spring transition (moderate certainty)
- Increased ocean acidity (high certainty)

These changes will affect human and other biological ecosystems within the cumulative impact analysis area (Washington Department of Ecology (Ecology) 2012; Mauger et al. 2015; NWFSC 2015). Changes to biological organisms and their habitats are likely to include shifts in timing of life history events, changes in growth and development rates, changes in habitat and ecosystem structure, and rise in sea level and increased flooding (Johannessen and Macdonald 2009; Littell et al. 2009). A particular concern in

Puget Sound is the impact of climate change on food webs (e.g., Banas et al. (2019), Greene et al. (2015)), which has obvious links to salmonid abundance, productivity, and survival.

For the Pacific Northwest portion of the United States, Hamlet (2011) notes that climate change will have multiple effects. These effects may in turn also affect the resources under consideration in this EA (see Chapter 3). Expected effects include:

- Overtaxing of stormwater management systems at certain times
- Increases in sediment inputs into water bodies from roads
- Increases in landslides
- Increases in debris flows and related scouring that damages human infrastructure
- Increases in fires and related loss of life and property
- Reductions in the quantity of water available to meet multiple needs at certain times of year (e.g., for irrigated agriculture, human consumption, and habitat for fish)
- Shifts in irrigation and growing seasons
- Changes in plant, fish, and wildlife species' distributions and increased potential for invasive species
- Declines in hydropower production
- Changes in heating and energy demand
- Impacts on homes along coastal shorelines from beach erosion and rising sea levels

The most heavily affected ecosystems due to human activities along the Pacific coast are likely to be near areas having high human population densities and along the continental shelves off Oregon and Washington (Halpern et al. 2009). The predictions of climate change and types of effects described above are based on models used to estimate effects of climate change under a wide range of change scenarios (from low to high changes) (Mauger et al. 2015). In the near term (next 15 to 20 years), the actual pace of climate change and its effects on resources will become clearer as evidence of these effects is accumulated. However, the effects of climate change are likely to be less pronounced in the near-term compared to the long-term, and annual weather patterns (variation in seasonal temperatures and precipitation) in the near-term may mask long-term trends (Washington Department of Ecology (Ecology) 2012). All resources considered in this EA will continue to be affected by climate change, especially through changes to stream temperature and flow, which contribute to habitats being modified for various species. The effects of climate change on each of the resources are described below in section 5.2, Cumulative Impacts by Resource.

5.1.2 Rural and Urban Development

The Snohomish River is near the rapidly growing population centers in the Puget Sound region. Land has been cleared for multiple uses throughout the watershed, including development near industrial and population centers, logging in the watershed, and farming in the estuary and low-elevation river valleys. In turn, the extensive alteration of floodplains habitats through land conversion has resulted in the loss of salmon habitat, which has contributed to the decline of salmon and steelhead populations in the basin.

Primary land uses in the basin are forestry, farming, and urban and rural residential development. According to (Snohomish River Basin 2019), forest lands cover approximately 70% of the watershed (roughly 50% of these lands are in federal ownership), and rural residential and urban areas make up a large percentage of the watershed's land base. In the lower Snohomish Basin, more than 90% of the original floodplain wetlands have been drained, filled, or channeled to accommodate farming or development (Snohomish River Basin 2019). The rapidly growing populations in the Seattle, Everett, and Marysville areas are spilling into the Snohomish Basin as people look for places to live and work. The projected population growth rate in the Snohomish River Basin between 2010 and 2035 is 36.9%. Most of this growth will occur in the western, incorporated portion of the watershed (Snohomish River Basin 2019).

Although the projected growth in the Snohomish River Basin is likely to affect salmon habitat, the Washington State Growth Management Act (GMA; Chapter 36.70A RCW) requires state and local governments to manage Washington's growth by identifying and protecting critical areas and natural resource lands, designating urban growth areas, preparing comprehensive plans, and implementing plans through capital investments and rural and urban development regulations. The GMA establishes state goals, sets deadlines for compliance, offers direction on how to prepare local comprehensive plans and regulations, and sets forth requirements for early and continuous public participation. Within the framework provided by the mandates of the Act, local governments have many choices regarding the specific content of comprehensive plans and implementing rural and urban development regulations.

While the GMA does not address linkages between the status of salmon and steelhead populations and growth management, the Act has value as an indirect means for managing habitat for salmonid protection. In 2013, the Tulalip Tribes and Snohomish County adopted a Memorandum of Understanding (MOU) establishing a process for coordinated long-range planning and information sharing. A key goal of the coordinated planning process envisioned in the 2013 MOU is to reduce inconsistencies between the Tribes' Comprehensive Land Use Plan and the Snohomish County Growth Management Act Comprehensive Plan for all lands within the boundaries of the Tulalip Indian Reservation.

Much of the flood plain and adjacent riparian areas in the Snohomish River Basin and aquatic habitat are under jurisdiction of the Snohomish County Shoreline Management Program (SMP). Compliance with the SMP when considering development projects in the Snohomish River Basin is required under Washington State's Shoreline Management Act. Forest lands managed by Federal and state agencies are guided by the conservation provisions of the Northwest Forest Plan (U.S. Forest Service 1997) or the Washington Trust Lands Habitat Conservation Plan (WDNR 1997), respectively.

Compared to public lands, there are generally fewer constraints on land management activities on private lands (e.g., timber harvest, agriculture, and urban development) that are intended to protect aquatic habitat. However, the Forest Practices Habitat Conservation Plan (Washington Department of Natural Resources (DNR) 2005), as implemented by private landowners that conduct forest activities (e.g., timber harvest) in compliance with the Washington State Forest Practices Act, includes habitat protection measures that help protect federally listed species, including salmon and steelhead. The amount of future timber harvest and conversion of forested and agricultural land to urban uses are difficult to quantify, but these activities are anticipated to continue in both the short- and long-term.

5.1.3 Habitat Restoration

Adopted in 2005, the Snohomish River Basin Salmon Conservation Plan (Salmon Plan) defines a strategic approach to salmonid recovery over a 50-year period and identifies 10-year benchmarks for habitat restoration actions (Snohomish Basin Salmon Recovery Forum 2005). Since 2005, there have been many in-situ successes on restoration projects in mainstems, estuaries, and tributaries. However, overall environmental conditions continue to decline.

The Salmon Plan focuses on restoring and protecting the natural processes that create and maintain floodplain features and support salmon throughout their life cycles. Restoration also benefits steelhead and other salmonids, such as bull and cutthroat trout (Snohomish River Basin 2019). According to Snohomish River Basin (2019), the two-pronged strategy for the first 10 years of implementation included the following:

- Improve habitat quantity and quality in the nearshore, estuary, and mainstem rivers
- Minimize habitat losses and make habitat gains through restoration in the rest of the Basin

Restoration efforts continue to make progress toward the plan goals, established in 2005, but a process was not designed to track rates of additional degradation (Snohomish River Basin 2019). The Salmon Plan defines 62 sub-basins in the Snohomish River Basin and establishes 12 strategy groups in the nearshore area based on their location, habitat conditions, and current and potential salmon use. Habitat restoration targets are organized by nearshore, estuary, mainstem, and other sub-basin strategy groups (Snohomish River Basin 2019).

The 2005 Salmon Plan set a 10-year target of 1,237 acres of estuary restoration, with the recognition that such restoration effort would only be the first step. To date, the Snohomish River estuary has the most restored area of any estuary in Puget Sound, with 1025.6 of the 10-year target of 1,237 acres restored (Snohomish River Basin 2019). Estuary restoration projects take time to reach peak performance to support juvenile salmonids. Restoration work carried out to date has been more complex, expensive, and time consuming than was likely assumed in 2005 (Snohomish River Basin 2019). In the mainstem, priorities include restoring riparian, edge, and off-channel habitat, and placing large woody debris where appropriate to support rearing of juvenile Chinook salmon and other species (Snohomish River Basin 2019).

An example of a recent successful restoration project is the breaching of the levee and mitigation efforts at the Tulalip Tribes' Qwuloolt restoration site in 2015, which allowed fish access to 375 acres of tidal estuary for the first time in more than a century. Also, the footprint of the former levee, removed as part of the Lower Tolt River Floodplain Reconnection Project, now provides refuge to juvenile salmon from fast river flows. Also, many landowners have undertaken voluntary restoration efforts on their residential properties and farms, highlighting the depth of community commitment to protecting and restoring our environment for the benefit of fish, wildlife, and people (Snohomish River Basin 2019).

The 2015 Snohomish Basin Protection Plan (SBPP) is an update to the Salmon Plan and serves as planning guidance for greater protection of hydrology and salmon habitat. The SBPP was developed to create watershed and ecosystem resilience in the face of growing populations and changing climatic conditions (Snohomish River Basin 2019). The SBPP identified important steps for protecting hydrology and examined new and existing tools. By protecting hydrology, the SBPP aims to ultimately protect habitat quality, quantity, and diversity for fish and wildlife (Snohomish River Basin 2019).

The Water Resource Inventory Area (WRIA) 7 Climate Change Impacts to Salmon Issue Paper (leDoux et al. 2017) identifies key recommendations for restoration priorities to build resilience for salmon and the larger Snohomish Basin ecosystem. The proposed restoration priorities include work on hydrology, temperature, stormwater, sedimentation, sea level rise and ocean acidification (leDoux et al. 2017).

Aquatic habitat restoration is also expected as local transportation entities and the Washington State Department of Transportation repair or replace culverts that have blocked fish passage in the Snohomish River Basin. Statewide, the Department is required to correct passage at over 400 culverts by 2030 to provide access to 90 percent of the habitat blocked by Department-owned barriers (WSDOT 2018).

5.1.4 Hatchery Production

The type and extent of salmon and steelhead hatchery programs—other than the one considered under the alternatives—and the number of fish released in the cumulative impact analysis areas for each resource will likely change over time in response to new information and evolving management objectives. While some hatchery programs in Puget Sound have reduced or proposed to reduce production in the future, some programs have increased or proposed to increase production to increase the prey base for Southern Resident killer whales, provide additional harvest benefits, mitigate for habitat degradation and climate change, and/or bolster abundance temporarily while habitat is restored. In general, adverse effects on natural-origin salmon and steelhead (e.g., genetic effects and competition and predation risks) would likely decrease over time for those species listed under the ESA because of future ESA consultations.

Hatchery program compliance with conservation provisions of the ESA will ensure that these programs do not jeopardize the continued existence of listed species and that "take" under the ESA caused by salmon and steelhead hatchery programs is minimized or avoided. Assuming future compliance with the ESA and continued implementation and/or expansion of conservation hatchery programs, such hatchery programs could be a benefit in helping increase the abundance of salmon and steelhead populations in the future. The proposed program, measured by releases of juvenile hatchery fish, represents 1 percent of the total hatchery production in the analysis area,[23] and a much smaller percentage of the total hatchery production in Puget Sound (i.e., the summer-run steelhead production in the Skykomish River Basin is less than 0.07% of Puget Sound salmon and steelhead production).

[23] Over 16,000,000 salmon and steelhead are released in the analysis area annually. See (NMFS 2016b, 2017a)for more details.

5.1.5 Fisheries

Fisheries that harvest salmon and steelhead in the analysis area will likely change over time in response to new information and revised management objectives. Such fisheries include those in the Snohomish River Basin and adjacent marine catch areas where hatchery-origin salmon and steelhead produced by hatchery programs in the river basin are harvested. These fisheries provide for tribal and non-tribal commercial fisheries and non-tribal recreational fisheries, as well as for tribal ceremonial and subsistence uses.

Fisheries would continue to have incidental impacts negatively affecting the abundance of ESA-listed natural-origin salmon and steelhead, but fisheries management program compliance with conservation provisions of the ESA will ensure that listed species are not jeopardized and that "take" under the ESA from fisheries is minimized or avoided. Where needed, reductions in fisheries effects on listed salmon and steelhead may occur through changes in harvest areas or timing of fisheries or changes in types of harvest methods used. To the extent that improvements in the status of listed salmon and steelhead populations occur, potential additional future fisheries may be considered in the future. However, such fisheries are not considered for the purpose of this analysis because improvements in the statuses of listed salmon and steelhead populations are too speculative at this point for a meaningful analysis.

A Chinook salmon harvest resource management plan is currently under development by Puget Sound Indian Tribes and WDFW and will be reviewed by NMFS (WDFW and PSTIT 2017). The plan is intended to provide guidance for implementing fisheries in Washington for management years 2021/2022 through 2030/2031. In addition, a fishing regime that meets the guidance provided in the resource management plan will be developed during annual pre-season planning each year (i.e., set exploitation rate ceilings for each management unit).

5.2 Cumulative Impacts by Resource

Below is an analysis of the effects on each resource and a discussion of disproportionality of effects for environmental justice communities and groups listed in Chapter 3, Affected Environment, when considered cumulatively with the alternatives and the past, present, and reasonably foreseeable future actions discussed above.

5.2.1 Water Quantity

Section 3.1, Water Quantity, describes existing conditions for water quantity. The direct and indirect effects of the alternatives on water quantity are described in Section 4.1, Water Quantity. Climate change and rural and urban development are expected to affect water quantity by changing seasonality and magnitude of river flows and groundwater such that water levels may be lower or higher than historically occurred at specific times of the year (e.g., more water during winter months, less water during summer months). Although existing regulations and water conservation are intended to help protect water quantity from effects related to future rural and urban development, if past and present trends continue, the effectiveness of these regulations over time would likely vary. Future habitat restoration (such as protection of aquifers and recharge areas) would likely maintain or improve water quantity because the Instream Resources Protection and Water Resources Program for the Snohomish River Basin (WAC Chapter 173-500-040) established instream flows necessary to protect and preserve wildlife, fish, and other environmental values and uses established rules for Washington State Department of Ecology's management of appropriations of all surface waters and hydraulically connected groundwater in the river basin to protect those instream flows.

As discussed in Section 5.1.4, Hatchery Production, changes in hatchery programs other than the one considered under the alternatives will occur over time. These changes are unlikely to substantially change water quantity in the Snohomish River Basin because non-consumptive hatchery water use would continue to be limited by existing water rights. However, reductions in hatchery production or terminations of programs could decrease the amount of water that is used in hatchery operations and thus, less water would be diverted between the intake and the point of return to the stream (outflow), although hatchery operators may continue to exercise their existing water rights. Salmon and steelhead fisheries would not be expected to affect water quantity because fishing activities are non-consumptive contact uses of water resources.

Overall, effects of climate change and rural and urban development on water quantity may reduce available water resources and increase the potential for low-flow conditions during summer months, while increasing the frequency and size of peak flow events, including floods, during winter months compared to the existing conditions. In contrast, habitat restoration may help alleviate some climate change effects on water quantity. Hatchery operations and fisheries would have no adverse effect on water quantity other than that described in Chapter 4. These cumulative impacts on water quantity, combined with the negligible effects under the alternatives, would not substantially change current trends. The water quantity changes associated with the alternatives would comprise a minimal increment of the overall water quantity impacts from past, present, and foreseeable actions.

5.2.2 Water Quality

Section 3.2, Water Quality, describes existing conditions for water quality. The direct and indirect effects of the alternatives on water quality are described in Section 4.2. Climate change and rural and urban development are expected to affect water quality primarily by increasing water temperatures and the presence of toxic chemicals in stormwater runoff. Although existing regulations are intended to help protect water quality from effects related to future rural and urban development, if past and present trends continue, the effectiveness of these regulations over time would likely vary. Future habitat restoration would likely improve water quality.

As discussed in Section 5.1.4, Hatchery Production, changes in hatchery programs other than those considered under the alternatives will occur over time. These changes are unlikely to change or improve water quality in the Snohomish River Basin because water quality would be protected from changes in production within the existing hatchery programs, or from new programs, by compliance with the NPDES permit issued for operations at the facilities included in this EA, which are intended to avoid exceedance of water quality standards. Salmon and steelhead fisheries would not be expected to affect water quality, other than the potential for unintentional and generally minor oil and gas leakage from motorboat use and do not result in the release of any substantive contaminants into the aquatic environment.

Overall, effects of climate change, rural and urban development, and hatchery production on water quality may reduce water quality from the existing conditions described in Section 3.2, Water Quality. These negative effects may be offset to some extent by habitat restoration; however, these actions may not fully, or even partially, mitigate for the greater impacts of climate change and rural and urban development on water quality, although this is the goal of many of the restoration programs. When combined with effects under Alternative 1, the negative trends of cumulative impacts on water quality would be minorly reduced because of the termination of hatchery-origin summer-run steelhead production in the Snohomish River Basin. In contrast, effects under Alternative 2 (Proposed Action), Alternative 3 (Tolt River Broodstock), and Alternative 4 (reduced production) would continue to minorly contribute to the negative trends associated with water quality. Regardless, the water quality changes associated with all of the alternatives would comprise a minimal increment of the overall water quality impacts from past, present, and foreseeable actions.

5.2.3 Salmon and Steelhead

Section 3.3, Salmon and Steelhead, describes existing conditions for salmon and steelhead that may be affected by the alternatives. The direct and indirect effects of the alternatives on salmon and steelhead are described in Section 4.3, Salmon and Steelhead. The effects of climate change would likely contribute to the future condition and function of salmon and steelhead habitat and affect hatchery-origin and natural-origin salmon and steelhead life stages in various ways, as described in Table 24. The effects of climate change on salmon and steelhead are described in general by ISAB (2007) and would vary among species and among species' life stages (NWFSC 2015). Climate change, particularly changes in streamflow and water temperatures over the near- and long-term (20 to 60 years), is an important factor likely to affect hatchery-origin and natural-origin salmon and steelhead.

Table 24. Examples of potential impacts of climate change on salmon and steelhead life stages under all alternatives.

Life Stage	***Effects***
Egg	*1) Increased water temperatures and decreased flows during spawning migrations for some species would increase pre-spawning mortality and reduce egg deposition.* *2) Increased maintenance metabolism would lead to smaller fry.* *3) Increased water temperature may increase disease occurences.* *4) Changed thermal regime during incubation may lead to lower survival.* *5) Faster embryonic development would lead to earlier hatching.* *6) Increased mortality would occur for some species because of more frequent winter flood flows as snow level rises.* *7) Lower flows would decrease access to or availability of spawning areas.*

Life Stage	Effects
Spring and Summer Rearing	*1) Faster yolk utilization may lead to early emergence.* *2) Smaller fry are expected to have lower survival rates.* *3) Higher maintenance metabolism would lead to greater food demand.* *4) Growth rates would be slower if food is limited or if temperature increases exceed optimal levels; growth could be enhanced where food is available, and temperatures do not reach stressful levels.* *5) Predation risk would increase if temperatures exceed optimal levels.* *6) Lower flows would decrease rearing habitat capacity.* *7) Sea level rise would eliminate or diminish the rearing capacity of tidal wetland habitats for rearing salmon and steelhead and would reduce the area of estuarine beaches for spawning by forage fishes.*
Overwinter Rearing	*1) Smaller size at start of winter is expected to result in lower winter survival.* *2) Mortality would increase because of more frequent flood flows as snow level rises.* *3) Warmer winter temperatures would lead to higher metabolic demands, which may also contribute to lower winter survival if food is limited, or higher winter survival if growth and size are enhanced.* *4) Warmer winters may increase predator activity/hunger, which can also contribute to lower winter survival.*

Sources: ISAB (2007); Glick et al. (2007); Beamish et al. (2009); Beechie et al. (2013); Wade et al. (2013); Mauger et al. (2015)

Under all alternatives, effects on salmon and steelhead from climate change are expected to be similar because climate change would impact fish habitat and life stages under each alternative in the same manner. In other words, hatchery production levels alone would not change the effects of climate change on aquatic habitat conditions (e.g., changes in stream flow and water temperature); however, the effects of Alternative 2, Alternative 3, and (to a lesser extent) Alternative 4 may partially offset some climate change effects on salmon and steelhead populations compared to Alternative 1, which would terminate summer-run steelhead hatchery and the Sunset Falls Fishway programs in the Skykomish River Basin. For example, eggs incubated in a hatchery would not be exposed to mortality resulting from more frequent peak flows that are projected to occur with climate change. Also, the Sunset Falls Fishway trap-and-haul program under Alternatives 2, 3, and 4 may offset some of the climate change effects, providing substantial additional habitat for spawning and rearing for the species transported above Sunset Falls, which would not occur under Alternative 1.

In the past, the Snohomish River Basin has maintained a primarily rural character, and this is likely to continue in the future. Anticipated future rural and urban development intensity, as described in Section 5.1.2, Rural and Urban Development, is low relative to Snohomish County and Puget Sound. Rural and urban development results in environmental effects such as reduced forested area, increased sedimentation, greater incidence of impervious surface water runoff to streams, changes in stream flow because of increased consumptive uses, increased shoreline armoring, artificial channelization in lower river areas, added barriers to fish passage, and other types of changes that would continue to affect hatchery-origin and natural-origin salmon and steelhead (Quinn 2010). An indirect effect of rural and urban development, both locally and on larger spatial scales, could be an increasing demand for natural resource extraction, such as forest products used in construction, each with concomitant effects on the environment's quality. Consequently, new rural and urban development may indirectly contribute to habitat degradation from increased timber harvest in the Snohomish River Basin. Although regulatory changes for increased environmental protection (such as local critical areas ordinances and forest practices rules), monitoring, and enforcement have helped reduce impacts of rural and urban development on salmon and steelhead in fresh and marine waters, rural and urban development may continue to reduce salmon and steelhead habitat, decrease water quantity and quality, and contribute to salmon and steelhead mortality.

Under all alternatives, effects on salmon and steelhead from rural and urban development are expected to be similar because rural and urban development would impact fish habitat and life history stages under each alternative in the same manner. In other words, salmon and steelhead hatchery production levels would not change the effects of rural and urban development on aquatic habitat conditions (e.g., changes in sedimentation and stormwater runoff from impervious surfaces); however, the effects of Alternative 2, Alternative 3, and Alternative 4 may partially offset some rural and urban development effects on salmon and steelhead populations compared to Alternative 1, the latter of which would terminate the steelhead hatchery programs in the Snohomish River Basin. For example, steelhead reared in a hatchery would not be exposed to mortality resulting from increased sedimentation and scouring effects during egg incubation from increased stormwater runoff that are projected to occur with rural and urban development.

Habitat restoration efforts described in Section 5.1.3, Habitat Restoration, are anticipated to occur in the cumulative impact analysis area in the future, and, while difficult to quantify, potential benefits are expected to occur in localized areas. Benefits from habitat restoration are expected to affect salmon and steelhead survival and abundance similarly under all alternatives. Examples of such benefits may include increased habitat quality for foraging and spawning, improved water quality for fish survival, and increased fish passage through culverts to previously blocked habitat. However, these actions may not fully mitigate the impacts of climate change and rural and urban development on fish and their associated habitats. In part, this is because climate change and rural and urban development will likely continue to occur over time and affect aquatic habitat, while habitat restoration is less certain under all alternatives due to its dependence on funding. Benefits from habitat restoration are expected to affect salmon and steelhead survival and abundance similarly under all alternatives.

The negative effects on natural-origin salmon and steelhead from future salmon and steelhead hatchery releases in Puget Sound are expected to decrease over time,[24] especially for listed species, as hatchery programs are reviewed for consistency with best hatchery management standards and approved under the ESA (Section 5.1.4, Hatchery Production). For example, reduction of genetic or ecological risks may occur through application of new research results that lead to improved management by increasing the efficiency of hatchery operations, and reducing the potential for encounters between hatchery- and natural-origin fish in migration, rearing, and spawning areas. In general, continued hatchery releases within the cumulative impact analysis area, along with other observed environmental trends, as described in the following paragraphs, would affect continued long-term viability of natural-origin salmon and steelhead. However, under all alternatives, the steelhead hatchery program would have an insubstantial contribution to the overall cumulative impacts from hatchery production in the analysis area because the numbers of fish released would be relatively small. Under existing conditions and all alternatives, summer-run steelhead hatchery releases from the Snohomish River Basin represent less than 0.07 percent of total Puget Sound hatchery production of about 167.8 million fish (Appendix B of NMFS 2019c). Consequently, only in the event of massive future reductions in other Puget Sound salmon and steelhead hatchery programs would any variation of the Skykomish steelhead hatchery program analyzed in this EA represent a substantial contribution to cumulative impacts from hatchery production.

[24] While this statement describes the general long-term trend, negative effects may increase in the short term while hatchery productions are being increased to benefit SRKWs, which are declining, in part, because of prey limitatons.

The positive effects on natural-origin salmon and steelhead from the operation of the Sunset Falls Fishway trap-and-haul program would have a small, but important, contribution to the overall cumulative impacts because that program would continue to provide habitat (otherwise unavailable) for anadromous salmonids in upstream areas less likely to be affected by past, present, and reasonably foreseeable actions and conditions.

As described in Section 5.1.5, Fisheries, management of Washington State's fisheries resources is expected to continue into the future and would change over time, based on pre-season run size forecasts, such that harvest meets resource conservation needs, meets sustainable fisheries goals, and assures all parties are afforded their allotted harvest opportunity. WDFW and Puget Sound treaty tribes conduct pre-season planning each year for salmon and steelhead fisheries in Puget Sound and its tributaries and adjust the fisheries accordingly to ensure fisheries are managed flexibly and sustainably. While the level of steelhead-directed fisheries within the analysis area is likely to decrease under Alternative 1 because the lack of hatchery summer-run steelhead available for harvest, indirect fisheries effect on salmon and steelhead may not change as fisheries targeting other species would continue to impact salmon and steelhead. Under Alternatives 2, 3, and 4, fishery effects on salmon and steelhead are likely to remain the same.

In summary, effects from climate change and rural and urban development would likely continue to degrade aquatic habitat over time, while habitat restoration can provide some (mostly localized) benefit to mitigate habitat degradation. In addition, effects on abundance and productivity of natural-origin salmon and steelhead from changes in hatchery production and fisheries would be expected to continue, but negative effects may decrease over time as programs are reviewed for consistency with ESA and with best management practices. Alternative 1 would add to the negative trend of cumulative impacts on steelhead population viability due to the loss of hatchery-origin summer-run steelhead from the Skykomish River Basin, the ending of the trap-and-haul program, and the higher risk of declines in the viability of the natural-origin salmon and steelhead populations that are or could be supported by those hatchery fish. In contrast, Alternative 2, Alternative 3, and Alternative 4 would partially offset the negative trend of cumulative impacts on steelhead due to the availability of summer-run steelhead from the hatchery program in the Skykomish River Basin, and on salmon and steelhead due to the availability of important additional spawning and rearing habitat above Sunset Falls, which has been least affected and is least likely to be affected in the future by rural and urban development. However, the changes associated with the alternatives would comprise a minimal increment of the overall impacts on salmon and steelhead from past, present, and foreseeable actions

5.2.4 Other Fish Species

Section 3.3.4, Other Fish Species, lists fish species other than salmon and steelhead that have a relationship with hatchery-origin steelhead as prey, predators, or competitors (see Table 10). The direct and indirect effects of the alternatives on these species are described in Section 4.4, Other Fish Species.

Climate change and resulting warmer stream temperatures would have a negative effect on the distribution and abundance of other fish species, and in particular bull trout. Bull trout generally require cold water temperatures, clean stream substrates for spawning and rearing, complex habitats, and connections among streams, lakes, and ocean habitats for annual spawning and feeding migrations, and they can be more sensitive to habitat degradation than salmon and steelhead (USFWS 2010). Rural and urban development would also have a negative effect on other fish species, and in particular bull trout because such development often leads to a loss of or decrease in complex habitats, clean stream substrates, and interconnections among habitats. Rural and urban development could also result in warming of surface waters due to loss of riparian vegetation that helps to provide shade to support cold water temperatures, which is another factor contributing to the decline of bull trout.

Effects from climate change, rural and urban development, and fisheries (incidental catch of other fish species) would likely result in a negative trend for other fish species, while habitat restoration would partially offset this trend. As discussed in Section 5.1.3, Habitat Restoration, the extent to which habitat restoration actions may mitigate impacts from climate change and rural and urban development is difficult to predict at this time. Changes in overall hatchery programs within Puget Sound over time may also affect other fish species. For example, reductions in hatchery production or terminations of hatchery programs may decrease the prey base available for some fish species, while increases could have the opposite effect.

These cumulative impacts over the next 15 years among the other fish species considered in this EA would be more pronounced for bull trout because of a higher sensitivity to aquatic habitat degradation; however, negative facility effects from encounters of other fish species during broodstock collection in the Skykomish River Basin are negligible. On balance, Alternative 1 would not provide any offset to the negative trend of cumulative impacts on other fish species due to the termination of hatchery-origin steelhead from the Skykomish River Basin. The higher risk of declines in the viability of the natural-origin summer-run steelhead populations under Alternative 1 would also affect prey availability for other fish species. In contrast, Alternative 2, Alternative 3, and Alternative 4 would partially offset the negative trend of cumulative impacts on other fish species due to the availability of hatchery-origin steelhead from the Skykomish River Basin as prey and a higher potential for maintaining or increasing the abundance of natural-origin steelhead available as prey, as well as the transport of bull trout above the falls. Regardless of the alternative, the changes associated with the alternatives would comprise a minimal increment of the overall impacts on other fish species from past, present, and foreseeable actions.

5.2.5 Wildlife

Section 3.5, Wildlife, describes the existing conditions of wildlife. The direct and indirect effects of the alternatives on wildlife species are described in Section 4.5, Wildlife.

As discussed in Section 4.5, Wildlife, the availability of salmon and steelhead affects Southern Resident killer whales because salmon and steelhead are their prey base and Southern Resident killer whales are declining and food limited, though steelhead are not the most preferred salmonid prey for this species. While the production described under the alternatives in this EA contributes to a small amount of the prey base, hatchery programs in Puget Sound cumulatively can have a meaningful impact on the whales' prey base. In addition, Section 5.2.3, Salmon and Steelhead, describes how climate change and rural and urban development in the cumulative impacts analysis area may reduce the abundance and productivity of natural-origin salmon and steelhead. The potential benefits of habitat restoration actions within the cumulative impact analysis area may not fully, or even partially, mitigate for the effects of climate change and rural and urban development on salmon and steelhead abundance as prey for wildlife. As discussed in Section 5.1.4, Hatchery Production, and Section 5.1.5, Fisheries, changes in hatchery programs and fisheries, respectively, will occur over time resulting in increased or decreased prey base for wildlife. Effects from climate change, rural and urban development, habitat restoration, hatchery production, and fisheries will likely affect Southern Resident killer whales. Cumulative impacts on Southern Resident killer whales have resulted in declining abundance. The contributions of the alternatives to overall cumulative impacts on Southern Resident killer whales would be small and not meaningful because the summer-run steelhead hatchery program in the Skykomish River Basin contributes very few fish to the whales' prey base and steelhead are not a high-priority component of the whales' diet (Hanson et al. 2010; Hilborn et al. 2012; Ford et al. 2016). The changes associated with the alternatives would comprise a minimal increment of the overall impacts on other wildlife species from past, present, and foreseeable actions.

5.2.6 Socioeconomics

Section 3.6, Socioeconomics, describes the existing conditions for socioeconomics. The direct and indirect effects of the alternatives on socioeconomics from hatchery employment and commercial and recreational harvest of steelhead are described in Section 4.6, Socioeconomics. Although unquantifiable, climate change and rural and urban development will likely reduce the number of salmon and steelhead available for harvest over time. Habitat restoration actions may not fully mitigate for the cumulative impacts of climate change and rural and urban development. Reductions in hatchery production or terminations of hatchery programs within Puget Sound (outside the Skykomish summer-run steelhead hatchery program considered under the alternatives) would increase the overall impact by decreasing the number of fish available for harvest, decreasing the number of trips and expenditures from recreational fishing, and decreasing fishing and hatchery-related employment and income, while increases in hatchery production may have opposite effects. Changes in fisheries may also occur over time, which could alter the direction and magnitude of socioeconomic effects provided by hatchery production of salmon and steelhead.

Alternative 1 would not provide any offset to the negative cumulative impacts on fishery-related socioeconomics due to the termination of Skykomish summer-run steelhead hatchery and the trap-and-haul programs. The termination of these two programs under Alternative 1 would affect employment and expenditures associated with these programs, as well as the abundance of hatchery-origin and natural-origin salmon and steelhead available for future harvest. In contrast, Alternative 2, Alternative 3, and (to a lesser extent) Alternative 4 would partially offset the negative cumulative impacts on socioeconomics due to the availability of hatchery-origin summer-run steelhead for harvest, maintenance of or increase in the abundance of natural-origin salmon and steelhead because both the hatchery program and the trap-and-haul program are designed to boost demographics of salmon and steelhead, and the contribution to hatchery employment and related expenditures in the Snohomish River Basin, compared to Alternative 1. However, the changes associated with the alternatives would comprise a small increment of the overall impacts on socioeconomics from past, present, and foreseeable actions.

5.2.7 Cultural Resources

Section 3.7, Cultural Resources, describes existing conditions for cultural resources. The direct and indirect effects of the alternatives on cultural resources are described in Section 4.7, Cultural Resources. Although unquantifiable, climate change and rural and urban development may reduce the number of salmon and steelhead, which provide an important cultural value and are harvested by Puget Sound Indian tribes. These effects may be partially offset by habitat restoration actions, although the potential benefits of these actions are difficult to quantify and may not accrue fully within the next 15 years. The Sunset Falls Fishway trap-and-haul program may also partially offset climate change and rural and urban development effects by providing access to more pristine habitat to salmon and steelhead, as that area is forecasted not to have substantial rural and urban development in the future. As discussed in Section 5.1.5, Fisheries, changes in fisheries management may occur over time such that the proportion of the salmon or steelhead available for harvest in terminal areas increases or decreases.

Alternative 1 would not provide any offset to the negative cumulative impacts on cultural resources due to the termination of ~~summer-run steelhead~~ESS hatchery program and the Sunset Falls Fishway trap-and-haul programs in the Snohomish River Basin. In contrast, Alternative 2, Alternative 3, and (to a lesser extent) Alternative 4 would partially offset the negative cumulative impacts on cultural resources due to the availability of hatchery-origin summer-run steelhead for tribal harvest and by providing salmon and steelhead additional habitat above Sunset Falls increasing their abundance and productivity so that these may be of better use by the tribes, compared to Alternative 1. Alternative 1 would result in a small, but important, adverse effect and other Alternatives, a small, but important, beneficial effect on cultural resources because other hatchery production in the Snohomish Basin also contributes to tribal harvest, though salmonid species are not necessarily interchangeable for ceremonial and cultural practices

5.2.8 Environmental Justice

Section 3.8, Environmental Justice, describes environmental justice communities and user groups in the analysis area. Section 4.8, Environmental Justice, discusses whether effects disproportionately affect environmental justice communities. As described in Section 5.2.3, Salmon and Steelhead, and Section 5.2.7, Cultural Resources, the overall effects from climate change, rural and urban development, habitat restoration, and fisheries would likely decrease the number of salmon and steelhead available for tribal harvest. When considering effects of the alternatives in addition to those from climate change, rural and urban development, habitat restoration, and fisheries, the adverse cumulative impacts would disproportionately affect tribes via negative effects on cultural resources under Alternative 1 due to the loss of ~~summer-run steelhead~~ESS hatchery production, which would limit the number of available steelhead for tribal harvest. Tribes rely on steelhead for ceremonial and subsistence purposes and so are more affected than other community members by reduced numbers of steelhead available for harvest. Under Alternative 2, Alternative 3 and (to a lesser extent) Alternative 4, the hatchery production would continue to provide steelhead for tribal harvest, partially offsetting decreases in salmon and steelhead from climate change, rural and urban development, and fisheries.

5.2.9 Summary

The increment of impact associated with the alternatives under consideration in this EA relative to cumulative impacts of the stressors reviewed in this section is not substantive for any resources. With respect to environmental justice, Alternative 1 (termination) would contribute to a disproportionately negative effect on tribal communities that use hatchery and trap and haul program produced resources.

6 PERSONS AND AGENCIES CONSULTED

7 FINDING OF NO SIGNIFICANT IMPACT

7.1 Background

This FONSI and EA are being prepared using the 1978 CEQ NEPA Regulations. NEPA reviews initiated prior to the effective date of the 2020 CEQ regulations may be conducted using the 1978 version of the regulations. The effective date of the 2020 CEQ NEPA Regulations was September 14, 2020. This review began on October 30, 2019, and the agency has decided to proceed under the 1978 regulations.

7.1.1 Proposed Action

The Proposed Action is for the NMFS to make an ESA determination under limit 6 of the 4(d) Rule for one steelhead hatchery program in the Skykomish River Basin described in a HGMP, and under section 10 (a)(1)(A), for a permit application for the operation and maintenance of the Sunset Falls Fishway trap-and-haul program submitted by WDFW.

7.1.2 Alternatives Evaluated in the Environmental Assessment

There were four alternatives evaluated in the EA:

- **Alternative 1 (No Action/Termination)**: Under Alternative 1, NMFS would not make a determination under the 4(d) Rule for the Skykomish summer-run steelhead hatchery program HGMP, nor issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program. Consequently, the programs would be terminated.
- **Alternative 2 (Proposed Action)**: Under the Alternative 2, NMFS would make a determination that the HGMP for the proposed summer-run steelhead hatchery program submitted by the co-managers meets ESA section 4(d) Limit 6 requirements, and also issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program.
- **Alternative 3 (Tolt River Source)**: Under Alternative 3, NMFS would make a determination that the modified HGMP using Tolt River steelhead as the initial source for a new summer-run steelhead hatchery program in the Skykomish River meets ESA

section 4(d) Limit 6 requirements, and also would issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program as described under Alternative 2.

- **Alternative 4 (Reduced Production)**: Under Alternative 4, NMFS would make a determination that a modified HGMP limiting releases to 56,000 smolts yearly meets the criteria prescribed under Limit 6 of the 4(d) Rule, and would issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program.

7.1.3 Selected Alternative

NMFS is choosing Alternative 2 (Proposed Action), under which NMFS would make a determination that the HGMP for the proposed Skykomish summer steelhead hatchery program submitted by the co-managers meets ESA section 4(d) Limit 6 requirements, and also issue a Section 10(a)(1)(A) permit for the Sunset Falls Fishway trap and haul program.

7.1.4 Related Consultations

The ESA and EFH consultations related to the Proposed Action are listed here:

- NMFS concluded that salmon and steelhead hatcheries in Puget Sound are not likely to jeopardize the continued existence of Puget Sound/Georgia Basin yelloweye rockfish (*Sebastes ruberrimus*) or bocaccio (*Sebastes paucispinis*). In addition, salmon and steelhead hatcheries in Puget Sound may affect, but are not likely to adversely affect the following species and designated critical habitat: Southern Resident killer whales (*Orcinus orca*), Green sturgeon (*Acipenser medirostris*), and eulachon (NMFS 2020a).
- NMFS determined that the proposed Skykomish summer steelhead hatchery program outlined within the HGMP is not likely to jeopardize the continued existence or recovery of ESA-listed salmon and steelhead in the Snohomish River Basin, or destroy or adversely modify their critical habitat (NMFS 2021b).
- NMFS also evaluated EFH for the Proposed Action and concluded that the Skykomish summer steelhead hatchery program, as described in the HGMP and ITS, includes the best approaches to avoid or minimize potential adverse effects (NMFS 2021b).

- The USFWS determined that the proposed Skykomish summer steelhead hatchery program would not jeopardize the continued existence or recovery of ESA-listed bull trout in the Snohomish River Basin, or destroy or adversely modify their critical habitat (USFWS 2021).

7.2 Significance Review

The CEQ Regulations state that the determination of significance using an analysis of effects requires examination of both context and intensity, and lists ten criteria for intensity (40 C.F.R. § 1508.27). In addition, the Companion Manual for National Oceanic and Atmospheric Administration Administrative Order 216-6A provides sixteen criteria, the same ten as the CEQ Regulations and six additional, for determining whether the impacts of a Proposed Action are significant. Each of the sixteen criteria are discussed below with respect to the Proposed Action, and considered individually as well as in combination with the others.

7.2.1 Can the Proposed Action reasonably be expected to cause both beneficial and adverse impacts that overall may result in a significant effect, even if the effect will be beneficial?

The Proposed Action is not expected to cause both beneficial and adverse impacts that overall may result in a significant effect. This conclusion pertains to both the overall impacts of the action as well as to the specific impacts to various resources considered. The EA identified eight resources that the Proposed Action may impact and categorized the magnitude of the potential impact from undetectable to high, adverse and positive.

Resources impacted at a negligible-adverse effect level were: water quality, water quantity, disease, and facility operations. NMFS determined that ESA-listed salmon and steelhead (through ecological effects of hatchery-origin fish on natural-origin fish) had low-adverse level effects. Many of the other resources affected by the Proposed Action, such as socioeconomics, cultural resources, and environmental justice, had impacts up to a medium-beneficial level. Taken together, NMFS did not find that there would be an overall significant effect.

7.2.2 Can the Proposed Action reasonably be expected to significantly affect public health or safety?

The effect on public health or safety was not considered in the EA because NMFS determined during the scoping process that the potential human health impacts from the Proposed Action would be so minor that they are discountable. The only potential public health or safety impact would be from hatchery effluent (by impacting water quality). However, the facilities used for the proposed Skykomish summer steelhead hatchery program are obligated to maintain water quality standards defined within their National Pollutant Discharge Elimination System (NPDES) permits. These facilities have been meeting the water quality standards while operating under these permits and will continue to do so with the new program. The trap and haul program is not expected to impact public health or safety because the facility does not discharge hatchery effluent (i.e., no feed or chemicals are added to the water at the Sunset Falls facility).

7.2.3 Can the Proposed Action reasonably be expected to result in significant impacts to unique characteristics of the geographic area, such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas?

The Proposed Action would not affect unique characteristics of the geographic area because there are no designated historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas in the project area. In general, operation of the hatchery programs has low impact on these resources, and there is no construction planned as part of the Proposed Action. Existing infrastructure is managed in accordance with existing tribal, state, and Federal regulations for water withdrawal and effluent discharge. NMFS and USFWS found that the Proposed Action is not likely to destroy or adversely modify any ESA-designated critical habitats for ESA-listed species within the analysis area in the consultations referenced above in Section 1.1.4. Additionally, as described in sections 3.7 and 4.7 of the FEA, while steelhead are an important cultural resource to the Tulalip and other tribes, the proposed action would not result in significant impacts to the Tribes' ability to access and utilize the resource.

7.2.4 Are the Proposed Action's effects on the quality of the human environment likely to be highly controversial?

The Proposed Action's effects on the quality of the human environment are not likely to be highly controversial. NMFS acknowledges that because this is a new program, there is a chance that there may be some additional uncertainty about potential impacts compared to an ongoing program. In addition, new information about the population structure (i.e., relationship between the North Fork and South Fork populations) is also emerging. However, the applicants will perform genetic and demographic monitoring, as well as convene a co-manager led work group to continue discussions concerning new information, which if warranted, could lead to adaptive changes within the program. Because of these mitigating factors, the action is unlikely to result in any highly controversial impacts on the human environment.

Moreover, NMFS has provided an opportunity for public comment on the Draft EA. In response, NMFS received a total of 649 comments, with 646 in favor of the Proposed Action, while three sets of comments raised concerns about the genetic and ecological effects of the steelhead hatchery programs. We supplemented our analysis of these two areas in the EA (see section 3.3) with more recent data to address the commenters' concerns. After considering new data, NMFS' assessment of the impacts of the Proposed Action on the human environment, including in particular salmon and steelhead resources, remains unchanged compared to the draft EA (see section 4.3).

7.2.5 Are the Proposed Action's effects on the human environment likely to be highly uncertain or involve unique or unknown risks?

The Proposed Action's effects on the human environment are not likely to be highly uncertain or involve unique or unknown risks. NMFS has authorized many hatchery programs of this nature, and the effects are not highly uncertain or involve unique or unknown risks. The Skykomish summer steelhead hatchery fish are not an ESA-listed species, but could affect them, so potential risks are addressed in the associated biological opinion (NMFS 2021b).

Potential unique or unknown risks have been identified in the EA, though as discussed above, and in the HGMP, the applicants will conduct further study and enact adaptive measures if necessary to minimize any unforeseen risk. Numerous scientific studies on hatchery risks have identified what NMFS considers an accurate list of potential concerns.

For most hatchery programs, there is some degree of uncertainty as to how well the hatchery programs would be able to achieve their goals. However, from experience, NMFS can determine an approximate risk level associated with the Proposed Action. The Proposed Action includes explicit steps to monitor and evaluate uncertainties and risks that allows timely program adjustment. NMFS also retains the ability, through its regulations, to require changes if the program is ineffective, particularly with respect to the control of genetic effects on natural-origin steelhead.

7.2.6 Can the Proposed Action reasonably be expected to establish a precedent for future actions with significant effects or represent a decision in principle about a future consideration?

The Proposed Action is not likely to establish a precedent for future actions with significant effects or to represent a decision in principle about a future consideration. Other hatchery operations in the Puget Sound have been analyzed through similar ESA analyses and NEPA reviews (NMFS 2019b), so this action, and the analysis thereof, while differing in details from other hatchery programs as described above, is not fundamentally unique. Moreover, we do not consider any hatchery program a precedent as each program has particular characteristics and risks involved and must be assessed on its own.

7.2.7 Is the Proposed Action related to other actions that when considered together will have individually insignificant but cumulatively significant impacts?

The Proposed Action will not have cumulatively significant impacts when considered together with other past, present, and reasonably foreseeable actions, such as other hatchery programs, fisheries, development, climate change, and habitat restoration, because the increment of impact relative to cumulative impacts of the stressors reviewed in the EA is not substantive for any resources (see Section 5.2). The type and extent of salmon and steelhead hatchery programs and the number of fish released in the analysis areas will likely change over time in response to new information and evolving management objectives. In general, adverse effects on natural-origin salmon and steelhead (e.g., genetic effects and competition and predation risks) would likely decrease over time for those species listed under the ESA because of future ESA consultations.

Hatchery program compliance with conservation provisions of the ESA will ensure that these programs do not jeopardize the continued existence of listed species and that “take” under the ESA caused by salmon and steelhead hatchery programs is minimized or avoided. Assuming future compliance with the ESA and continued implementation and/or expansion of conservation hatchery programs, such hatchery programs could be a benefit in helping increase the abundance of salmon and steelhead populations in the future.

NMFS and the USFWS determined that the take of ESA-listed species would not jeopardize listed species when considering all existing conditions, all other permits, and other actions in the area (NMFS 2020a, 2021b; USFWS 2021).

7.2.8 Can the Proposed Action reasonably be expected to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources?

The Proposed Action does not include any new construction and is, therefore, unlikely to adversely affect districts, sites, highways, structures, or objects listed in or eligible for listing in the National Register of Historic Places. The Proposed Action is also unlikely to cause loss or destruction of significant scientific, cultural, or historic resources because of the limited geographic scope of the project area, which includes none of the aforementioned structures or resources. In addition, the Proposed Action would increase the number of steelhead returning, which is culturally important to the tribes.

7.2.9 Can the Proposed Action reasonably be expected to have a significant impact on endangered or threatened species, or their critical habitat as defined under the Endangered Species Act of 1973?

The Proposed Action would adversely impact endangered or threatened species, or their critical habitat, as described in the EA, at a level NMFS has determined will be no more than low-adverse. The EA describes each of the potential pathways by which the various alternatives considered could impact ESA-listed species. In reaching our conclusions, NMFS has also considered the analysis included in the associated biological opinions, which determined that the programs will not appreciably reduce the likelihood of survival and recovery of ESA-listed species within the action area, and the conclusion that ESA-listed species will not be jeopardized (NMFS 2021b; USFWS 2021).

The EA and associated biological opinions also summarize the impacts of the Proposed Action on ESA-designated critical habitat (NMFS 2020a, 2021b; USFWS 2021). All of the relevant biological opinions concluded that the expected impacts on critical habitat from the activities associated with the Skykomish summer steelhead hatchery program (e.g., water withdrawals) are unlikely to adversely modify or destroy critical habitat.

7.2.10 Can the Proposed Action reasonably be expected to threaten a violation of Federal, state, or local law or requirements imposed for environmental protection?

The Proposed Action is not expected to threaten any violations of Federal, state, or local laws or requirements imposed for environmental protection. The Proposed Action is specifically designed to comply with the ESA, and the evaluation and review of the Skykomish summer steelhead hatchery program and Sunset Falls trap and haul program under the ESA is part of the purpose of the action. Hatchery operations are required to comply with the Clean Water Act, including obtaining and operating within the limits of NPDES permits for discharge from hatchery facilities.

7.2.11 Can the Proposed Action reasonably be expected to significantly adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act?

The Proposed Action is not expected to significantly adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act. Steelhead are not predators of marine mammals (Section 3.5, Wildlife), and although steelhead could compete with harbor seals, sea lions, and porpoises for food, the total number of steelhead that would be produced under the Proposed Action is a small proportion of the total hatchery-origin and natural-origin salmonids in the analysis area, and would not be expected to have a measurable negative impact on any marine mammal stock. Similarly, while steelhead may be prey for these marine mammal stocks, the total number of steelhead that would be produced under the Proposed Action is a small portion of the total hatchery-origin and natural-origin salmonids in the analysis area, and would not be expected to have measurable positive impacts on any marine mammal stocks, including the Southern Resident killer whales, which have not been found to prefer steelhead (Section 4.5, Wildlife). Thus, effects on marine mammal species are negligible, and any effects would most likely be beneficial.

7.2.12 Can the Proposed Action reasonably be expected to significantly adversely affect managed fish species?

The Proposed Action is not expected to significantly adversely affect MSA-managed fish species beyond what NMFS identifies as low-adverse levels. The impacts of the Proposed Action on managed fish species, specifically Chinook and coho salmon, within the Snohomish River basin are limited to a low-adverse level of impact. These impacts are due to intra- and inter-species competition and predation related to the release of juveniles. Effects on managed fish species that are also ESA-listed species within the project area have been analyzed in the associated biological opinions (NMFS 2021b; USFWS 2021), and have been incorporated into our effect level assessment in the EA (section 4.3), and our findings here. Effects on non-ESA-listed managed fish are also analyzed in the EA (section 4.3).

7.2.13 Can the Proposed Action reasonably be expected to significantly adversely affect essential fish habitat (EFH) as defined under the Magnuson-Stevens Fishery Conservation and Management Act?

There are impacts on EFH anticipated, but they are expected to be small. Adult spawning and holding habiat, and juvenile rearing habitat are not expected to be affected by the operation of the programs. The migration corridor may be impacted from the operation of hatchery water withdrawals and the operation of weirs. The water withdrawals are small enough in scale that changes in flow would be undetectable, and weirs would be operated using best management practices as described in the HGMPs.

7.2.14 Can the Proposed Action reasonably be expected to significantly adversely affect vulnerable marine or coastal ecosystems, including but not limited to, deep coral ecosystems?

The release of Skykomish summer steelhead hatchery juveniles, and the resulting returning adult steelhead would not have a discernable effect on vulnerable marine or coastal ecosystems because the number of juvenile hatchery fish and returning adults is small (less than fraction of a percent) relative to the overall abundance of salmon and steelhead within these areas.

7.2.15 Can the Proposed Action reasonably be expected to significantly adversely affect biodiversity or ecosystem functioning (e.g., benthic productivity, predator-prey relationships, etc.)?

There is a potential that the Proposed Action may adversely affect biodiversity and ecosystem function, but the impacts are anticipated to be negligible. As described above, one of the risks associated with the release of hatchery fish is adverse ecological interactions between hatchery juveniles and natural-origin juveniles below the point of release in the mainstem Snohomish River. The proposed Skykomish summer steelhead hatchery releases may have a minor beneficial effect by being prey for other species, including ESA-listed bull trout, other fish species, and piscivorous birds. The program represents only a small portion of the total amount of food available to predators. In addition, there may be some potential negative effects if the fish released from the program prey upon other species of concern. Also, returning Skykomish summer steelhead hatchery-origin adults may result in a benefit to benthic productivity through marine-derived nutrients after spawning, if they die. In addition, the proposed releases are small in the context of other salmonid releases in the Snohomish River basin and surrounding basins.

7.2.16 Can the Proposed Action reasonably be expected to result in the introduction or spread of a nonindigenous species?

The Proposed Action is not reasonably expected to result in the introduction or spread of nonindigenous species because the hatcheries only propagate steelhead that return to the Skykomish River basin.

7.3 Determination

In view of the information presented in this document and the analysis contained in the EA, it is hereby determined that NMFS' ESA determination on the Skykomish River summer steelhead hatchery program and the Sunset Falls trap and haul program will not significantly impact the quality of the human environment as described above and in the supporting EA. In addition, all beneficial and adverse impacts of the Proposed Action have been addressed to reach the conclusion of no significant impacts. Accordingly, preparation of an environmental impact statement for this action is not necessary.

______________________________ July 2, 2021

Barry A. Thom Date

Regional Administrator

NMFS West Coast Region

8 REFERENCES

Amoss, P. T. 1987. The fish God gave us: the first salmon ceremony revived. Arctic anthropology Volume 24(1), pages 56-66.

Antipa, B. J. 2019a. Email to Emi Melton (NMFS) from Brodie Antipa (DFW). Some more questions for the S Fk program. Nov 25, 2019. 1p.

Antipa, B. J. 2019b. Email to Emi Melton (NMFS) from Brodie Antipa (DFW). Some more questions for the S Fk program. Here are avian mortality records for Reiter/Wallace, actually all state facilities but Reiter/Wallace/Tokul are all in here, some years there is no mortality depending on the facility. Dec 9, 2019 at 1:59 PM. 1p.

Antipa, B. J. 2019c. Email to Emi Melton (NMFS) from Brodie Antipa (DFW). Some more questions for the S Fk program. Here are avian mortality records for Reiter/Wallace, actually all state facilities but Reiter/Wallace/Tokul are all in here, some years there is no mortality depending on the facility. Dec 6, 2019 at 8:16 AM. 2p.

Ayllon, F., J. L. Martinez, and E. Garcia-Vazquez. 2006. Loss of regional population structure in Atlantic salmon, *Salmo salar* L., following stocking. ICES Journal of Marine Science. Volume 63, pages 1269-1273.

Banas, N. S., H. T. T. Nguyen, S. Garnier, P. MacCready, and S. E. Allen. 2019. Climate impacts on patterns of phytoplankton production in Puget Sound, USA: A model synthesis and narrowing of hypotheses. Salish Sea Marine Surival Technical Report, 37p. . Retrieved from website shoughton.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. University of Washington Water Center. Retrieved from website shoughton.

Beacham, T. D., and C. B. Murray. 1990. Temperature, egg size, and development of embryos and alevins of five species of pacific salmon: A comparative analysis. Transactions of the American Fisheries Society. Volume 119(6), pages 927-945.

Beamer, E., A. McBride, C. Greene, R. Henderson, G. Hood, K. Wolf, K. Larsen, C. Rice, and K. Fresh. 2005. Delta and Nearshore Restoration for the Recovery of Wild Skagit River Chinook Salmon: Linking Estuary Restoration to Wild Chinook Salmon Populations. 97p.

Beamish, R. L., B. E. Riddell, K. L. Lange, E. F. Jr., S. Kang, T. Nagasawa, V. Radchenko, O. Temnykh, and S. Urawa. 2009. The effects of climate on Pacific salmon - A summary of published literature. North Pacific Anadromous Fish Commission (NPAFC) Special Publication No. 1. Published Literature. 11p.

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, J. Kimball, J. Stanford, G. Pess, P. Roni, P. Kiffney, and N. Mantua. 2013. Restoring Salmon Habitat for a Changing Climate. River Research and Applications. Volume 29(8), pages 939-960.

Berejikian, B. A., and M. J. Ford. 2004. Review of Relative Fitness of Hatchery and Natural Salmon. December 2004. U.S. Dept. Commer., NOAA Technical Memorandum NMFS-NWFSC-61. 43p.

Bjornn, T. C., and D. W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan, editor. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society. Special Publication 19.

Boxall, A. B., L. A. Fogg, P. A. Blackwell, P. Kay, E. J. Pemberton, and A. Croxford. 2004. Veterinary medicines in the environment. Reviews of Environmental Contaminants & Toxicology. Volume 180, pages 1-91.

Brenkman, S. J., G. R. Pess, C. E. Torgersen, K. K. Kloehn, J. J. Duda, and S. C. Corbett. 2008. Predicting recolonization patterns and interactions between potamodromous and anadromous salmonids in response to dam removal in the Elwha River, Washington State. Northwest Science Special Issue. Volume 82, pages 91-106.

Busack, C., and K. P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. AFS Symposium Volume 15, pages 71-80.

CBFWA. 1996. Draft Programmatic Environmental Impact Statement. Impacts of Artificial Salmon and Steelhead Production Strategies in the Columbia River Basin. December 10, 1996. Prepared by the Columbia Basin Fish and Wildlife Authority, Portland, Oregon. 475p.

Cederholm, C. J., D. H. Johnson, R. E. Bilby, L. G. Dominguez, A. M. Garrett, W. H. Graeber, E. L. Greda, M. D. Kunze, B. G. Marcot, J. F. Palmisano, R. W. Plotnikoff, W. G. Pearch, C. A. Simenstad, and P. C. Trotter. 2000. Pacific Salmon and Wildlife - Ecological Contexts, Relationships, and Implications for Management. Special edition technical report. Prepared for D.H. Johnson and T.A. O'Neil (managing directors), Wildlife-Habitat Relationships, and Implications for Management. WDFW, Olympia, Washington.

Chasco, B., I. C. Kaplan, A. Thomas, A. Acevedo-Gutiérrez, D. Noren, M. J. Ford, M. B. Hanson, J. Scordino, S. Jeffries, S. Pearson, K. N. Marshall, and E. J. Ward. 2017a. Estimates of Chinook salmon consumption in Washington State inland waters by four marine mammal predators from 1970 to 2015. Canadian Journal of Fisheries and Aquatic Sciences. Volume 74(8), pages 1173–1194.

Chasco, B. E., I. C. Kaplan, A. C. Thomas, A. Acevedo-Gutiérrez, D. P. Noren, M. J. Ford, M. B. Hanson, J. J. Scordino, S. J. Jeffries, K. N. Marshall, A. O. Shelton, C. Matkin, B. J. Burke, and E. J. Ward. 2017b. Competing tradeoffs between increasing marine mammal predation and fisheries harvest of Chinook salmon. Scientific Reports. Volume 7(1), pages 1-14.

Christie, M. R., M. L. Marine, R. A. French, R. S. Waples, and M. S. Blouin. 2012. Effective size of a wild salmonid population is greatly reduced by hatchery supplementation. Heredity. Volume 109, pages 254-260.

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

Dawley, E. M., R. D. Ledgerwood, T. H. Blahm, R. A. Kirm, and A. E. Rankis. 1984. Migrational characteristics and survival of juvenile salmonids entering the Columbia River estuary during 1983. July 1984. Annual report of research financed by Bonneville Power Administration Agreement DE-A-179-83BP39652. NMFS, Seattle, Washington. 94p.

DeVries, P. 1997. Riverine salmonid egg burial depths: Review of published data and implications for scour studies. Canadian Journal of Fisheries and Aquatic Sciences. Volume 54, pages 1685–1698.

Edmands, S. 2007. Between a rock and a hard place: Evaluating the relative risks of inbreeding and outbreeding for conservation and management. Molecular Ecology. Volume 16, pages 463-475.

Eldridge, W. H., J. M. Myers, and K. A. Naish. 2009. Long-term changes in the fine-scale population structure of coho salmon populations (*Oncorhynchus kisutch*) subject to extensive supportive breeding. Heredity. Volume 103, pages 299-309. Available at www.nature.com/hdy.

Eleazer, E. 2020. Email to Emi Melton (NMFS) from Edward Eleazer (DFW). Staff time/operation cost of Sunset Falls. Jan 15, 2020. 3p.

Essington, T. E., T. P. Quinn, and V. E. Ewert. 2000. Intra- and inter-specific competition and the reproductive success of sympatric Pacific salmon. Canadian Journal of Fisheries and Aquatic Sciences. Volume 57, pages 205-213.

Everest, F. H., and D. W. Chapman. 1972. Habitat selection and spatial Interaction by juvenile Chinook salmon and steelhead trout in two Idaho streams. Journal of the Fisheries Research Board of Canada Volume 29, pages 91-100.

Flagg, T. A., B. A. Berejikian, J. E. Colt, W. W. Dickhoff, L. W. Harrell, D. J. Maynard, C. E. Nash, M. S. Strom, R. N. Iwamoto, and C. V. W. Mahnken. 2000. Ecological and behaviorial impacts of artificial production strategies on the abundance of wild salmon populations. A review of practices in the Pacific Northwest. NOAA Technical Memorandum NMFS-NWFSC-41. NMFS, Seattle, Washington. 98p.

Ford, M., K. Nichols, R. Waples, E. C. Anderson, M. Kardos, I. Koch, G. McKinney, M. R. Miller, J. Myers, K. Naish, S. Narum, K. G. O'Malley, D. Pearse, T. Seamons, A. Spidle, P. Swanson, T. Q. Thompson, K. Warheit, and S. Willis. 2020. Reviewing and Synthesizing the State of the Science Regarding Associations between Adult Run Timing and Specific Genotypes in Chinook Salmon and Steelhead: Report of a workshop held in Seattle, Washington, 27–28 February 2020. June 2020. 57p.

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. November 2011. U.S. Dept. Commer., NOAA Tech. Memo., NMFS-NWFSC-113. 307p.

Ford, M. J., J. Hempelmann, B. Hanson, K. L. Ayres, R. W. Baird, C. K. Emmons, J. I. Lundin, G. S. Schorr, S. K. Wasser, and L. K. Park. 2016. Estimation of a killer whale (*Orcinus orca*) population's diet using sequencing analysis of DNA from feces. PLoS ONE. Volume 11(1), pages 1-14.

Frankham, R., C. J. A. Bradshaw, and B. W. Brook. 2014. Genetics in conservation management: revised recommendations for the 50/500 rules, Red List criteria and population viability analyses. Biological Conservation. Volume 170, pages 56-63. Retrieved from website shoughton.

Galbreath, P. F., C. A. Beasley, B. A. Berejikian, R. W. Carmichael, D. E. Fast, M. J. Ford, J. A. Hesse, L. L. McDonald, A. R. Murdoch, C. M. Peven, and D. A. Venditti. 2008. Recommendations for Broad Scale Monitoring to Evaluate the Effects of Hatchery Supplementation on the Fitness of Natural Salmon and Steelhead Populations. October 9, 2008. Final report of the Ad Hoc Supplementation Monitoring and Evaluation Workgroup (AHSWG). 87p.

Gislason, G., E. Lam, G. Knapp, and M. Guettabi. 2017. Economic Impacts of Pacific Salmon Fisheries. July 2017. 100p.

Glick, P., J. Clough, and B. Nunley. 2007. Sea-level Rise and Coastal Habitats in the Pacific Northwest: An Analysis for Puget Sound, Southwestern Washington, and Northwestern Oregon. National Wildlife Federation. 106p.

Grant, W. S. 1997. Genetic Effects of Straying of Non-Native Hatchery Fish into Natural Populations. Proceedings of the workshop, June 1-2, 1995, Seattle, Washington. U.S. Department of Commerce, NOAA Tech. Memo., NMFS-NWFSC-30. 157p.

Greene, C., L. Kuehne, C. Rice, K. Fresh, and D. Penttila. 2015. Forty years of change in forage fish and jellyfish abundance across greater Puget Sound, Washington (USA): anthropogenic and climate associations. Marine Ecology Progress Series. Volume 525, pages 153-170. Retrieved from website shoughton.

Groot, C., and L. Margolis. 1991. Pacific Salmon Life Histories. UBC Press. Vancouver, British Columbia, Canada. 588p.

Gunther, E. 1950. The Indian Background of Washington History *in* Pacific Northwest Quarterly, Volume 41, Number 3. July, 11, 1950. Pages 189-202.

Gustafson, R. G., T. C. Wainwright, G. A. Winans, F. W. Waknitz, L. T. Parker, and R. S. Waples. 1997. Status Review of Sockeye Salmon from Washington and Oregon. December 1997. Seattle, Washington. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-33. NMFS, Seattle, Washington. 300p.

Gustafson, R. G., R. S. Waples, J. M. Myers, L. A. Weitkamp, G. J. Bryant, O. W. Johnson, and J. J. Hard. 2007. Pacific salmon extinctions: Quantifying lost and remaining diversity. Conservation Biology Volume 21(4), pages 1009-1020.

Haggerty, M. 2020a. Memorandum to Emi Melton from Mike Haggerty. PNI Alt 4 and Skamania Overlap with Summer NOS. December 3, 2020. 1p.

Haggerty, M. 2020b. Final Draft. Memorandum to Emi Melton from Mike Haggerty. Data and Analyses used for the Evaluation of the Skykomish River Summer-Run Steelhead HGMP. December 15, 2020. 23p.

Haggerty, M. 2021. Memorandum to Emi Melton and Scott Sebring from Mike Haggerty. Projected hatchery stray summer steelhead into the S.F. Tolt population from the proposed release of 116,000 summer steelhead at Reiter Ponds. 2/18/2021. 2p.

Halpern, B. S., C. V. Kappel, K. A. Selkoe, F. Micheli, C. M. Ebert, C. Kontgis, C. M. Crain, R. G. Martone, C. Shearer, and S. J. Teck. 2009. Mapping cumulative human impacts to California current marine ecosystems. Conservation Letters. Volume 2, pages 138-148.

Hamlet, A. F. 2011. Impacts of Climate Variability and Climate Change on Transportation Systems and Infrastructure in the Pacific Northwest. Climate Impacts Group, University of Washington, Seattle, Washington.

Hanson, M. B., R. W. Baird, J. K. B. Ford, J. Hempelmann-Halos, D. M. V. Doornik, J. R. Candy, C. K. Emmons, G. S. Schorr, B. Gisborne, K. L. Ayres, S. K. Wasser, K. C. Balcomb, K. Balcomb-Bartok, J. G. Sneva, and M. J. Ford. 2010. Species and stock identification of prey consumed by endangered Southern Resident Killer Whales in their summer range. Endangered Species Research. Volume 11 (1), pages 69-82.

Hard, J. J., R. Kope, W. Grant, F. W. Waknitz, L. Parker, and R. Waples. 1996. Status review of pink Salmon from Washington, Oregon, and California. February 1996. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-25. 141p.

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.

Haring, D. 2002. Salmonid Habitat Limiting Factors Analysis Snohomish River Watershed Water Resource Inventory Area 7. Final report. December 2002. Washington State Conservation Commission. 331p.

Hausch, S. J., and M. C. Melnychuk. 2012. Residualization of hatchery steelhead: A meta-analysis of hatchery practices. North American Journal of Fisheries Management. Volume 32(5), pages 905-921.

Heard, W. R. 1991. Life history of pink salmon (*Oncorhynchus gorbuscha*). Pages 119-230 in C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Univ. British Columbia, Vancouver, British Columbia.

Hilborn, R., S. P. Cox, F. M. D. Gulland, D. G. Hankin, N. T. Hobbs, D. E. Schindler, and A. W. Trites. 2012. The Effects of Salmon Fisheries on Southern Resident Killer Whales: Final Report of the Independent Science Panel. November 30, 2012. Prepared with the assistance of D.R. Marmorek and A.W. Hall, ESSA Technologies Ltd., Vancouver, B.C. for NMFS, Seattle, Washington and Fisheries and Oceans Canada (Vancouver. BC). 87p.

Hillman, T. W., and J. W. Mullan. 1989. Effect of Hatchery Releases on the Abundance of Wild Juvenile Salmonids. Chapter 8 *in* Summer and Winter Ecology of Juvenile Chinook salmon and steelhead trout in the Wenatchee River, Washington. Report to Chelan County PUD by D.W. Chapman Consultants, Inc. Boise, Idaho. 22p.

Horner, N. J. 1978. Survival, Densities and Behavior of Salmonid Fry in Stream in Relation to Fish Predation. July 1978. A Master's Thesis, University of Idaho, Moscow, Idaho. 132p.

HSRG. 2004. Hatchery reform: Principles and Recommendations of the Hatchery Scientific Review Group. April 2004. Available at Long Live the Kings. 329p.

HSRG. 2009. Columbia River Hatchery Reform Project Systemwide Report. Appendix A. White Paper No. 1. Predicted Fitness Effects of Interbreeding between Hatchery and Natural Populations of Pacific Salmon and Steelhead. 38p.

ICTRT. 2007. Considering alternative Artificial Propagation programs: Implications for the viability of listed Anadromous Salmonids in the Interior Columbia River. 77p.

ISAB. 2007. Climate Change Impacts on Columbia River Basin Fish and Wildlife. May 11, 2007. Report ISAB 2007-2. Northwest Power and Conservation Council, Portland, Oregon. 146p

Johannessen, S. C., and R. W. Macdonald. 2009. Effects of local and global change on an inland sea: The Strait of Georgia, British Columbia, Canada. Climate Research. Volume 40(1), pages 1-21.

Johnson, M. A., J. Spangler, M. Jones, R. B. Couture, and D. L. G. Noake. 2020. Angler Harvest of Alsea River Hatchery Winter Steelhead: An Evaluation of Wild Broodstock Collection Techniques. Oregon Department of Fish and Wildlife; Report Series Number 2020-05. 47p.

Johnson, O. W., W. S. Grant, R. G. Cope, K. Neely, F. W. Waknitz, and R. S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Dept. Commer., NOAA Technical Memorandum NMFS-NWFSC-32. 298p.

Kondolf, G. M., and M. G. Wolman. 1993. The Sizes of Salmonid Spawning Gravels. Water Resources Research. Volume 29(7), pages 2275-2285.

Larsen, D. A., M. A. Middleton, J. T. Dickey, R. S. Gerstenberger, C. V. Brun, and P. Swanson. 2017. Use of morphological and physiological indices to characterize life history diversity in juvenile hatchery winter-run steelhead. Transactions of the American Fisheries Society. Volume 146(4), pages 663-679.

leDoux, B., J. Engle, M. Ruff, and C. Wahl. 2017. WRIA 7 Climate Change Impacts to Salmon Issue Paper. Final Draft. January 2017. 24p. Retrieved from website shoughton.

Levings, C. D., C. D. McAllister, and B. D. Chang. 1986. Differential use of the Campbell River Estuary, British Columbia, by wild and hatchery-reared juvenile chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences. Volume 43(7), pages 1386-1397.

Littell, J. S., M. McGuire Elsner, L.C. Whitely Binder, and A.K. Snover (eds). 2009. The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate - Executive Summary. *In* The Washington Climate Change Impacts Assessment: Evaluating Washington's Future in a Changing Climate, Climate Impacts Group, University of Washington, Seattle, Washington.

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. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. 309p.

McClelland, E. K., and K. Naish. 2007. Comparisons of F_{st} and Q_{st} of growth-related traits in two populations of coho salmon. Transactions of the American Fisheries Society. Volume 136, pages 1276-1284.

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. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-42. 174p.

McMichael, G. A., C. S. Sharpe, and T. N. Pearsons. 1997. Effects of residual hatchery-reared steelhead on growth of wild rainbow trout and spring Chinook salmon. Transactions of the American Fisheries Society. Volume 126(2), pages 230-239.

McNeil, W. J. 1991. Expansion of cultured Pacific salmon into marine ecosystems. Aquaculture. Volume 98(1-3), pages 173-183.

Melton, E. 2020. Memorandum for the File calculating the travel rate for the Skykomish steelhead hatchery releases. December 1, 2020. 2p.

Melton, E. 2021. Memo to file - Salmon and steelhead predominant occurrence timing and juvenile natural-origin abundance. January 9, 2021. 2p.

Moore, M. E., B. A. Berejikian, and E. P. Tezak. 2010. Early marine survival and behavior of steelhead smolts through Hood Canal and the Strait of Juan de Fuca. Transactions of the American Fisheries Society. Volume 139(1), pages 49-61.

Moore, M. E., B. A. Berejikian, F. A. Goetz, A. G. Berger, S. S. Hodgson, E. J. Connor, and T. P. Quinn. 2015. Multi-population analysis of Puget Sound steelhead survival and migration behavior. Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science. Volume 537, pages 217–232.

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.

Naish, K. A., J. E. Taylor, P. S. Levin, T. P. Quinn, J. R. Winton, D. Huppert, and R. Hilborn. 2007. An evaluation of the effects of conservation and fishery enhancement hatcheries on wild populations of salmon. Advances in Marine Biology. Volume 53, pages 61-194. Retrieved from website shoughton.

Naman, S. W., and C. S. Sharpe. 2012. Predation by hatchery yearling salmonids on wild subyearling salmonids in the freshwater environment: A review of studies, two case histories, and implications for management. Environmental Biology of Fisheries. Volume 94(1), pages 21-28.

Nelson, K., and B. Kelder. 2005. 2003 Skykomish River Chinook and coho out-migration study. Annual report No. 05-3. Tulalip Natural Resources Department, Tulalip, Washington. 84p.

Nilsson, N.-A. 1967. Interactive Segregation Between Fish Species. Pages 295-313 *in* Gerking, S. D., editor. The Biological Basis of Freshwater Fish Production Blackwell Scientific.

NMFS. 1995. Juvenile Fish Screen Criteria. Revised February 16, 1995. NMFS, Portland, Oregon. 15p.

NMFS. 1996. Juvenile Fish Screen Criteria for Pump Intakes: Addendum. May 9, 1996. NMFS Environmental and Technical Services Division, Portland, Oregon. 4p. Available at http://www.westcoast.fisheries.noaa.gov/publications/hydropower/fish_screen_criteria_for_pumped_water_intakes.pdf.

NMFS. 2000. Guidelines for electrofishing waters containing salmonids listed under the Endangered Species Act. NMFS, Northwest Region, Portland, Oregon.

NMFS. 2004. Puget Sound Chinook Harvest Resource Management Plan Final Environmental Impact Statement. December 2004. National Marine Fisheries Service, Northwest Region, Seattle, Washington. 1537p.

NMFS. 2005. Record of Decision Puget Sound Chinook Harvest Resource Management Plan Final Environmental Impact Statement. NMFS Northwest Region with Puget Sound Treaty Tribes and Washington Department of Fish and Wildlife. February 2005. 32p.

NMFS. 2008. Assessing Benefits and Risks & Recommendations for Operating Hatchery Programs consistent with Conservation and Sustainable Fisheries Mandates. Appendix C of Supplementary Comprehensive Analysis of the Federal Columbia River Power System and Mainstem Effects of the Upper Snake and other Tributary Actions. May 5, 2008. NMFS, Portland, Oregon.

NMFS. 2011. Anadromous Salmonid Passage Facility Design. July 2011. National Marine Fisheries Service, Northwest Region, Portland, Oregon. 140p.

NMFS. 2014. Draft Environmental Impact Statement on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs. 1650p.

NMFS. 2015. NMFS Northwest fisheries Science Center Geoviewer. https://www.webapps.nwfsc.noaa.gov/apex/f?p=280:1::::. Accessed November 10, 2015. .

NMFS. 2016a. 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. 2016b. Endangered Species Act Section 7(a)(2) Biological Opinion, Conference 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 Dungeness River Basin Salmon Under Limit 6 of the Endangered Species Act Section 4(d) Rule. Portland, Oregon. May 31, 2016. NMFS Consultation No.: NWR-2013-9701. 158p.

NMFS. 2017a. 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 Six Hatchery and Genetic Management Plans for Snohomish River basin Salmon under Limit 6 of the Endangered Species Act Section 4(d) Rule. September 27, 2017. NMFS Consultation No.: NWR-2013-9699. 189p.

NMFS. 2017b. Final Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Six Hatchery Programs for Snohomish River Basin Salmon as Described in Joint State-Tribal Hatchery and Genetic Management Plans Satisfy the Endangered Species Act Section 4(d) Rule. March 2017. 222p.

NMFS. 2019a. ESA Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (*Oncorhynchus mykiss*). WCR/NMFS/NOAA. December 20, 2019. 174p.

NMFS. 2019b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. Recreational and Tribal Treaty Steelhead Fisheries in the Snake River Basin. NMFS Consultation No.: WCR-2018-10283. 131p.

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. Final Environmental Assessment for Four Salmon Hatchery Programs in the Stillaguamish River Basin. October 24, 2019. 242p.

NMFS. 2020a. Biological Assessment for the Operation and Maintenance of the Sunset Falls Trap-and-Haul Facility and Integrated Skykomish River summer steelhead Program. August 25, 2020. 56p.

NMFS. 2020b. Endangered Species Act Section 7(a)(2) Biological for NMFS Sustainable Fisheries Division's determinations on salmon and steelhead hatchery programs in Puget Sound under limit 6 of the ESA 4(d) rules for listed salmon and steelhead in Puget Sound (50 CFR § 223.203(b)(6)). Consultation No.: WCRO 2020-01366. November 4, 2020. 81p.

NMFS. 2020c. Endangered Species Act Section 7(a)(2) Biological for NMFS Sustainable Fisheries Division's determinations on salmon and steelhead hatchery programs in Puget Sound under limit 6 of the ESA 4(d) rules for listed salmon and steelhead in Puget Sound (50 CFR § 223.203(b)(6)). Consultation No.: WCRO 2020-01366. .

NMFS. 2020d. 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. 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. April 23, 2021. NMFS Consultation Number: WCRO-2019-04075. 176p.

NMFS. 2021b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Conference Opinion Biological Opinion on the Authorization of the West Coast Ocean Salmon Fisheries Through Approval of the Pacific Salmon Fishery Management Plan Including Amendment 21 and Promulgation of Regulations Implementing the Plan for Southern Resident Killer Whales and their Current and Proposed Critical Habitat. NMFS Consultation Number: WCRO-2019-04074. April 21, 2021. 190p.

NMFS. 2021c. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation

Round Butte Hatchery Summer Steelhead Program. Round Butte Hatchery Summer Steelhead Program. June, 23, 2021. Consultation Number: WCRO-2020-03433. 1p.

NWFSC. 2015. Status Review Update for Pacific Salmon and Steelhead listed under the Endangered Species Act: Pacific Northwest. December 21, 2015. NWFSC, Seattle, Washington. 356p.

NWIFC. 2013. Letter to William Stelle and Phil Anderson from Mike Grayum. Tribal policy statement for salmon hatcheries in the face of treaty rights at risk. January 31, 2013. NWIFC, Olympia Washington. 3p.

Patino, E. 2020. Note to Emi on calculations of Percent of total phosphorous contribution from summer steelhead program under current conditions and under the proposed action with different amounts of outplanting. November 10, 2020. 1p.

Pearsons, T. N., G. A. McMichael, S. W. Martin, E. L. Bartrand, M. Fischer, S. A. Leider, G. R. Strom, A. R. Murdoch, K. Wieland, and J. A. Long. 1994. Yakima River Species Interaction Studies. Annual report 1993. December 1994. Division of Fish and Wildlife, Project No. 1989-105, Bonneville Power Administration, Portland, Oregon. 264p.

Pearsons, T. N., and A. L. Fritts. 1999. Maximum size of Chinook salmon consumed by juvenile coho salmon. North American Journal of Fisheries Management. Volume 19(1), pages 165-170.

Pearsons, T. N., and C. A. Busack. 2012. PCD Risk 1: A tool for assessing and reducing ecological risks of hatchery operations in freshwater. Environmental Biology of Fishes. Volume 94, pages 45-65.

Peven, C. M., R. R. Whitney, and K. R. Williams. 1994. Age and length of steelhead smolts from the mid-Columbia River Basin, Washington. N. AMer. J. Fish. Manage. 14:77-86.

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.

Philipp, D. P., S. J. Cooke, J. E. Claussen, J. B. Koppelman, C. D. Suski, and D. P. Burkett. 2009. Selection for vulnerability to angling in largemouth bass. Transactions of the American Fisheries Society. Volume 138(1), pages 189-199.

Piper, R. G., I. B. McElwain, L. E. Orme, J. P. McCraren, L. G. Fowler, and J. R. Leonard. 1986. Fish Hatchery Management, 5th edition. US Dept. of Interior, USFWS.

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

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

PSTT, and WDFW. 2004. Resource Management Plan. Puget Sound Hatchery Strategies for steelhead, coho salmon, chum salmon, sockeye salmon and pink salmon. March 31, 2004. 194p.

Quinn, T. 2010. An Environmental and Historical Overview of the Puget Sound Ecosystem. Pages 11 to 18 *in* H. Shipman, M.N. Dethier, G. Gelfenbaum, K.L. Gresh, and R.S. Dinocola, editors. Puget Sound Shorelines and the Impacts of Armoring. Proceedings of a State of the Science Workshop, May 16-19, 2009. Union, Washington. U.S. Geological Survey Scientific Investigations report 2015-5254.

Quinn, T. P. 1984. Homing and straying in Pacific salmon. Pages 357-362 *in* McCleave, J. D., G. P. Arnold, J. J. Dodson, and W. H. Neill, editors. Mechanisms of migration in fishes. Plenum Publishing Corporation.

Quinn, T. P. 1993. A review of homing and straying of wild and hatchery-produced salmon. Fisheries Research. Volume 18, pages 29-44.

Quinn, T. P. 1997. Homing, Straying, and Colonization. Genetic Effects of Straying of Non-Native Fish Hatchery Fish into Natural Populations. NOAA Tech. Memo., NMFS-NWFSC-30. 13p.

Quinn, T. P. 2018. The behavior and ecology of Pacific salmon and trout. University of Washington Press, Seattle.

Rand, P. S., B. A. Berejikian, A. Bidlack, D. Bottom, J. Gardner, M. Kaeriyama, R. Lincoln, M. Nagata, T. N. Pearsons, M. Schmidt, W. W. Smoker, L. A. Weitkamp, and L. A. Zhivotovsky. 2012. Ecological interactions between wild and hatchery salmonids and key recommendations for research and management actions in selected regions of the North Pacific Environmental Biology of Fishes. Volume 94, pages 343-358.

Rensel, J., K. L. Fresh, J. J. Ames, R. L. Emmett, J. H. Meyer, T. Scribner, S. Schroder, and C. Willis. 1984. Evaluation of Potential Interaction Effects in the Planning and Selection of Salmonid Enhancement Projects. J. Rensel, and K. Fresh editors. Report prepared by the Species Interaction Work Group for the Enhancement Planning Team for implementation of the Salmon and Steelhead Conservation and Enhancement Act of 1980. WDFW, Olympia, Washington. 90p.

Resources, M. 1999. Tribal Circumstances & Impacts from the Lower Snake River Project on the Nez Perce, Yakama, Umatilla, Warm Springs, and Shoshone Bannock Tribes Executive Summary. 22p.

Riley, S. C., H. J. Fuss, and L. L. LeClair. 2004. Ecological effects of hatchery-reared juvenile Chinook and coho salmon on wild juvenile salmonids in two Washington streams. North American Journal of Fisheries Management. Volume 24(2), pages 506-517.

Ruckelshaus, M. H., K. P. Currens, W. H. Graeber, R. R. Fuerstenberg, K. Rawson, N. J. Sands, and J. B. Scott. 2006. Independent Populations of Chinook Salmon in Puget Sound. July 2006. U.S. Dept. Commer., NOAA Technical Memorandum NMFS-NWFSC-78. 145p.

Ryman, N. 1991. Conservation genetics considerations in fishery management. Journal of Fish Biology. Volume 39 (Supplement A), pages 211-224.

Ryman, N., P. E. Jorde, and L. Laikre. 1995. Supportive breeding and variance effective population size. Conservation Biology. Volume 9(6), pages 1619-1628.

Salo, E. O. 1991. Life history of chum salmon,*, in* C. Groot and L. Margolis (editors), Pacific salmon life histories, pages 231-309. Univ. B.C. Press, Vancouver, B.C.

Sandercock, F. K. 1991. The Life History of Coho Salmon (*Oncorhynchus kisutch*) *in* C. Groot and L. Margolis (eds.), Life history of Pacific Salmon. Univ. of British Columbia Press, Vancouver, B.C.

Scott, J. 2019. Email to Emi Melton (NMFS) from James Scott (DFW). Skykomish steelhead update. Wed, Dec 18, 2019. 1p.

Scott, J. B., and W. T. Gill, editors. 2008. *Oncorhynchus mykiss*: Assessment of Washington State's Steelhead Populations and Programs. Preliminary draft for Washington Fish & Wildlife Commission. February 1, 2008. WDFW, Olympia, Washington. 424p.

Shapovalov, L., and A. C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout (*Salmo gairdneri*) and Silver Salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and Recommendations Regarding Their Management. California Department of Fish and Game Fish Bulletin 98.

Sharpe, C. S., B. R. Beckman, K. A. Cooper, and P. L. Hulett. 2007. Growth modulation during juvenile rearing can reduce rates of residualism in the progeny of wild steelhead broodstock. North American Journal of Fisheries Management. Volume 27(4), pages 1355-1368.

Skalski, J. R., S. L. Whitlock, R. L. Townsend, and R. Harnish. 2021. Passage and Survival of Juvenile Salmonid Smolts through Columbia and Snake River Dams, 2010–2018. North American Journal of Fisheries Management.

Snohomish Basin Salmon Recovery Forum. 2005. Snohomish River Basin Salmon Conservation Plan. June 2005. Snohomish County Department of Public Works, Surface Water Management Division. Everett, Washington. 402p.

Snohomish River Basin. 2019. Salmon Conservation Plan Status and Trends. April 2019. 51p. Retrieved from website shoughton.

Snow, C., A. Murdoch, and T. Kahler. 2013. Ecological and demographic costs of releasing nonmigratory juvenile hatchery steelhead in the Methow River, Washington. North American Journal of Fisheries Management. Volume 33(6), pages 1100-1112.

SSPS. 2007. 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.

Stay, A. C. 2012. Treaty Tribes & Hatcheries. The Water Report, Auburn, Washington. May 15, 2012. 30p.

Steward, C. R., and T. C. Bjornn. 1990. Supplementation of Salmon and Steelhead Stocks with Hatchery Fish: A Synthesis of Published Literature. Technical Report 90-1. Idaho Cooperative Fish and Wildlife Research Unit, Moscow, Idaho. 132p.

Tatara, C. P., and B. A. Berejikian. 2012. Mechanisms influencing competition between hatchery and wild juvenile anadromous Pacific salmonids in fresh water and their relative competitive abilities. Environmental Biology of Fishes. Volume 94(1), pages 7-19.

Tatara, C. P., D. A. Larsen, M. R. Cooper, P. Swanson, M. A. Middleton, J. T. Dickey, D. Harstad, M. Humling, C. R. Pasley, and B. Berejikian. 2019. Age at release, size, and maturation status influence residualism in hatchery steelhead. North American Journal of Fisheries Management. Volume 39(3), pages 468-484. Retrieved from website shoughton.

Taylor, E. B. 1991. Behavioral interaction and habitat use in juvenile Chinook, *Oncorhynchus tshawytscha*, and coho *O. kisutch*, salmon. Animal Behaviour. Volume 42, pages 729-744.

Thom, B. A. 2017. Letter to Jim Unsworth (WDFW) from Barry Thom (NMFS). Management plans (HGMPs) for Puget Sound salmon and steelhead hatchery programs. July 21, 2017. NMFS, Portland, Oregon. 3p.

Tipping, J. M., A. L. Gannam, T. D. Hilson, and J. B. Poole. 2003. Use of size for early detection of juvenile hatchery steelhead destined to become precocious males. North American Journal of Aquaculture. Volume 65, pages 318-323.

Topping, P., L. Kishimoto, J. Holowatz, D. Rawding, and M. Groesbeck. 2008. 2006 Juvenile Salmonid Production Evaluation Report: Green River, Dungeness River, and Cedar Creek. Washington Department of Fish and Wildlife. FPA 08-05. August 2008. 136p.

Topping, P., and M. Zimmerman. 2011. Green River Juvenile Salmonid Production Evaluation: 2009-2010 Annual Report. January 2011. FPA 11-01. WDFW, Olympia, Washington. 109p.

Tulalip Tribes. 2012. Skykomish River Summer Chinook (*Oncorhynchus tshawytscha*) Hatchery Genetic Management Plan (HGMP). December 20, 2012. 99p.

Tulalip Tribes. 2018a. Habitat Restoration. 1p.

Tulalip Tribes. 2018b. We are Tulalip. 1p.

Tulalip Tribes. 2018c. Who We Are. 1p.

Tulalip Tribes. 2018d. Fisheries. 1p.

Tynan, T. 1997. Life History Characterization of Summer Chum Salmon Populations in the Hood Canal and Eastern Strait of Juan De Fuca Regions. Washington Department of Fish and Wildlife Hatchery Program. Report # H97-06. 112p.

U.S. Forest Service. 1997. 1997 Northwest Forest Plan. An Ecosystem Management Approach. Watersheds, Communities, and People. 16p.

Underwood, K. D., S. W. Martin, M. L. Schuck, and A. T. Scholz. 1995. Investigations of Bull Trout (*Salvelinus confluentus*), Steelhead Trout (*Oncorhynchus mykiss*), and Spring Chinook Salmon (*O. tshawytscha*) Interactions in Southeast Washington Streams. Final Report 1992. DOE/BP-17758-2. January 1995. 188p.

Unsworth, J. W. Turner, R. N., regarding Modifications to steelhead hatchery programs. Letter to Robert Turner (NMFS). January 19, 2016.

USFWS, and NMFS. 1997. Secretarial Order 3206. 14p.

USFWS. 2010. Bull trout background information (biology, species description, proposed critical habitat description, species profile), at http://www.fws.gov/pacific/bulltrout/. Website accessed May 28, 2014.

USFWS, and WFWO. 2013. Listed and Proposed Endangered and Threatened Species and Critical Habitat; Candidate Species; and Species of Concern. Revised September 3, 2013. 2p.

USFWS. 2015a. Recovery Plan for the Coterminous United States Population of Bull Trout (*Salvelinus confluentus*). September 29, 2015. Portland, Oregon. xii + 179 pages.

USFWS. 2015b. Coastal Recovery Unit implementation plan for bull trout (Salvelinus confluentus). U.S. Fish and Wildlife Service, Pacific Region, Portland, Oregon. 160p.

USFWS. 2021. Endangered Species Act - Section 7 Consultation and Biological Opinion for the Sunset Falls Trap-and-Haul Facility and Integrated Skykomish River Summer Steelhead Program. U.S. Fish and Wildlife Service Reference: 01EWFW00-2020-F-1607. 122p.

Volkhardt, G., D. Seiler, S. Neuhauser, and L. Kishimoto. 2006a. 2004 Skagit River Wild 0+ Chinook Production Evaluation. Annual Report. Washington Department of Fish and Wildlife Fish Program, Science Division. FPA 05-15. May 2006. 58p.

Volkhardt, G., P. Topping, and L. Kishimoto. 2006b. 2005 Juvenile Salmonid Production Evaluation Report – Green River, Dungeness River, and Cedar Creek. FPA 06-10. WDFW, Olympia, Washington. 101p.

Wade, A. A., T. J. Beechie, E. Fleishman, N. J. Mantua, H. Wu, J. S. Kimball, D. M. Stoms, and J. A. Stanford. 2013. Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology. Volume 50, pages 1093–1104.

Waples, R. S. 1999. Dispelling some myths about hatcheries. Fisheries. Volume 24(2), pages 12-21.

Waples, R. S., K. Hindar, S. Karlsson, and J. J. Hard. 2016. Evaluating the Ryman-Laikre effect for marine stock enhancement and aquaculture. Current Zoology. Volume 62(6), pages 617–627.

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

Warheit, K. I., T. R. Seamons, B. E. Craig, and J. B. Scott. 2021. Population Structure and Genetic Characteristics of Snohomish River Basin Steelhead. March 30, 2021. WDFW, Olympia, Washington. 72p.

Washington Department of Ecology (Ecology). 2012. Preparing for a Changing Climate. Washington State's Integrated Climate Reponse Strategy. WDOE Publication No. 12-01-004. Olympia, Washington. 207p.

Washington Department of Natural Resources (DNR). 2005. Forest Practices Habitat Conservation Plan. Olympia, Washington. Available at:

http://www.dnr.wa.gov/BusinessPermits/Topics/ForestPracticesHCP/Pages/fp_hcp.aspx. plus 15 appendices. 274p.

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

WDFW. 1994. 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI). Appendix one. Puget Sound Stocks. Hood Canal and Strait of Juan de Fuca Volume. December 1994. Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes, Olympia, Washington. 432p.

WDFW, and WWTIT. 1994. 1992 Washington State Salmon and Steelhead Stock Inventory (SASSI). Appendix one. Puget Sound Stocks. Hood Canal and Strait of Juan de Fuca Volume. December 1994. Washington Department of Fish and Wildlife and Western Washington Treaty Indian Tribes, Olympia, Washington. 432p.

WDFW. 1999a. Washington State Sport Catch Report 1995. April 1999. WDFW, Olympia, Washington. 88p. Retrieved from website shoughton.

WDFW. 1999b. Washington State Sport Catch Report 1996. December 1999. WDFW, Olympia, Washington. 93p. Retrieved from website shoughton.

WDFW. 1999c. Washington State Sport Catch Report 1997. December 1999. WDFW, Olympia, Washington. 94p. Retrieved from website shoughton.

WDFW. 2001. Washington State Sport Catch Report 1998. February 2001. WDFW, Olympia, Washington. 90p. Retrieved from website shoughton.

WDFW. 2002. Washington State Sport Catch Report 1999. August 2002. WDFW, Olympia, Washington. 97p. Retrieved from website shoughton.

WDFW. 2005. Washington State Sport Catch Report 2001. May 2005. WDFW, Olympia, Washington. 127p. Retrieved from website shoughton.

WDFW. 2008. Washington State Sport Catch Report 2002. April 2008. WDFW, Olympia, Washington. 122p. Retrieved from website shoughton.

WDFW. 2010. Washington State Sport Catch Report 2003. July 2010. WDFW, Olympia, Washington. 119p. Retrieved from website shoughton.

WDFW. 2011a. Washington State Sport Catch Report 2007. September 2011. WDFW, Olympia, Washington. 95p. Retrieved from website shoughton.

WDFW. 2011b. Washington State Sport Catch Report 2006. September 2011. WDFW, Olympia, Washington. 91p. Retrieved from website shoughton.

WDFW. 2011c. Washington State Sport Catch Report 2005. July 2011. WDFW, Olympia, Washington. 97p. Retrieved from website shoughton.

WDFW. 2011d. Washington State Sport Catch Report 2004. July 2011. WDFW, Olympia, Washington. 95p. Retrieved from website shoughton.

WDFW. 2012. Washington State Sport Catch Report 2008. July 2012. WDFW, Olympia, Washington. 93p. Retrieved from website shoughton.

WDFW. 2013a. Washington State Sport Catch Report 2009. January 2013. WDFW, Olympia, Washington. 94p. Retrieved from website shoughton.

WDFW. 2013b. Wallace River Summer Chinook Hatchery Program (Integrated), Skykomish River Summer Chinook (*Oncorhynchus tshawytscha*) HGMP. Feburary 11, 2013. Olympia, Washington. 67p.

WDFW. 2014a. 2013 Annual Report for the Operation and Maintenance of the Sunset Falls Trap and Haul Fishway. Permit #14433. March 28, 2014. WDFW, Olympia, Washington. 8p. Retrieved from website shoughton.

WDFW. 2014b. Washington State Sport Catch Report 2011. December 2014. WDFW, Olympia, Washington. 94p. Retrieved from website shoughton.

WDFW. 2014c. Washington State Sport Catch Report 2010. August 2014. WDFW, Olympia, Washington. 98p. Retrieved from website shoughton.

WDFW. 2015a. Avian mortality excel final report. January 1, 2015 thru December 31, 2015.

WDFW. 2015b. Washington State Sport Catch Report 2012. August 2015. WDFW, Olympia, Washington. 91p. Retrieved from website shoughton.

WDFW. 2015c. 2014 Annual Report for the Operation and Maintenance of the Sunset Falls Trap and Haul Fishway. Permit #14433. January 15, 2015. WDFW, Olympia, Washington. 7p. Retrieved from website shoughton.

WDFW. 2016a. Washington State Sport Catch Report 2013. February 2016. WDFW, Olympia, Washington. 93p. Retrieved from website shoughton.

WDFW. 2016b. 2015 Annual Report for the Operation and Maintenance of the Sunset Falls Trap and Haul Fishway. Permit #14433. January 14, 2016. WDFW, Olympia, Washington. 7p. Retrieved from website shoughton.

WDFW. 2016 Hatcheries avian mortality excel report.

WDFW. 2017. 2016 Annual ESA Take Report for Section 10(a)(1)(B) Permit 1554. April 2017. WDFW, Ephrata, Washington. 17p.

WDFW, and PSTIT. 2017. Puget Sound Chinook Comprehensive Harvest Management Plan Annual Report Covering the 2016-2017 Fishing Season. September 2017. Olympia, Washington. 140p.

WDFW. 2017 Avian mortality excel report.

WDFW. 2018a. Early winter steelhead final annual report, Dungeness, Nooksack, Stillaguamish, and Snohomish hatchery programs. March 28, 2019. 20p.

WDFW. 2018b. Washington State Sport Catch Report 2016. May 2018. WDFW, Olympia, Washington. 83p. Available at https://wdfw.wa.gov/publications/02002/wdfw02002.pdf.

WDFW. 2018 Avian mortality excel report.

WDFW. 2019a. Washington State Sport Catch Report 2017. September 2019. WDFW, Olympia, Washington. 83p. Retrieved from website shoughton.

WDFW. 2019b. 2018 Annual Report for the Operation and Maintenance of the Sunset Falls Trap and Haul Fishway. Permit #14433. January 7, 2019. WDFW, Olympia, Washington. 6p. Retrieved from website shoughton.

WDFW. 2019c. Letter to Allyson Purcell (NMFS) from Kelly Cunningham (WDFW). Sunset Falls Section 10 application for re-issuance from NMFS. August 8, 2019. WDFW, Olympia, Washington. 26p.

WDFW, and Tulalip Tribes. 2019. South Fork Skykomish River Summer Steelhead Hatchery Program HGMP. April 12, 2019. WDFW, Auburn, Washington. 61p.

WDFW. 2020a. Observations on Bull Trout and Summer Steelhead Spawning in the Nork Fork Skykomish River. May 27, 2020. 5p.

WDFW. 2020b. 2017 Annual Fish Count Data for the Sunset Falls Trap and Haul Operation excel report. Retrieved from website shoughton.

WDFW. 2020c. 2018 Annual Fish Count Data for the Sunset Falls Trap and Haul Operation excel report. Retrieved from website shoughton.

WDFW. 2021. Proposed Enhancements to Genetic Monitoring Program Associated with Implementation of Skykomish Summer Steelhead Hatchery Program. April 13, 2021. WDFW, Olympia, Washington. 19p.

WDNR. 1997. Final Habitat Conservation Plan. Department of Natural Resources, Olympia, Washington. September 1997. 546p.

Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. Status Review of Coho Salmon from Washington, Oregon and California. September 1995. NOAA Tech. Memo., NMFS-NWFSC-24. NMFS, Seattle, Washington. 266p.

WFC, and WDFW. 2019. Signed Skamania steelhead hatchery programs term sheet. April 16, 2019. 4p.

Withler, R. E., M. J. Bradford, D. M. Willis, and C. Holt. 2018. Genetically based targets for enhanced contributions to Canadian Pacific Chinook salmon populations. DFO Canadian Science Advisory Secretariat Research Document 2018/019. xii+88p.

WSDOT. 2018. WSDOT Fish Barrier Correction: Moving Forward, Connecting Habitat. February 2018. 2p.

WWTIT, and WDFW. 2006. The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State. Revised July 2006. 38p.

1 Appendix A - Competition and Predation Literature Summary and Qualitative Evaluation Method

This appendix provides a summary of the available scientific literature describing inter- and intraspecific competition and predation of hatchery-origin salmon and steelhead on natural-origin salmon and steelhead in freshwater, estuarine, and nearshore marine habitats. This summary is intended to describe the existing literature and any conclusions contained therein. For more details, please see the literature citations in Chapter 6, References.

In addition, this appendix describes a qualitative evaluation method (QEM) that NMFS has employed in its evaluation of the proposed Skykomish summer steelhead hatchery programs for assessing the risk of competition and predation to natural-origin fish from hatchery-origin steelhead in freshwater. The QEM uses initial risk level categories from Rensel et al. (1984), which are High, Low and Unknown[25], then reduces the risk levels when certain criteria are met based on site specific factors (see Appendix A Section 3, Evaluation Methods). When the risk reduction criteria are applied, the initial baseline risk from Rensel (1984) is reduced by zero, one, or two levels of risk for each criterion (as described in Appendix A Section 3 Evaluation Methods). Based on using the criteria for risk reduction, an average risk reduction for each species across life stages and two temporal scenarios for predation and competition, respectively, is assessed. To reach our conclusions, NMFS describes the final risk assessment defined as Large, Medium, Small, Minimal, or Close to None depending on the base risk level from Rensel (1984) (High, Low, Unknown) and how many step reductions in risk result from applying the criteria (Table 1).

Table 1. Risk reduction definitions based on risk reduction criteria for competition and predation.

	Adjusted Risk if Rensel (1984) Risk is High/Unknown	**Adjusted Risk if Rensel (1984) Risk is Low**
Risk Reduction Steps		
0	Large	Small
-1	Medium	Minimal
-2	Small	Close to None
-3	Minimal	Close to None

[25] Note that "high" and "low" in the context of Rensel (1984) do not have a relationship with the definitions of "high" and "low" impact NMFS has developed in Chapter 4 (Environmental Consequences) of this EA.

-4 or more	Close to None	Close to None

The QEM is a simplified evaluation of competition and predation because not all potential ecological factors are explicitly considered. As described below, the current state of knowledge of competition and predation effects on natural-origin salmon and steelhead from hatchery-origin fish is relatively limited.

The following subsections provide (1) a review of salmon and steelhead competition and predation in freshwater, estuarine, and nearshore marine habitats; (2) a description of the methodology, factors considered, and criteria; and (3) the results of the evaluation for salmon hatchery programs in the Skykomish River Basin.

1 Review of Competition Between Hatchery-Origin Salmon and Steelhead Juveniles

1.1 Freshwater Areas

Competition occurs when demand for limited resources (e.g., food and/or space) by two or more organisms exceeds available supply. Competition is a normal ecological interaction that is part of how fauna adapt to their biological and physical environments and does not necessarily yield negative effects in nature. However, if resources are limited or if hatchery-origin fish preclude natural-origin fish from using these resources, competitive interactions may result in negative effects on natural-origin fish from their co-occurrence with hatchery-origin fish (Rensel et al. 1984). Hatchery-origin fish may compete for food and rearing space with different life stages of co-occurring natural-origin fish. Juvenile hatchery-origin fish may compete with natural-origin salmon and steelhead juveniles for food resources and rearing space in freshwater, estuary, and nearshore marine habitats (Flagg et al. 2000; Naish et al. 2007). An important objective of hatchery management is to minimize the negative effects of competition from hatchery-origin fish on natural-origin-fish (HSRG 2004).

Salmon and steelhead have evolved different juvenile life history strategies in freshwater. These strategies effectively partition use of limited resources among species, thereby reducing the extent of interspecific competitive interactions among salmon and steelhead in nature (Nilsson 1967; Rensel et al. 1984; Groot and Margolis 1991; Taylor 1991).

Juvenile hatchery-origin salmon and steelhead released into the freshwater natural environment primarily compete with natural-origin salmon and steelhead for resources when the hatchery-origin fish migrate downstream. Species that rear in freshwater for one or more years make a physiological transition to become smolts and then typically out-migrate rapidly (e.g., steelhead, coho salmon, and spring-run Chinook salmon). Hatchery programs that pose the least juvenile competition risk are those that mimic the outmigration of natural-origin fish by producing rapidly migrating smolts that use rivers and streams as corridors to the estuary.

To help reduce risks to natural-origin fish, hatchery programs in Puget Sound are generally operated to release hatchery-origin juvenile fish as smolts to encourage rapid outmigration, which is the approach to be taken in the proposed action. The temporal overlap of hatchery-origin fish is therefore reduced as fish out-migrate quickly, which reduces the opportunity to interact with co-occurring natural-origin juveniles (Flagg et al. 2000; PSTT and WDFW 2004).

Hatchery-origin fish that fail to out-migrate and, instead, live in freshwater are called residuals. Volitional release of fish decreases residualism. Compared to fish that out-migrate promptly, residuals have a greater opportunity to compete with natural-origin fish for food and space. Although most residuals may not survive, they may compete with natural-origin fish when present (McMichael et al. 1997).

Rensel et al. (1984) reviewed the freshwater resource competition risks posed by hatchery-origin fish to natural-origin salmon and steelhead and categorized species combinations to determine if the risk (High, Low, or Unknown) of competition by hatchery-origin fish would have a negative impact on natural-origin salmon and steelhead in freshwater areas (Table 2). Rensel et al. (1984) concluded that natural-origin Chinook salmon, coho salmon, and steelhead have a relatively high risk of competition effects (both interspecific and intraspecific) from hatchery-origin fish representing any of these three species.

Table 2. Initial default risk of hatchery-origin steelhead competition on natural-origin salmon and steelhead without considering site-specific factors.

	Natural-origin Species				
Hatchery Steelhead	**Chinook Salmon**	**Steelhead**	**Coho Salmon**	**Chum Salmon**	**Pink Salmon**
Competition in freshwater	H	H	H	L	L

Source: (Rensel et al. 1984)
Note: H = high risk, L = low risk, and U = unknown risk of an impact occurring.

Large releases of hatchery-origin fish could displace natural-origin fish from their preferred habitats within the vicinity of hatchery release locations (Steward and Bjornn 1990; Pearsons et al. 1994; Riley et al. 2004). However, Tatara and Berejikian (2012) found that the density of natural-origin and hatchery-origin fish relative to habitat-carrying capacity likely has a considerable influence on competitive interactions. Riley et al. (2004) found that small-scale releases of hatchery-origin Chinook salmon or coho salmon have few substantial ecological effects on natural-origin salmon fry in small coastal Washington streams, particularly when natural-origin fry occur at low densities.

In general, the potential effect of hatchery-origin salmon and steelhead competition on the survival of natural-origin fish depends on the degree of spatial and temporal overlap with hatchery-origin fish, relative fish sizes, and relative abundance of the two groups (Steward and Bjornn 1990). Effects would also depend on the degree of dietary overlap, food availability, size-related differences in prey selection, foraging tactics, and differences in microhabitat use (Steward and Bjornn 1990). Competition is greatest when hatchery-origin fish are more numerous than natural-origin fish, hatchery-origin fish are of equal or greater size, and/or hatchery-origin fish are released high in watersheds, thereby increasing the extent of spatial and temporal overlap in which competitive interactions may occur.

1.2 Estuarine and Nearshore Marine Areas

Hatchery-origin juveniles can compete with natural-origin juveniles in estuarine and nearshore marine areas, leading to negative impacts on natural-origin fish in instances where resources may be limiting (Dawley et al. 1984; Rensel et al. 1984). The levels of risk for competition in estuaries and nearshore marine waters are dependent on temporal and spatial overlap and fish size. However, research has not always concluded that competition with hatchery-origin fish exerts a density-dependent effect that reduces the growth and survival of natural-origin fish (e.g., Levings et al. (1986); McNeil (1991)). Rand et al. (2012) concluded that natural-origin salmon in estuarine and marine shelf ecosystems were more likely to be affected by natural environmental variability than by hatchery release strategies. Additionally, hatchery-origin steelhead smolts spend less than 36 hours in the estuary or nearshore marine waters (Moore et al. 2010). Therefore, generally, the likely temporal overlap between hatchery-origin steelhead and natural-origin salmon and steelhead in estuaries and nearshore marine waters is low. Consequently, competition on natural-origin salmon species by hatchery-origin steelhead in the estuaries and nearshore marine waters is not likely and will not be considered any further in the analysis for this EA.

2 Review of Predation by Hatchery-Origin Salmon and Steelhead Juveniles

2.1 Freshwater Areas

Risks of predation on natural-origin fish are greatest in natural freshwater habitats adjacent to and downstream from the hatchery release sites where hatchery-origin fish are likely to be most concentrated. Literature reviews of effects of hatchery-origin salmon and steelhead on natural-origin fish suggest that the potential for predation on natural-origin salmon and steelhead by hatchery-reared smolts is highly variable and depends on the relative size, relative number, distribution, behavioral responses, and the amount of spatial and temporal overlap (Rensel et al. 1984; Flagg et al. 2000; Riley et al. 2004; Naish et al. 2007; Naman and Sharpe 2012). Much of what follows is excerpted from these reviews.

Most studies of predation in freshwater suggest that hatchery-origin fish may prey on fish that are up to 50 percent of their length (Rensel et al. 1984; Pearsons and Fritts 1999), whereas other studies suggest that hatchery-origin predators prefer smaller prey, generally up to 33 percent of their length (Horner 1978; Hillman and Mullan 1989; CBFWA 1996). Hatchery-origin fish that do not migrate and take up residence (residuals) have the potential to be predators for longer time periods.

Predation risks to natural-origin salmon and steelhead attributable to direct predation (direct consumption) or indirect predation (increases in predation due to attraction of predators) can result from hatchery-origin salmon and steelhead releases. Hatchery-origin fish may prey on juvenile natural-origin salmon and steelhead at several stages of their life history. Newly released hatchery-origin smolts have the potential to prey on smaller natural-origin fry and parr that they encounter in fresh water during their outmigration. Because of their size, newly emerged natural-origin salmon and steelhead fry are likely to be the most vulnerable to predation by releases of hatchery-origin fish in the event of co-occurrence. This vulnerability may be greatest when fry emerge from the gravel and may decrease as fry grow and move into shallow shoreline areas (Everest and Chapman 1972). In general, natural-origin salmon and steelhead are most vulnerable to predation when abundance of natural-origin fish is depressed and hatchery-origin abundance is high, in small streams where migration distances are long, and when environmental conditions favor high visibility (Rensel et al. 1984).

Rensel et al. (1984) categorized species combinations to determine if there is a High, Low, or Unknown risk of direct predation by hatchery-origin fish that would have a negative impact on natural-origin salmon and steelhead in freshwater. Without considering local factors (like degrees of spatial and temporal overlap of hatchery-origin and natural-origin fish), predation risks in freshwater were found to be greatest to natural-origin pink and chum salmon from releases of larger sized hatchery-origin coho salmon, Chinook salmon, and steelhead (Table 3).

Table 3. Initial default risk of hatchery-origin steelhead predation on natural-origin salmon and steelhead without consideration of site-specific factors.

Hatchery Steelhead	Natural-origin Species				
	Chinook Salmon	**Steelhead**	**Coho Salmon**	**Chum Salmon**	**Pink Salmon**
Predation in freshwater	U	U	U	H	H

Source: (Rensel et al. 1984)
Note: H = high risk, L = low risk, and U = unknown risk of an impact occurring.

2.2 Estuarine and Nearshore Marine Areas

Rensel et al. (1984) categorized the risk of direct predation by hatchery-origin fish on natural-origin salmon and steelhead in early marine life. Predation risks during this time were determined to be greatest to natural-origin pink salmon, and chum salmon from releases of yearling hatchery-origin steelhead (Table 3). However, for the same reasons as for competition (Section 1.2), predation on natural-origin salmon species by hatchery-origin steelhead in the estuaries and nearshore marine waters is not likely and will not be considered any further in the analysis for this EA.

3 Evaluation Methods

3.1 Freshwater Competition

The QEM that NMFS used in this analysis provides an indicator of the risk of competitive interactions occurring in freshwater through interference (i.e., aggression). Competitive interactions generally do not result in direct mortality. Rather, competition may result in higher expenditures of energy, loss of foraging opportunities, higher vulnerability to predation, or lower forage quality because a fish is forced to occupy lower-quality habitat. While it is difficult to determine negative consequences of competitive interactions with certainty, it is reasonable to conclude that negative consequences are minimized when competitive interactions are rare. The evaluation does not consider exploitative competition, which would require knowledge of food webs, prey abundance and distribution, and the degree of diet overlap between hatchery-origin and natural-origin salmon and steelhead, all of which would be difficult to acquire.

The QEM output is one of five categories of risk levels to natural-origin salmon or steelhead juveniles: large, moderate, small, minimal, and close to none. The QEM is based on the factors discussed above and listed below.

- Hatchery-origin species and life stage

- Natural-origin species and life stage
- Average size of hatchery- and natural-origin species (length in millimeters)
- Relative population size of hatchery- and natural-origin species
- Periodicity of hatchery- and natural-origin species
- Release location and technique (e.g., volitional release) of hatchery-origin species

Other factors that could affect competitive interactions such as hatchery-origin survival rate during the outmigration, habitat capacity, habitat complexity (Pearsons and Busack 2012), and turbidity (Rensel et al. 1984; Bash et al. 2001) are not considered explicitly in the evaluation.

The basic premise of the QEM is that the initial default risk level for competition in Table 2 (Rensel et al. 1984) can be reduced by site-specific information using a set of nine criteria (Table 4) in a step-by-step process with three potential answers (true, false, and unknown). Each of the nine criteria provides a rationale (a true response) for reducing the risk level from the previous step by zero, one, or two categories of risk. A false or unknown response means there is no rationale for reducing the risk level from the previous step based on that criterion. Implicit in the sequential nature of the evaluation is that risk reduction factors are assumed to be cumulative for each life stage, with total risk considered to be an average across life stages, which assumes each life stage adjustment contributes in an unweighted fashion to risk reduction for the population A response of unknown occurs when the available information is insufficient for determining if a factor would reduce the risk of competition.

Table 4. Sequential criteria for the qualitative competition evaluation in fresh water to adjust risk from default level as appropriate.

#	Criterion	True	False or Unknown	Table number to find site-specific information to apply to the criterion.
1	Hatchery-origin summer-run steelhead co-occur with natural-origin steelhead, coho, Chinook, pink, and chum salmon and have a default potential risk to the natural-origin species under consideration.	The default potential risk to natural-origin steelhead, coho salmon, or Chinook salmon is High. The default potential risk to natural-origin pink salmon and chum salmon is Low. Go to Criterion 2.	N/A	Table 2
2	Hatchery-origin summer-run steelhead are two times larger or more than the natural-origin species.	Competition is unlikely to occur because of size differences. Reduce the potential risk by two categories (e.g., Medium to Minimal). Go to Criterion 5.	Potential risk is unchanged. Go to Criterion 3.	Table 16
3	The average (or median) length of hatchery-origin summer-run steelhead at the time of release is 25 percent or more smaller than the length of natural-origin species.	Reduce the potential risk by two categories (e.g., Medium to Minimal). Go to Criterion 5.	Potential risk is unchanged. Go to Criterion 4.	Table 16
4	The average (or median) length of hatchery-origin summer-run steelhead at the time of release is 5 to 25 percent smaller than the average length of natural-origin species.	Reduce the potential risk by one category (e.g., Medium to Minimal). Go to Criterion 5.	Potential risk is unchanged. Go to Criterion 5.	Table 16

#	Criterion	True	False or Unknown	Table number to find site-specific information to apply to the criterion.
5	The number of hatchery-origin summer-run steelhead is substantially fewer (<= 50%) than the number of natural-origin juveniles produced in the basin.	Reduce the potential risk by one category (e.g., Medium to Minimal). Go to Criterion 6.	Potential risk is unchanged. Go to Criterion 6.	Table 17
6	The number of days of potential overlap between hatchery-origin and natural-origin fish is less than or equal to 7 days.	Reduce the potential risk by two categories (e.g., Medium to Minimal). Go to Criterion 8.	Potential risk is unchanged. Go to Criterion 7.	Table 18 and Table 19
7	The number of days of potential overlap between hatchery-origin and natural-origin fish is greater than 7 days and less than or equal to 14 days.	Reduce the potential risk by one category (e.g., Medium to Minimal). Go to Criterion 8.	Potential risk is unchanged. Go to Criterion 8.	Table 18 and Table 19
8	Hatchery-origin ~~Skamania~~ summer-run steelhead are released less than or equal to 15 miles from the estuary.	Reduce the potential risk by two categories (e.g., Medium to Minimal). Final Result.	Potential risk is unchanged. Go to Criterion 9.	Reiter Ponds release site is 50.3 miles from estuary (including Ebey slough, Section 4.1.4)
9	Hatchery-origin ~~Skamania~~ summer-run steelhead are released more than 15 miles and less than or equal to 30 miles from the estuary.	Reduce the potential risk by one category (e.g., Medium to Minimal). Final Result.	Potential risk is unchanged. Go to Criterion 10.	Reiter Ponds release site is 50.3 miles from estuary (including Ebey slough, Section 4.1.4)
10	Hatchery-origin ~~Skamania~~ summer-run steelhead are released more than 30 miles from the estuary.	Potential risk is unchanged. Final Result.	Potential risk is unchanged. Final Result.	Reiter Ponds release site is 50.3 miles from estuary (including Ebey slough, Section 4.1.4)

3.1.1 Fish Size (Criterion 2-4)

Relative size (criterion 2) is one of the most important factors influencing competitive interactions (Pearsons and Busack 2012). In addition, the level of dominance between individuals can be influenced by species and by source (hatchery-origin or natural-origin). Criteria 2, 3, and 4 of the QEM provide rationale for reducing the risk level of negative effects from competitive interactions based on the relative size of hatchery-origin and natural-origin fish.

Under Criterion 2, the risk of competitive interactions is reduced by two levels (e.g., large to small) if the average hatchery-origin fish was more than twice the size (length) of an average natural-origin fish because such an interaction would more likely be predatory rather than competitive (Pearsons and Busack 2012).

Under criteria 3 and 4, it is assumed that hatchery fish will generally dominate a natural-origin fish when the hatchery-origin fish is approximately the same size or larger than a natural-origin fish. For the QEM, Dominance Mode 2 from Pearsons and Busack (2012) was modified, which provides a hypothetical percentage of hatchery-origin fish that would dominate a natural-origin fish based on the difference in size (Table 4). Under Mode 2 a hatchery-origin fish more often dominates an interaction with a natural-origin fish. For the qualitative evaluation, if the average size of hatchery fish is more than 25 percent smaller than the average size of natural-origin fish, the risk level is reduced by two categories (e.g., high to low). If the average size of hatchery fish is 5 to 25 percent smaller than natural-origin fish, the risk level is reduced by one category (e.g., high to moderate). Under all other size comparisons, such as the hatchery-origin fish generally being larger than natural-origin fish, the risk level is unchanged.

3.1.2 Relative Abundance of Hatchery- and Natural-Origin fish (Criterion 5)

Relative abundance of hatchery-origin and natural-origin fish is criterion 5 for the QEM. The risk of adverse effects from competition can be reduced if the potential for encounters between hatchery- and natural-origin fish is low. If the number of hatchery-origin fish released is relatively low compared to the number of natural-origin fish, then the frequency of encounters between hatchery- and natural-origin fish is also likely to be low. In other words, a natural-origin fish is more likely to encounter another natural-origin fish than it would a hatchery-origin fish. For this evaluation, we selected 50 percent less hatchery-origin fish as the threshold for lowering risk by one category level (e.g., Medium to Minimal).

3.1.3 Temporal Overlap (Criterion 6 and 7)

Temporal overlap between hatchery-origin and natural-origin fish is considered in criteria 6 and 7 in the QEM. Hatchery operations often manage fish growth so that most juveniles have achieved complete smoltification at the time of release and are released at a time after the peak of outmigration by natural-origin fish. Fish that have completed the smoltification process generally migrate at a faster rate than fish that have not completed the process. Nevertheless, there can be some temporal overlap between hatchery and natural-origin fish.

For the QEM, competition risk level is reduced by two risk level categories if the temporal overlap between hatchery-origin and natural-origin outmigration is 7 days or fewer. If the temporal overlap is between 8 to 14 days, risk level is reduced by one category, and if the overlap is for more than 14 days, there is no reduction in risk.

3.1.4 Spatial Overlap (Criteria 8-10)

Spatial overlap between hatchery-origin and natural-origin fish is considered in 8 and 9 in the QEM. The farther a hatchery-origin fish must swim to reach the estuary once released, the higher likelihood that encounters with natural-origin fish would occur. The QEM uses releases 15 miles or less from the estuary to grant a substantial reduction in risk (two risk categories) and 15 to 30 miles from the estuary to grant slight reduction in risk (one risk category). For releases greater than 30 miles, there would be no reduction in the risk level for competitive interactions. All releases for the proposed action are more than 30 miles from the estuary, so no risk reduction is associated with release distance.

3.2 Freshwater Predation

The approach to a qualitative evaluation of predation by hatchery released fish is similar to the methods for evaluating competitive interactions. The method is based on the factors discussed in Section 2.1 and are a subset of the quantitative factors considered in the PCD Risk 1 model by Pearsons and Busack (2012), listed below.

- Hatchery-origin species and life stage
- Natural-origin species and life stage
- Average size of hatchery- and natural-origin species (length in millimeters)
- Periodicity of hatchery- and natural-origin species
- Release location of hatchery-origin species

The evaluation begins with an initial default level of potential predation risk between a hatchery- and natural-origin species of interest as shown in Table 3, and specific factors reduce this level of risk. Based on Rensel et al. (1984) for hatchery releases of steelhead, the initial potential for negative effects is high for interactions with natural-origin pink salmon and chum salmon and unknown for Chinook salmon, steelhead, and coho salmon (Table 3).

The evaluation is a sequential list of seven criteria (Table 5). Each of the seven criteria provides rationale (a true response) for reducing the risk level from the previous step by one or two categories of risk. A false or unknown response means there is no rationale for reducing the risk level from the previous step based on that criterion. Implicit in the sequential nature of the evaluation is that risk reduction factors are assumed to be cumulative for each life stage, with total risk considered to be an average across life stages, which assumes each life stage adjustment contributes in an unweighted fashion to risk reduction for the population. A response of unknown occurs when the available information is insufficient for determining if a factor would reduce the risk of predation.

Other factors that could reduce predatory interactions such as hatchery-origin survival rate during the outmigration (Rensel et al. 1984; Bash et al. 2001), the relative abundance of hatchery-origin and natural-origin fish, or volitional hatchery release techniques are not considered explicitly in the evaluation.

Table 5. Sequential criteria for the qualitative predation evaluation in fresh water to adjust risk from default level as appropriate.

#	Criterion	True	False or Unknown	Table # to find site-specific information to apply to the criterion
1	The hatchery-origin steelhead co-occur with natural-origin steelhead, coho, Chinook, pink, and chum salmon and has a default potential risk to the natural-origin species under consideration.	The default potential risk for natural-origin chum and pink salmon is High. The default potential risk for natural-origin Chinook and coho salmon and steelhead is unknown Go to Criterion 2.	. N/A	Table 3

#	Criterion	True	False or Unknown	Table # to find site-specific information to apply to the criterion
2	The hatchery-origin steelhead are two times larger or more than the natural-origin species.	Potential risk is unchanged. Go to Criterion 3.	Predation is unlikely to occur because of minimal size differences. Reduce the potential risk by two categories (e.g., Medium to Minimal). Go to Criterion 3.	Table 16
3	The number of hatchery-origin summer-run steelhead is substantially fewer (<= 50%) than the number of natural-origin juveniles produced in the basin.	Reduce the potential risk by one category (e.g., Medium to Minimal). Go to Criterion 4.	Potential risk is unchanged. Go to Criterion 4.	Table 17
4	The number of days of potential overlap between hatchery-origin steelhead and natural-origin fish is less than or equal to 7 days.	Reduce the potential risk by two categories (e.g., Medium to Minimal). Go to Criterion 6.	Potential risk is unchanged. Go to Criterion 5.	Table 18 and Table 19
5	The number of days of potential overlap between hatchery-origin summer-run steelhead and natural-origin fish is greater than 7 days and less than or equal to 14 days.	Reduce the potential risk by one category (e.g., Medium to Minimal). Go to Criterion 6.	Potential risk is unchanged. Go to Criterion 6.	Table 18 and Table 19
6	Hatchery-origin Steelhead are released less than or equal to 15 miles from the estuary.	Reduce the potential risk by two categories (e.g., Medium to Minimal). Final Result.	Potential risk is unchanged. Go to Criterion 7.	Reiter Ponds release site is 50.3 miles from estuary (including Ebey slough, Section 4.1.4)
7	Hatchery-origin Steelhead are released more than 15 miles and less than or equal to 30 miles from the estuary.	Reduce the potential risk by one category (e.g., Medium to Minimal). Final Result.	Potential risk is unchanged. Go to Criterion 8.	Reiter Ponds release site is 50.3 miles from estuary (including Ebey slough, Section 4.1.4)

#	Criterion	True	False or Unknown	Table # to find site-specific information to apply to the criterion
8	Hatchery-origin Steelhead are released more than 30 miles from the estuary.	Potential risk is unchanged.	Potential risk is unchanged.	Reiter Ponds release site is 50.3 miles from estuary (including Ebey slough, Section 4.1.4)

3.2.1 Fish Size (Criterion 2)

Relative size is one of the most important factors influencing predatory interactions (Pearsons and Busack 2012). Criterion 2 of the evaluation method provides rationale for reducing the risk of negative effects from predation based on the relative size of hatchery-origin and natural-origin fish. Under Criterion 2, the risk of predation is reduced by two levels (e.g., large to small) if the average hatchery-origin fish is less than twice the size (length) of an average natural-origin fish.

3.2.2 Relative Abundance (Criterion 3)

The risk of adverse effects from predation can also be reduced if the potential for encounters between hatchery- and natural-origin fish is low. If the number of hatchery-origin fish released is relatively low compared to the number of natural-origin fish, then the frequency of encounters between hatchery- and natural-origin fish is also likely to be low. In other words, a natural-origin fish is more likely to encounter another natural-origin fish than it would a hatchery-origin fish. For this evaluation we selected 50 percent less hatchery-origin fish as the threshold for lowering predation risk level by one category level (e.g., Medium to Minimal).

3.2.3 Temporal Overlap (Criteria 4 and 5)

For the qualitative predation evaluation, temporal overlap was considered the same as for the competition evaluation. The risk level is reduced by two risk level categories if temporal overlap between hatchery- and natural-origin fish is equal or less than 7 days. For temporal overlap of 8 to 14 days, the risk level would be reduced by one category, and if the overlap is for more than 14 days, there would be no reduction in risk. Rationale for these thresholds was the same as for the competition evaluation.

3.2.4 Spatial Overlap (Criteria 6-8)

Spatial overlap for the predation evaluation was considered the same as for the competition evaluation and used the same rationale. A distance of 15 miles or less from the estuary results in a reduction in risk by two categories, and between 15 to 30 miles from the estuary results in a reduction in risk by one category. For releases greater than 30 miles from the estuary there would be no reduction in the risk of predation. All releases for the proposed action are more than 30 miles from the estuary, so no risk reduction is associated with release distance.

3.3 Adult Competition

As described in NMFS (2014), returning adult hatchery-origin steelhead may compete with natural-origin salmon and steelhead for spawning habitat and mates. Hatchery-origin females may compete for redd sites (spawning sites) with other steelhead (and salmon) females. Hatchery-origin steelhead males may compete with natural-origin steelhead males to fertilize eggs. The magnitude of the effect depends on the relative abundance, fish size, spawning date, and habitat preferences of the species in question (Essington et al. 2000; Flagg et al. 2000). Hatchery-origin steelhead that spawn on gravels where natural-origin fish (salmon or steelhead) had spawned previously (called redd superimposition), would also increase competition risks to the natural-origin fish. Adult competition on the spawning grounds occurs only when there is spatial and temporal overlap in spawning between hatchery-origin and natural-origin fish. Temporal overlap includes the overlap in spawning up until the time of emergence because hatchery-origin steelhead can superimpose redds of other fish up until the time the fry emerge from the gravel. The greatest potential for negative interactions would be where available spawning habitat is limiting.

Substrate composition, cover, and water flow, velocity, and quality are important habitat elements for salmon and steelhead during spawning (Bjornn and Reiser 1991). The number of spawners that can be accommodated in a stream is a function of the area suitable for spawning, area required for each redd, suitability of cover, and spawning behavior (Bjornn and Reiser 1991). Different salmon and steelhead species have varying habitat preferences for spawning, which can help reduce competition (Essington et al. 2000; Flagg et al. 2000).

In general, spawning sites selected by females are based on habitat preferences, and when the density of spawners is high, a female may seek less optimum sites, superimpose her eggs on an existing redd, try to remove a female from a site already inhabited, or wait for the resident female to die or leave (Quinn 2018). Males compete for spawning opportunities when density is high, or if it is later in the spawning season when females may be scarce, males establish hierarchies of dominance, fighting other males to spawn with the selected female (Quinn 2018).

4 Skykomish River Freshwater Juvenile Competition and Predation Risks Evaluation

As described in this Appendix, NMFS used the QEM to estimate the risk level of competitive and predatory interactions between juvenile hatchery-origin steelhead and juvenile natural-origin salmon and steelhead in the analysis area under current conditions (i.e., the ~~Skamania~~ESS program) and that would result under Alternative 2 (i.e., proposed steelhead program). We applied the nine criteria for competition in freshwater (Table 4) and the seven criteria for predation in freshwater (Table 5) based on the best available information for each of the criteria as per the QEM. All values for criteria for Alternative 3 are the same as those for Alternative 2. A little less than half the number of steelhead would be released under Alternative 4 compared to Alternative 2. Therefore, the outcome of applying criterion 3 for competition (Table 4) and criterion 5 for predation (Table 5), the criteria associated with whether the hatchery-release abundance is less than 50% of the natural-origin juvenile abundance, could differ between Alternative 4 and Alternatives 2 and 3, but in this case it does not (Table 17). Thus, the results for Alternative 2 apply to Alternatives 3 and 4, and Alternatives 3 and 4 are not described separately below. For ~~analysis related to the current conditions,~~ all analyses, hatchery-origin steelhead are yearlings~~, while under Alternative 2, the hatchery-origin steelhead are yearlings and 2-year olds (the difference in age class resulting from a difference in the hatchery programs).~~

~~Because~~ Skykomish hatchery steelhead ~~are~~will initially be volitionally released, then forced, and because there is no record of how quickly they leave the rearing ponds during the release period, this analysis includes two scenarios. Scenario A assumes all fish leave at once at the beginning of the release period. Scenario B assumes they all leave at once at the end of the release period. However, as discussed further under Temporal Overlap (criteria 6 and 7), natural-origin steelhead fry do not overlap with the ~~Skamania~~ESS steelhead program (current conditions), and natural-origin coho fry do not overlap with both the ~~Skamania~~ESS steelhead program (current conditions) and the proposed steelhead program (Alternative 2). Therefore, these life stages for these species will not be discussed further in this analysis. The following subsections describe the results of the QEM evaluations in the Skykomish River Basin.

4.1 Freshwater Juvenile Competition

The following tables summarize the QEM application results for competition for each species, considering Scenario A and Scenario B, under current conditions and under Alternative 2. The narrative description of how these criteria apply follows the tables. For Scenarios A and B (discussed in detail under Temporal Overlap), fish size is assumed to be the smaller value and the larger value, respectively, based on the Size Range column in Table 16 because the scenarios assumed fish emigrating at the beginning or the end of the release period, respectively.

Chinook Salmon

Table 6. Risk level reductions for juvenile competition between ~~Skamania~~ESS hatchery-origin steelhead yearling smolts and Chinook salmon under current conditions based on the application of competition criteria in Table 4.

Juvenile Outmigration Timing	Chinook salmon life-stage	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
		2	3	4	5	6	7	8	9	
Scenario A	Fry	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Parr	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Yearling	-2	0	0	0	0	-1	0	0	-3
Scenario B	Fry	-2	0	0	-1	-2	0	0	0	-5
Scenario B	Parr	-2	0	0	-1	0	-1	0	0	-4
Scenario B	Yearling	0	0	0	0	0	-1	0	0	-1
									Average Reduction	-4

Table 6 illustrates the use of the QEM to adjust (reduce) the default high risk level of competition between hatchery-origin steelhead and natural-origin Chinook juveniles under current conditions by an average of 4 categories, which results in an adjustment from high to close to none (-4).

Table 7. Risk level reductions for juvenile competition under Alternative 2 between Chinook salmon juveniles and yearling hatchery-origin steelhead based on the application of competition criteria in Table 4.~~Hatchery-origin steelhead are either yearlings or 2-year-old smolts under Alternative 2.~~

Juvenile Outmigration Timing	Chinook salmon life-stage	Hatchery-origin steelhead smolts	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
			2	3	4	5	6	7	8	9	
Scenario A	Fry	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Parr	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Yearling	Yearlings	0	0	0	0	0	-1	0	0	-1
Scenario B	Fry	Yearlings	-2	0	0	-1	-2	0	0	0	-5
Scenario B	Parr	Yearlings	0	0	0	-1	0	-1	0	0	-2
Scenario B	Yearling	Yearlings	0	0	0	0	-2	0	0	0	-2
~~Scenario A~~	~~Fry~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario A~~	~~Parr~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario A~~	~~Yearling~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~

Juvenile Outmigration Timing	Chinook salmon life-stage	Hatchery-origin steelhead smolts	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
			2	3	4	5	6	7	8	9	
~~Scenario B~~	~~Fry~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
~~Scenario B~~	~~Parr~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario B~~	~~Yearling~~	~~2-Year-Olds~~	~~0~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
									Average Reduction		-~~4~~3

Table 7 illustrates the use of the QEM to adjust (reduce) the default high risk level of competition between hatchery-origin steelhead yearlings and ~~two-year-old smolts and~~ natural-origin Chinook juveniles under Alternative 2 by an average of 4 categories, which results in an adjustment from high to ~~close to none -4(~~minimal (-3).

<u>Steelhead</u>

Table 8. Risk level reductions for juvenile competition under current conditions between ~~Skamania~~ESS hatchery-origin steelhead smolts and natural-origin steelhead based on the application of competition criteria in Table 4. There is no co-occurrence between natural-origin steelhead fry and ~~Skamania~~ESS hatchery steelhead yearling smolts under current conditions.

Juvenile Outmigration Timing	Natural-Origin Steelhead life-stage	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
		2	3	4	5	6	7	8	9	
Scenario A	Parr	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Yearling	0	0	0	-1	0	-1	0	0	-2
Scenario B	Parr	0	0	0	-1	0	-1	0	0	-2
Scenario B	Yearling	0	0	0	-1	0	-1	0	0	-2
								Average Reduction		-3

Table 8 illustrates the use of the QEM to adjust (reduce) the default high risk level of competition between hatchery-origin steelhead (all yearlings) and natural-origin steelhead juveniles under current conditions by an average of 3 categories, which results in an adjustment from high to minimal (-3).

Table 9. Risk level reductions in juvenile competition under Alternative 2 between natural-origin and hatchery-origin steelhead based on the application of competition criteria in Table 4. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Steelhead life-stage	Hatchery-origin steelhead smolts	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
			2	3	4	5	6	7	8	9	
Scenario A	Fry	Yearlings	-2	0	0	-1	-2	0	0	0	-5

Juvenile Outmigration Timing	Steelhead life-stage	Hatchery-origin steelhead smolts	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
			2	3	4	5	6	7	8	9	
Scenario A	Parr	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Yearling	Yearlings	0	0	0	-1	0	-1	0	0	-2
Scenario B	Fry	Yearlings	0	0	0	-1	-2	0	0	0	-3
Scenario B	Parr	Yearlings	0	0	0	-1	-2	0	0	0	-3
Scenario B	Yearling	Yearlings	0	0	0	-1	0	-1	0	0	-2
~~Scenario A~~	~~Fry~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
~~Scenario A~~	~~Parr~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario A~~	~~Yearling~~	~~2-Year-Olds~~	~~0~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario B~~	~~Fry~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
~~Scenario B~~	~~Parr~~	~~2-Year-Olds~~	~~0~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-2~~
~~Scenario B~~	~~Yearling~~	~~2-Year-Olds~~	~~0~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
									Average Reduction		-3

Table 9 illustrates the use of the QEM to adjust (reduce) the default high risk level of competition between hatchery-origin steelhead yearlings and ~~two-year-old smolts and~~ natural-origin steelhead juveniles under Alternative 2 by an average of 3 categories, which results in an adjustment from high to minimal (-3).

<u>Coho Salmon</u>

Table 10. Risk level reductions for juvenile competition under current conditions between coho salmon juveniles and ~~Skamania~~ESS hatchery yearling smolts based on the application of competition criteria in Table 4.

Juvenile Outmigration Timing	Coho Salmon life-stage	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
		2	3	4	5	6	7	8	9	
Scenario A	Fry	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Parr	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Yearling	-2	0	0	-1	0	-1	0	0	-4
Scenario B	Fry	-2	0	0	-1	0	-1	0	0	-4
Scenario B	Parr	-2	0	0	-1	-2	0	0	0	-5
Scenario B	Yearling	0	0	0	-1	0	-1	0	0	-2
								Average Reduction		-4

Table 10 illustrates the use of the QEM to adjust (reduce) the default high risk level of competition between hatchery-origin steelhead (all yearlings) and natural-origin coho salmon juveniles under current conditions by an average of 4 categories, which results in an adjustment from high to close to none (-4).

Table 11. Risk level reductions for juvenile competition under Alternative 2 between coho salmon juveniles and hatchery-origin steelhead based on the application of competition criteria in Table 4. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Coho salmon life-stage	Hatchery-origin steelhead smolts	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
			2	3	4	5	6	7	8	9	
Scenario A	Fry	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Parr	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario A	Yearling	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario B	Fry	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario B	Parr	Yearlings	-2	0	0	-1	-2	0	0	0	-5
Scenario B	Yearling	Yearlings	0	0	0	-1	-2	0	0	0	-3
~~Scenario A~~	~~Fry~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario A~~	~~Parr~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario A~~	~~Yearling~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario B~~	~~Fry~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario B~~	~~Parr~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
~~Scenario B~~	~~Yearling~~	~~2-Year-Olds~~	~~0~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
									Average Reduction		-4

Table 11 illustrates the use of the QEM to adjust (reduce) the default high risk level of competition between hatchery-origin steelhead yearlings and ~~two-year-old smolts and~~ natural-origin coho salmon juveniles under Alternative 2 by an average of 4 categories, which results in an adjustment from high to close to none (-4).

<u>Chum Salmon</u>

Table 12. Risk level reductions for juvenile competition under current conditions between chum salmon fry and ~~Skamania~~ESS hatchery steelhead yearling smolts based on the application of competition criteria in Table 4.

Juvenile Outmigration Timing	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
	2	3	4	5	6	7	8	9	
Scenario A	-2	0	0	-1	0	-1	0	0	-4
Scenario B	-2	0	0	-1	0	-1	0	0	-4
							Average Reduction		-4

Table 12 illustrates the use of the QEM to adjust (reduce) the default low risk level of competition between hatchery-origin steelhead (all yearlings) and natural-origin chum salmon juveniles under current conditions by an average of 4 categories, which results in an adjustment from low to close to none (-4).

Table 13. Risk level reductions for juvenile competition under Alternative 2 between chum salmon fry and hatchery-origin steelhead based on the application of competition criteria in Table 4. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Hatchery-origin steelhead smolts	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
		2	3	4	5	6	7	8	9	
Scenario A	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario B	Yearlings	-2	0	0	-1	-2	0	0	0	-5
~~Scenario A~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario B~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
									Average Reduction	-5

Table 13 illustrates the use of the QEM to adjust (reduce) the default low risk level of competition between hatchery-origin steelhead yearlings and ~~two-year-old smolts and~~ natural-origin chum salmon juveniles under Alternative 2 by an average of 5 categories, which results in an adjustment from low to close to none (-5).

<u>Pink Salmon</u>

Table 14. Risk level reductions for juvenile competition under current conditions between pink salmon fry and ~~Skamania~~ESS steelhead yearling smolts based on the application of competition criteria in Table 4.

Juvenile Outmigration Timing	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
	2	3	4	5	6	7	8	9	
Scenario A	-2	0	0	-1	0	-1	0	0	-4
Scenario B	-2	0	0	-1	0	-1	0	0	-4
								Average Reduction	-4

Table 14 illustrates the use of the QEM to adjust (reduce) the default low risk level of competition between hatchery-origin steelhead (all yearlings) and natural-origin pink salmon juveniles under current conditions by an average of 4 categories, which results in an adjustment from low to close to none (-4).

Table 15. Risk level reductions for juvenile competition under Alternative 2 between pink salmon fry and hatchery-origin steelhead based on the application of competition criteria in Table 4. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Hatchery-origin steelhead life stage	Criteria # in Table 3, Appendix A - Competition Criteria								Sum of Reductions
		2	3	4	5	6	7	8	9	
Scenario A	Yearlings	-2	0	0	-1	0	-1	0	0	-4
Scenario B	Yearlings	-2	0	0	-1	-2	0	0	0	-5
~~Scenario A~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario B~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
									Average Reduction	-5

Table 15 illustrates the use of the QEM to adjust (reduce) the default low risk level of competition between hatchery-origin steelhead yearlings and ~~two-year-old smolts and~~ natural-origin pink salmon juveniles under Alternative 2 by an average of 5 categories, which results in an adjustment from low to close to none (-5).

4.1.1 Co-Occurrence

At least a portion of the ~~Skamania~~ESS hatchery-origin steelhead smolts volitionally released from April 15 to May 15 (current conditions) or for the proposed Skykomish summer steelhead program from April 15 to May 31 (Alternative 2) each year would occur in the same area and time as at least one life-stage of all the species of salmon and steelhead present in the analysis area. Therefore, co-occurrence (criterion 1) between hatchery-origin steelhead and Chinook salmon, steelhead, coho salmon, chum salmon and pink salmon juveniles is possible.

4.1.2 Fish Size

Fish size (Table 2, criterion 2) is the next criterion to be considered in the sequential order of the QEM, after establishing co-occurrence (criterion 1). Generally, hatchery-origin steelhead ~~yearlings and 2-year-old smolts~~ are larger than all and more than twice as large as most of the natural-origin fish (with some exceptions) they encounter once released (Table 16), so criterion 2 supports a reduction for competition risk for all species (Table 6 through Table 15). Criteria 3 and 4 are moot for those species' lifestages for which criterion 2 is true. For all other species' lifestages, criterion 3 and 4 are false because the size of hatchery-origin yearlings ~~and 2-year-old smolts~~ are between 25% smaller and twice as large as natural-origin fry, parr, and yearlings. For Scenarios A and B (discussed in detail under Temporal Overlap), fish size is assumed to be the smaller value and the larger value, respectively, from the Size Range column in

Table 16, because the scenarios assumed fish emigrating at the beginning or the end of the release period would be at low and high end of the range, respectively.

Table 16. Relative size of hatchery-origin and natural-origin fish by life-stage in the analysis area.

Species	Life Stage	Size Range (inches)*
~~Skamania~~ESS Summer-run Steelhead	Yearling Smolt	7.4 -7.81
Proposed Steelhead Program	Yearling smolt	6.6-7.1
~~Proposed Steelhead Program~~	~~2-year-old smolt~~	~~8.3~~
Chinook Salmon	Fry	1.3-2.3
	Parr	2.2-3.6
	Yearling	3.6-6.1
Steelhead	Fry	0.9-3.9
	Parr	2.6-5.2
	Smolt	4.3-8.5
Coho Salmon	Fry	1.1-1.4
	Parr	1.5-2.9
	Yearling	2.9-7.5
Chum Salmon	Fry	1.3-2.0
Pink Salmon	Fry	1.3-1.7

* Notes and sources:
Natural-origin parr and yearling Chinook salmon data from Beamer et al. (2005).
Natural-origin steelhead size data estimates from Shapovalov and Taft (1954).
Natural-origin coho salmon data for Green River from Topping et al. (2008) (for smolts) and Beacham and Murray (1990) and Sandercock (1991) (for fry). Parr size range extrapolated from smolt and fry data considering year-round residence and Topping and Zimmerman (2011).
Natural-origin chum salmon data from Volkhardt et al. (2006a); Volkhardt et al. (2006b) (Green River fall-run), and Tynan (1997) (summer-run).
Natural-origin pink salmon data from Topping et al. (2008) (Dungeness pink salmon) and Topping and Zimmerman (2011) (Green River pink salmon).

4.1.3 Relative abundance of Hatchery- and Natural-Origin fish

Relative abundance is criterion 5 in the sequential order of the QEM (Table 4). Criterion 5 applies a threshold of hatchery abundance below 50 percent of natural-origin abundance for lowering competition risk level by one category level (e.g., Medium to Minimal). For natural-origin Chinook yearlings under current conditions and under the proposed Skykomish summer-run steelhead hatchery program, criterion 5 would be false, suggesting no reduction of risk associated with this criterion for Chinook yearlings

(Table 17). Similarly, natural-origin Chinook yearlings would have a false result under criterion 5 under the reduced production of Alternative 4 (Table 17). All other Chinook lifestages and other species have a reduction in competition risk level due to criterion 5 under both alternatives (Table 17).

Table 17. Abundance of natural-origin salmon and steelhead by life-stage relative to the hatchery releases.

Species	Life Stage	Does Natural-Origin juvenile abundance exceed hatchery release by twice as much (exceed 232,000)? (current conditions and Alternative 2) *1	Does Natural-Origin juvenile abundance exceed hatchery release by twice as much (exceed 112,000)? (Alternative 4)*1
Chinook Salmon	Fry	Y	Y
	Parr	Y	Y
	Yearling	**N**	**N**
Steelhead	Fry	Y	Y
	Parr	Y	Y
	Smolt	Y	Y
Coho Salmon	Fry	Y	Y
	Parr	Y	Y
	Yearling	Y	Y
Chum Salmon	Fry	Y	Y
Pink Salmon	Fry	Y	Y

[*] Source: (Haggerty 2020b)

[1] 232,000 is equal to twice the number of steelhead juveniles that would be released under Alternative 2 and 3, and 112,000 is equal to twice the number of steelhead juveniles that would be released under Alternative 4.

4.1.4 Temporal Overlap

Temporal overlap includes criteria 6 and 7 in the sequential order of the QEM (Table 4). Steelhead smolts out-migrate rather quickly once released. The travel rate of hatchery-origin steelhead smolts exiting Reiter Ponds is anticipated to be around 6.76 miles/day (Melton 2020). Reiter Ponds is on river mile 46. The total distance these fish travel is 50.3 river miles because 4.3 river miles are added to account for migrating through Ebey Slough. Therefore, the residence time in freshwater is 50.3 miles divided by 6.76 miles per day, which equals 7.44 days (rounded up to 8 days for the analysis).

To determine the temporal overlap between hatchery-origin steelhead and natural-origin salmon and steelhead, two scenarios were analyzed because of uncertainties about how hatchery-origin steelhead volitionally leave Reiter Ponds. For our analysis in this EA, Scenario A for the current ~~Skamania~~ESS program assumes that all fish leave volitionally the first day and are present in the river up to 8 days afterwards (i.e., April 15 to April 22). Scenario B for the current ~~Skamania~~ESS program assumes all fish leave the hatchery the last day and are present in the system up to 8 days afterward (i.e., May 15 to May 22). Similarly, Scenario A for the proposed steelhead program under Alternative 2 assumes that all fish leave volitionally the first day and are present in the river up to 8 days afterwards (i.e., April 15 to April 22). Scenario B assumes all fish leave the hatchery the last day and are present in the system up to 8 days afterward (i.e., May 31 to June 7).

These two scenarios are the two extreme ends of the smolt behavior, and most likely steelhead smolts leave Reiter Ponds during days or weeks after the exit is opened. The anticipated impacts are likely to be something between Scenario A and B. Therefore, the average of risk levels for Scenario A and Scenario B is considered the likely risks for competition.

Once released, at least one life stage of each species of salmonids that are present in the analysis area has temporal overlap with hatchery-origin steelhead smolts. The maximum temporal overlap between hatchery-origin steelhead from the current ~~Skamania~~ESS program and the proposed Skykomish summer steelhead program and natural-origin salmonids in the analysis area under either scenario is 8 days (Table 19), based on the timing information in Table 18.

Table 18. Predominant freshwater occurrence or release timing for natural-origin and hatchery-origin salmon and steelhead juveniles by life stage.

Species	**Life Stage**	**Predominant Occurrence[1]**
~~Skamania~~ESS Summer-run Steelhead	Yearling Smolt	April 15 – May 22[2]
Proposed Steelhead Program	~~Yearling and 2-year-old smolts~~Yearling smolts	April 15 – June 7[3]
Chinook Salmon	Fry	January – April
	Parr	April– July
	Yearling	January – May
Steelhead	Fry	June – October
	Parr	October – mid-May
	Smolt	late April – June
Coho Salmon	Fry	March -September
	Parr	September-April
	Yearling	late April – May
Chum Salmon	Fry	Feb-May
Pink Salmon	Fry	March – May

[1] Source: (Melton 2021)

[2] May 15 is the last release date, but we add 8-day travel time to account for the hatchery-origin fish fully exit the river
[3] May 31 is the last release date, but we add 8-day travel time to account for the hatchery-origin fish fully exit the river

Table 19. Number of days of overlap between hatchery-origin ~~Skamania~~ESS summer-run steelhead and natural-origin salmonids in the analysis area.

		Natural-origin Species and Life Stage										
		Chinook			Steelhead			Coho			Chum	Pink
		Yearling	Parr	Fry	Smolt[26]	Parr	Fry	Yearling	Parr	Fry	Fry	Fry
		Jan – May	April – July	Jan – Apr	Late Apr– June	Oct – Mid-May	Jun – Oct	Late Apr – May	Sept – Apr	Mar – Sept	Feb – May	Mar – May
~~Skamania~~ ESS Program	Scenario A (4/15-4/22)	8	8	8	8	8	0	8	8	8	8	8
	Scenario B (5/15-5/22)	8	8	0	8	8	0	8	0	8	8	8
Proposed Program (yearlings ~~and 2-year-old fish~~)	Scenario A (4/15-4/22)	8	0	8	8	8	0	8	8	8	8	8
	Scenario B (5/31-6/7)	1	8	0	8	0	7	1	0	8	1	1

At least one natural-origin life-stage from all species overlaps 8 days for Scenario A or Scenario B under current conditions or under Alternative 2. Natural-origin steelhead fry and hatchery-origin steelhead releases do not overlap temporally under current conditions and were not considered in our analysis accordingly. The application of the QEM resulted in 1 to 2 reductions of competition risk level for criterion 7 for all species and lifestages (Table 6 through Table 15).

4.1.5 Spatial Overlap

The release site for the summer-run steelhead program (current and proposed) is 50.3 miles from the estuary, accounting for Ebey Slough. Therefore, there is no reduction of risk in the QEM for any of the species based on this factor.

[26] Steelhead juveniles can reside in fresh water for one to three years before they become smolts.

4.2 Freshwater Juvenile Predation

The following tables summarize the QEM application results for predation for each species, considering Scenario A and Scenario B, under current conditions and under Alternative 2. The narrative description of how these criteria apply follows the tables.

Chinook Salmon

Table 20. Risk level reductions for predation on juvenile Chinook salmon by ~~Skamania~~ESS hatchery steelhead yearlings under current conditions based on the application of criteria in Table 5.

Juvenile Outmigration Timing	Chinook salmon life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
		2	3	4	5	6	7	
Scenario A	Fry	0	-1	0	-1	0	0	-2
Scenario A	Parr	0	-1	0	-1	0	0	-2
Scenario A	Yearling	0	0	0	-1	0	0	-1
Scenario B	Fry	0	-1	-2	0	0	0	-3
Scenario B	Parr	0	-1	0	-1	0	0	-2
Scenario B	Yearling	0	0	0	-1	0	0	-1
						Average Reduction		-2

Table 20 illustrates the use of the QEM to adjust (reduce) the default unknown risk level of predation on natural-origin Chinook salmon juveniles by hatchery-origin steelhead under current conditions by an average of 2 categories, which results in an adjustment to small (-2) if the default risk level were high.

Table 21. Risk level reductions for predation on juvenile Chinook salmon by hatchery-origin steelhead under Alternative 2 based on the application of criteria in Table 5. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Chinook salmon life-stage	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
			2	3	4	5	6	7	
Scenario A	Fry	Yearling	0	-1	0	-1	0	0	-2
Scenario A	Parr	Yearling	0	-1	-2	0	0	0	-3
Scenario A	Yearling	Yearling	-2	0	0	-1	0	0	-3
Scenario B	Fry	Yearling	0	-1	-2	0	0	0	-3
Scenario B	Parr	Yearling	0	-1	0	-1	0	0	-2
Scenario B	Yearling	Yearling	-2	0	-2	0	0	0	-4
~~Scenario A~~	~~Fry~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario A~~	~~Parr~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
~~Scenario A~~	~~Yearling~~	~~2-Year-Olds~~	~~0~~	~~0~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-1~~
~~Scenario B~~	~~Fry~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
~~Scenario B~~	~~Parr~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario B~~	~~Yearling~~	~~2-Year-Olds~~	~~-2~~	~~0~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-4~~

Juvenile Outmigration Timing	Chinook salmon life-stage	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
			2	3	4	5	6	7	
							Average Reduction		-3

Table 21 illustrates the use of the QEM to adjust (reduce) the default unknown risk level of predation on natural-origin Chinook salmon juveniles by hatchery-origin steelhead under Alternative 2 by an average of 3 categories, which results in an adjustment to minimal (-3) if the default risk level were high.

<u>Steelhead</u>

Table 22. Risk level reductions for predation on natural-origin steelhead by ~~Skamania~~ESS hatchery steelhead yearlings under current conditions based on the application of criteria in Table 5. There is no co-occurrence between natural-origin steelhead fry and ~~Skamania~~ESS hatchery steelhead yearling smolts under current conditions.

Juvenile Outmigration Timing	Steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
		2	3	4	5	6	7	
Scenario A	Parr	0	-1	0	-1	0	0	-2
Scenario A	Yearling	-2	-1	0	-1	0	0	-4
Scenario B	Parr	-2	-1	0	-1	0	0	-4
Scenario B	Yearling	-2	-1	0	-1	0	0	-4
						Average Reduction		-4

Table 22 illustrates the use of the QEM to adjust (reduce) the default unknown risk level of predation on natural-origin steelhead juveniles by hatchery-origin steelhead (all yearlings) under current conditions by an average of 4 categories, which results in an adjustment to close to none (-4) if the default risk level were high.

Table 23. Risk level reductions for predation on natural-origin steelhead by hatchery-origin steelhead under Alternative 2 based on the application of criteria in Table 5. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Steelhead life-stage	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
			2	3	4	5	6	7	
Scenario A	Fry	Yearlings	0	-1	-2	0	0	0	-3
Scenario A	Parr	Yearlings	0	-1	0	-1	0	0	-2
Scenario A	Yearling	Yearlings	-2	-1	0	-1	0	0	-4
Scenario B	Fry	Yearlings	-2	-1	-2	0	0	0	-5
Scenario B	Parr	Yearlings	-2	-1	-2	0	0	0	-5
Scenario B	Yearling	Yearlings	-2	-1	0	-1	0	0	-4

Juvenile Outmigration Timing	Steelhead life-stage	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
			2	3	4	5	6	7	
~~Scenario A~~	~~Fry~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
~~Scenario A~~	~~Parr~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario A~~	~~Yearling~~	~~2-Year-Olds~~	~~-2~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
~~Scenario B~~	~~Fry~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
~~Scenario B~~	~~Parr~~	~~2-Year-Olds~~	~~-2~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
~~Scenario B~~	~~Yearling~~	~~2-Year-Olds~~	~~-2~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-4~~
							Average Reduction		-4

Table 23 illustrates the use of the QEM to adjust (reduce) the default unknown risk level of predation on natural-origin steelhead juveniles by hatchery-origin steelhead under Alternative 2 by an average of 4 categories, which results in an adjustment to close to none (-4) if the default risk level were high.

<u>Coho Salmon</u>

Table 24. Risk level reductions for predation on natural-origin coho by ~~Skamania~~ESS hatchery steelhead yearlings under current conditions based on the application of criteria in Table 5.

Juvenile Outmigration Timing	Coho salmon life stage	Criteria # in Table 4, Appendix A - Predation Criteria						
		2	3	4	5	6	7	Sum of Reductions
Scenario A	Fry	0	-1	0	-1	0	0	-2
Scenario A	Parr	0	-1	0	-1	0	0	-2
Scenario A	Yearling	0	-1	0	-1	0	0	-2
Scenario B	Fry	0	-1	0	-1	0	0	-2
Scenario B	Parr	0	-1	-2	0	0	0	-3
Scenario B	Yearling	-2	-1	0	-1	0	0	-4
						Average Reduction		-3

Table 24 illustrates the use of the QEM to adjust (reduce) the default unknown risk level of predation on natural-origin coho salmon juveniles by hatchery-origin steelhead (all yearlings) under current conditions by an average of 3 categories, which results in an adjustment to minimal (-3), if the default risk level were high.

Table 25. Risk level reductions for predation on juvenile coho salmon by hatchery-origin steelhead under Alternative 2 based on the application of criteria in Table 5. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Coho salmon life-stage	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
			2	3	4	5	6	7	
Scenario A	Fry	Yearlings	0	-1	0	-1	0	0	-2
Scenario A	Parr	Yearlings	0	-1	0	-1	0	0	-2
Scenario A	Yearling	Yearlings	0	-1	0	-1	0	0	-2
Scenario B	Fry	Yearlings	0	-1	0	-1	0	0	-2
Scenario B	Parr	Yearlings	0	-1	-2	0	0	0	-3
Scenario B	Yearling	Yearlings	-2	-1	-2	0	0	0	-5
~~Scenario A~~	~~Fry~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario A~~	~~Parr~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario A~~	~~Yearling~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario B~~	~~Fry~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario B~~	~~Parr~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
~~Scenario B~~	~~Yearling~~	~~2-Year-Olds~~	~~-2~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-5~~
							Average Reduction		-3

Table 25 illustrates the use of the QEM to adjust (reduce) the default unknown risk level of predation on natural-origin coho salmon juveniles by hatchery-origin steelhead under Alternative 2 by an average of 3 categories, which results in an adjustment to minimal (-3) if the default risk level were high.

Chum Salmon

Table 26. Risk level reductions for predation on natural-origin chum salmon by ~~Skamania~~ESS hatchery steelhead yearlings under current conditions based on the application of criteria in Table 5.

Juvenile Outmigration Timing	Chum salmon life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
		2	3	4	5	6	7	
Scenario A	Fry	0	-1	0	-1	0	0	-2
Scenario B	Fry	0	-1	0	-1	0	0	-2
						Average Reduction		-2

Table 26 illustrates the use of the QEM to adjust (reduce) the default high risk level of predation on natural-origin chum salmon fry by hatchery-origin steelhead (all yearlings) under current conditions by an average of 2 categories, which results in an adjustment from high to small (-2).

Table 27. Risk level reductions for predation on juvenile chum salmon by hatchery-origin steelhead under Alternative 2 based on the application of criteria in Table 5. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
		2	3	4	5	6	7	
Scenario A	Yearlings	0	-1	0	-1	0	0	-2
Scenario B	Yearlings	0	-1	-2	0	0	0	-3
~~Scenario A~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario B~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~
						Average Reduction		-3

Table 27 illustrates the use of the QEM to adjust (reduce) the default high risk level of predation on natural-origin chum salmon fry by hatchery-origin steelhead under Alternative 2 by an average of 3 categories, which results in an adjustment from high to minimal (-3).

<u>Pink Salmon</u>

Table 28. Risk level reductions for predation on natural-origin pink salmon by ~~Skamania~~ESS hatchery steelhead yearlings under current conditions based on the application of criteria in Table 5.

Juvenile Outmigration Timing	Pink salmon life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
		2	3	4	5	6	7	
Scenario A	Fry	0	-1	0	-1	0	0	-2
Scenario B	Fry	0	-1	0	-1	0	0	-2
						Average Reduction		-2

Table 28 illustrates the use of the QEM to adjust (reduce) the default high risk level of predation on natural-origin pink salmon fry by hatchery-origin steelhead (all yearlings) under current conditions by an average of 2 categories, which results in an adjustment from high to small (-2).

Table 29. Risk level reductions for predation on juvenile pink salmon by hatchery-origin steelhead under Alternative 2 based on the application of criteria in Table 5. Hatchery-origin steelhead are ~~either yearlings or 2-year-old~~yearling smolts under Alternative 2.

Juvenile Outmigration Timing	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
		2	3	4	5	6	7	
Scenario A	Yearlings	0	-1	0	-1	0	0	-2
Scenario B	Yearlings	0	-1	-2	0	0	0	-3
~~Scenario A~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~0~~	~~-1~~	~~0~~	~~0~~	~~-2~~
~~Scenario B~~	~~2-Year-Olds~~	~~0~~	~~-1~~	~~-2~~	~~0~~	~~0~~	~~0~~	~~-3~~

Juvenile Outmigration Timing	Hatchery-origin steelhead life stage	Criteria # in Table 4, Appendix A - Predation Criteria						Sum of Reductions
		2	3	4	5	6	7	
						Average Reduction		-3

Table 29 illustrates the use of the QEM to adjust (reduce) the default high risk level of predation on natural-origin pink salmon fry by hatchery-origin steelhead under Alternative 2 by an average of 3 categories, which results in an adjustment from high to minimal (-3).

4.2.1 Criteria that Apply the Same as Competition

Co-occurrence, relative abundance and temporal and spatial overlap for predation are the same and result in reductions in risk-level categories for predation (Table 5) as for competition above in Section 4.1.

4.2.2 Fish Size

Fish size (Table 2, criterion 2) is the next criterion to be considered in the sequential order of the QEM, after establishing co-occurrence (criterion 1). If hatchery-origin steelhead smolts are more than twice as large as natural-origin salmon and steelhead (Table 16), criterion 2 does not provide any reductions in predation risk level. As for competition (Section 4.1), for Scenarios A and B, fish size is assumed to be the smaller value and the larger value respectively from the Size Range column in Table 16.

4.3 Skykomish River Freshwater Adult Competition

Adult returns from the current ~~Skamania~~ESS program start to spawn in January, and it is assumed that adults from the new program would have the same spawning timing as the current natural-origin summer-run steelhead population (mid-March - mid-June) (Table 30). Therefore, there is some temporal overlap with natural-origin North Fork Skykomish summer-run steelhead and Skykomish winter-run steelhead (and perhaps coho salmon for the ~~Skamania~~ESS program in January) spawning in the Skykomish River that could lead to spawning site competition (Table 30).

Redd superimpositions ~~generally occur~~occur when other adults spawn on top of previously created redds, and in this specific case, when hatchery-origin adults dig a redd in the same place that is deep enough to affect the deposited eggs of natural-origin adults before fry emerge. Salmon and steelhead may be susceptible to redd superimposition from returning hatchery-origin steelhead adults because spawning (Table 30) and emergence timing (Table 18) result in temporal overlap, though it is unknown whether all species overlap in spawning areas (spatial overlap). Different species have specific preferences for substrate size in which they dig redds, which limits the spatial overlap naturally even if there is temporal overlap among species (Table 31). Assuming that hatchery-origin and natural-origin fish of the same species have similar substrate preference and redd depth, the difference in substrate preferences between hatchery-origin steelhead that could spawn in the wild and Chinook, coho and pink salmon, for example, is likely sufficient to provide for spatial isolation, limiting redd superimposition (Table 31). Also, different species dig redds of different depth (Table 31). However, the differences in the average redd depths among species are not likely to be enough to rule out egg displacement by steelhead if there is a spatial overlap.

Table 30. Run and spawn timing of salmon and steelhead in the analysis area.

Species	Run Timing	Holding	Spawning
~~Skamania~~ESS Summer-run Steelhead	May – September[1,2]	June - December	January – March[2]
Skykomish Chinook Salmon	May – July[3]	Mid-May – September	September – October[4]
Skykomish Winter-run Steelhead	November – April[5]	November - March	Mid-March – Mid-June[5]
Skykomish Summer-run Steelhead (and proposed Skykomish summer steelhead hatchery steelhead)	July – October[5,6]	Mid-July - March	Mid-February – April[7]
Coho	September – October[6]	Mid-September – November	Late-October - January[6]
Chum Salmon	October – December[8]	October	November - December[6]
Pink Salmon (odd year)	August – Mid-September[6]	August - September	Late-September - October[6]
Pink Salmon (even year)	August – Mid-September[6]	August -Mid-September	September[6]

[1] From (WDFW 1999c) (WDFW 1999a, b, 2001, 2002, 2005, 2008, 2010, 2011d, c, b, a, 2012, 2013a, 2014b, c, 2015b, 2016b, 2018a, 2019a)
[2] From WDFW Weekly Hatchery Reports (2010-2015), accessible at https://wdfw.wa.gov/fishing/management/hatcheries/escapement#weekly-reports.
[3]PSIT and WDFW (2010)
[4] (Ruckelshaus et al. 2006)
[5]Myers et al. (2015)
[6] (WDFW 1994)
[7] Assumed based on South Fork Tolt summer-run steelhead spawn timing (Haggerty 2020b)
[8] Haring (2002)

Table 31. Median substrate size and egg pocket depth for salmonid species present in the Snohomish River Basin.

Species	Median Substrate Size[1] (mm)	Redd Depth[2]			
		Top Avg (cm)	Top Range (cm)	Bottom Avg (cm)	Bottom Range (cm)
Chinook Salmon	35	21.5	5-51	37.3	19-80
Steelhead	26	21.5	10-30	30	-
Chum Salmon	30	22.5	5-49	-	20-40
Coho Salmon	20	19.2	6-38	33	16-55
Pink Salmon	9	-	18-50[3]	-	18-50[3]

[1] (Kondolf and Wolman 1993)
[2] (DeVries 1997)
[3] From discrete eggs

When temporal and spatial overlap between hatchery-origin steelhead and other salmonid species exists, spawning habitat must be limited and the abundance of hatchery-origin steelhead in the spawning grounds must be high relative to the abundance of other species or groups of fish for redd superimposition to occur. Hatchery-origin ~~Skamania~~ESS steelhead are not intended to spawn in the wild, and most fish are removed either by fisheries or at the hatchery trap for broodstock. The estimated number of hatchery-origin ~~Skamania~~ESS steelhead currently spawning in the analysis area could be up to 284 fish per year (Haggerty 2020b), which is low compared to Chinook, coho, chum, and pink salmon (Table 32). Therefore, even if the habitat is limited (which is not known), the number of potential ~~Skamania~~ESS fish spawning in the wild under current conditions is likely low relative to Chinook, coho, chum, and pink salmon. The proposed Skykomish summer steelhead hatchery program will use native fish as original broodstock until hatchery-returns are established and will be managed as a program requiring a proportion of natural-origin fish as broodstock continuously thereafter. In addition to providing fish for fisheries, this hatchery program is intended to improve the demographics of the native summer-run steelhead population in the Skykomish River Basin where a certain number of hatchery-origin steelhead would be allowed to spawn in the wild. Therefore, the proposed Skykomish summer steelhead hatchery program does not result in adult competition beyond what is expected from natural processes.

Table 32. Average Escapement for Salmonid Species in the Snohomish River Basin.

Species	**Average Escapement* (2006-2018)**
Skykomish Chinook	3,273
Snohomish Coho	92,462
Snohomish Odd-Year Pinks	966,962

Species	Average Escapement* (2006-2018)
Skykomish Chum	24,966
Skykomish Winter-run Steelhead	1,081[1]
Skykomish Summer-run Steelhead	360[2]

* Escapement is the number of fish that return to spawning habitat.
[1] No data for 2008-2009.
[2] No data for 2006 and 2007.
Source: (Haggerty 2020b)

2 REFERENCES

To see references, please see Chapter 8 of the EA above.

1 Appendix B: Public comments received, and NMFS responses to comments

During our public comment period from February 4, 2021 to March 8, 2021, NMFS received 649 comment letters that included 48 comments that have been summarized with responses below. Of the 649 comment letters, 646 letters were in support of the proposed hatchery program. NMFS would like to express appreciation to all commenters for submitting comments and contributing to this important discussion of impacts.

One of the commenters incorporated previous comments concerning the HGMP and PEPD into comments for the DEA. Specific responses to comments provided about the HGMP and PEPD will be documented in the Evaluation and Recommended Determination (ERD).

1.1 Process

Comment 1: One commenter requested that NMFS certify that all applicable environmental laws have been followed, including, but not limited to the Endangered Species Act, National Environmental Policy Act, Administrative Procedure Act (APA), and Clean Water Act (CWA).

Response: NMFS is preparing this EA in accordance with NEPA, and the underlying action is a review of hatchery programs pursuant to the ESA. The relationship of the EA to ESA is discussed in Section 1 and 1.3.2 of the EA, and impacts to endangered and threatened species are discussed in sections (Section 3.3 and 4.3). The relationship of the CWA is discussed in Section 3.2 in the EA, and water quality impacts are discussed in sections 3.1 and 4.1.

The purpose of an EA is to disclose environmental impacts in order to determine whether an action raises potentially significant impacts to the human environment. While it is important for the reader to understand that the underlying action would authorize hatchery operations, a review of all potential legal matters faced by the applicant in operating its program is beyond NMFS' purview and would not be particularly helpful to fostering an informed discussion of the environmental/human impacts.

Comment 2: A commenter suggested that goals, performance objectives, and indicators are not clear and did not address Section 50 C.F.R. § 223.203(b)(5)(i)(A) of the ESA. In addition, it was suggested that, "the statements of program goals, performance objectives, and performance indicators in each of the

HGMP is inappropriately general and vague at best, ignoring relevant and substantive biological issues that arise in conservation contexts."

Response: Because this question is in regards to the HGMP, it will be addressed in the response to comments for the PEPD/HGMP.

The objectives are stated in Section 1.8 of the HGMP and 1.1 of the EA. Performance objectives and indicators are shown in Tables 1.10.1.1 and 1.10.2.1 in the HGMP. Additional information on monitoring and evaluation can be found in HGMP Section 11.

Comment 3: A commenter suggested that the EA does not adequately utilize the Viable Salmonid Population ("VSP") concepts and does not meet these requirements of ESA Section 50 C.F.R. § 223.203(b)(5)(i)(B).

Response: Because this question is in regards to the HGMP, it will be addressed in the response to comments for the PEPD/HGMP.

Comment 4: A commenter stated that the broodstock program described in the HGMP does not reflect appropriate priorities, citing ESA Section 50 C.F.R. § 223.203(b)(5)(i)(C).

Response: Because this question is in regards to the HGMP, it will be addressed in the response to comments for the PEPD/HGMP. The EA also includes information about genetic impacts in Sections 3.3.1 and 4.3.1.

Comment 5: One commenter proposed that the HGMP does not include adequate adaptive measures, and does not comply with ESA Section 50 C.F.R. § 223.203(b)(5)(i)(I).

Response: Because this question is in regards to the HGMP, it will be addressed in the response to comments for the PEPD/HGMP. The EA discusses applying adaptive management to the results of monitoring but does not discuss details of the process (in sections 3.3.8 and 4.3.8). Details on the adaptive management process are suggested in tables 1.10.1.1 and 1.10.2.1 in the HGMP.

Comment 6: A comment stated that the DEA is deficient because it does not sufficiently evaluate whether any of the alternatives will satisfy all the requirements for approval under the 4(d) Rule (50 C.F.R. § 223.203(b)(6)). More specifically, the DEA is deficient for failing to conduct any quantitative risk assessment of the various alternatives.

Response: NMFS disagrees with the commenters that suggest that there is inadequate consideration within the EA of the direct, indirect, and cumulative impacts of the proposed hatchery program. Section 3 of the EA, specifically Section 3.3, discusses potential impacts (both positive and adverse) in detail, which are summarized in Table 8, page 31 of the EA. In particular, as the comment references standards under the ESA, the EA considers the impacts to ESA-listed species at section 4.3.

NMFS also notes that the EA contains quantitative analyses: for example, Appendix A and the genetic analysis that was developed for the biological opinion. Additional detail regarding the impacts of the hatchery program can be found in the associated biological opinion (NMFS 2021b).

Comment 7: One commenter proposed that NMFS should decline to approve the joint plan because the HGMP does not meet the criteria of Limit 5 of the 4(d) Rule.

Response: Because this question is in regards to the HGMP, it will be addressed in the response to comments for the PEPD/HGMP. NMFS will make a final determination approving or disapproving the joint plan in its forthcoming Evaluation and Recommended Determination (ERD) and decision documents.

Comment 8: One commenter suggested that the EA is flawed because it did not include a population viability analysis (PVA).

Response: NMFS did not do a formal PVA; however, NMFS does not consider this a flaw. When assessing a hatchery program, NMFS assesses the overall risk to viability to a particular population. This assessment is based on the four viable salmonid population measures: abundance, productivity, spatial structure, and diversity. NMFS conducts a status review of our ESA-listed salmon and steelhead populations every five years to determine if a change in risk category is needed (e.g., NWFSC (2015)). Additional analyses on population viability were conducted in the new biological opinion (NMFS 2021b).

No PVA approach of which we are aware adequately deals with population status on the level of complexity we find in the Snohomish Basin.

NMFS believes that the proposed program would result in a benefit to Puget Sound Steelhead DPS viability because the new steelhead hatchery program is intended to replace the negative impacts of past early summer-run (Skamania) steelhead production with a program that would potentially increase abundance and improve spatial structure.

Comment 9: A commenter suggested that the EA was inadequate because the description of the purpose and need were too vague to conduct a meaningful analysis.

Response: The purpose and need of the proposed action are described in Section 1.1, page 1 of the EA:

The purpose of the Proposed Action is to determine whether the summer-run steelhead hatchery program in the Skykomish River Basin, as described in the HGMPs submitted by the co-managers, meets the requirements of the ESA under Limit 6 of the 4(d) Rule, and whether the trap and haul program permit application meets the requirement of the ESA section 10(a)(1)(A). NMFS' need for the Proposed Action is to respond to the co-managers' request for approval of the hatchery program under Limit 6 of the 4(d) Rule and the trap and haul program under the ESA section 10(a)(1)(A); to ensure the recovery of ESA-listed Puget Sound salmon and steelhead by conserving their productivity, abundance, diversity and distribution; and to ensure NMFS meets its tribal trust responsibilities.

NMFS believes that the purpose and need are appropriate for the action NMFS is considering, which is determination if the programs meet the criteria of ESA Section 4(d) and Section 10(a)(1)(A), respectively.

1.2 Adequacy of evaluation within the EA

Comment 10: A commenter suggested that geneticists from the NW Science Center had not been consulted, nor has the HSRG evaluated the program.

Response: An environmental assessment does not require agencies to consult specific entities to develop information, but to rely on the best available information on which to base its determination. Nevertheless, NMFS has engaged and sought expert opinions from genetics staff from the Northwest

Fisheries Science Center, the tribes, and WDFW regarding this program. The EA provides a citation where an individual made a meaningful contribution to the EA. While there is no requirement that the HSRG review a proposed hatchery program, over the past three years NMFS has conducted regular discussions with all the geneticists on the HSRG through the Puget Sound Genetic Risk Work Group. It should further be noted that the HSRG no longer exists, having been defunded at the end of 2020.

Comment 11: A commenter suggested that the DEA relies upon a series of false assumptions and questionable scientific conclusions to analyze and eliminate alternatives from consideration, and that NMFS has relied on faulty assumptions that render the DEA arbitrary and capricious.

Response: NMFS used the best available science and was actively involved in research that was referenced in our assessment. Given the general nature of the comment, it is not possible to determine which assumptions may be faulty, nor what scientific conclusions are questionable.

Comment 12: One commenter did not understand why the no action alternative did not just remove the Skamania Hatchery program and keep the Sunset Falls trap and haul portion of the program.

Response: NMFS interprets that the "no action" as what would happen if the Proposed Action does not occur. Because the Proposed Action includes both 4(d) approval of the HGMP and the trap and haul program, no action, in this case, means, "what would happen if NMFS does not issue a 4(d) determination and the Section 10 permit?" The outcome of this is described in Section 2 of the FEA.

Comment 13: A commenter disagreed with the explanation in the HGMP of why the no action alternative was dismissed. They suggested that:

The list of grounds for the rejection continues by listing not only the co-managers' desire to continue to provide a harvest subsidy, but the unsupported claims that it would not "be compatible with Treaty Indian fishing rights (U.S. v Washington) or the Magnuson/Stevens Fishery Conservation and Management Act for sustainable fisheries". Such an assertion clearly requires some explanation on both issues (compatibility with Treaty Indian fishing rights and (unspecified) requirements pursuant to the Magnuson/Stevens Fishery Conservation and Management Act. These issues alone require an analysis under NEPA.

Response: Because this question is in regards to the HGMP, it will be addressed in the response to comments for the PEPD/HGMP. As discussed above, the EA is focused on assessing the significance of any potential environmental impacts, not the legal compatibility of the action with other requirements that the applicant may face.

Comment 14: One comment suggested that NMFS review the discrepancies between the Quicksilver Plan and the co-manager RMP with WDFW to ensure that the state has accurately and appropriately submitted the plan in question. Specifically, the commenters suggest:

On page 6 of the Quicksilver plan it reads: "Prior to submitting a steelhead hatchery resource management plan for consideration by NMFS, the department shall request review of the proposed program by the Hatchery Scientific Review Group (or other independent scientific review entity) to evaluate the proposed program and identify potential improvements."

Response: The Proposed Action that NMFS reviewed is what WDFW submitted through the HGMP/Section 10 permit application process. As noted above, NMFS has consulted with the HSRG regarding the HGMPs in preparation of this EA. At present, the HSRG is not active, due to having been defunded at the end of 2020. Any questions for WDFW regarding their internal requirements, and whether those internal requirements are compatible with co-management under US v WA, would be beyond the purview of this EA.

Comment 15: One commenter suggested that the DEA violates NEPA because it does not satisfy the intent or requirements of NEPA since it fails to take a hard look at the potential negative effects of the proposed hatchery program.

Response: NMFS disagrees with the commenter; NMFS did take a hard look at all impacts that were identified within the EA, for example, see Section 4 of the EA and Appendix A. As shown in various sections within the EA, NMFS has analyzed the potential negative impacts from hatchery programs (see Section 4.3 of the EA), and also has completed an ESA section 7 consultation of the proposed hatchery program (NMFS 2021b). In addition, USFWS has completed a biological opinion on the hatchery effects on bull trout (USFWS 2021).

1.3 Development of an EIS

The following comments regard commenters' concerns about the development of an EIS. In general, the draft EA is not a document where NMFS makes a determination as to whether an EIS is required; that is done through issuance of a decision document, which will be either a Finding of No Significant Impact (FONSI) or a determination that an EIS is required. If NMFS reaches a FONSI in its decision document, NMFS will issue the FONSI along with the Final EA.

Comment 16: One commenter thought an EIS is required to consider the genetic issues concerning the purging over time of genetic material lowering individual fitness due to natural selection in the absence of the flow of the genetic material lowering fitness in the wild.

Response: Genetic issues and potential negative impacts are discussed in Section 3.3.5.1 and 4.3.1 in the EA and section 2.5.2.2 in the biological opinion (NMFS 2021c). Also, please see response to comment 25 below regarding genetic impacts. With respect to the requirement to prepare an EIS, please see our response to comment 15.

Comment 17: A commenter suggested that an EIS is necessary to evaluate whether other take permits have been granted which affect Snohomish steelhead DIPs, and whether or not a full accounting of the take that has already been permitted yields additional impacts that can still be dispersed.

Response: NMFS interprets this comment to be related to cumulative impacts. Section 5.1.4 and 5.1.5 in the EA discuss the cumulative impacts of hatcheries and fisheries, respectively. All hatchery programs submitted to NMFS for review are required to comply with conservation provisions of the ESA, which minimize or avoid take. Please see Section 5.1.4 and 5.1.5 for additional information regarding take.

In addition, take permits for Snohomish steelhead are mentioned in various footnotes within the EA. For example, footnote 8, page 48, footnote 12 on page 71 and footnote 14 on page 73. The HGMP lists existing permits for Snohomish steelhead in Section 2.1, and Section 15. In addition, for a complete understanding, see section 1.2 in the biological opinion (NMFS 2021c).

Comment 18: A commenter thought an EIS is necessary to determine what the term the “trade-offs” between levels of harvest necessary to meet tribal trust responsibilities and the conservation portion of the program.

Response: Tribal concerns are discussed in sections 3.7 and 4.7, while harvest is discussed in sections 3.6.2 and 4.6. With respect to the requirement to prepare an EIS, please see our response to comment 15.

Comment 19: Another commenter suggested that a full EIS is necessary because NMFS ignored a recent detailed study of recreational steelhead catch-and-release mortality and associated reductions in reproductive success of steelhead that survive catch-and- release.

Response: The impacts of the proposed action on fisheries are summarized in the EA (sections 3.6.2 and 4.6), and were determined through a consultation (see NMFS (2020b)). With respect to the requirement to prepare an EIS, please see our response to comment 15. NMFS has reviewed the study mentioned by the commenter.

Comment 20: One commenter felt a genuine alternative that should be fully evaluated in an EIS is an alternative to get the hatchery fish entirely out of the way of wild, NOR populations and allow natural selection to completely “drive” the recovery of DIP fitness and demographics absent harvest pressure

Response: The “no action” alternative that was evaluated within the EA includes termination of the programs. With respect to the requirement to prepare an EIS, please see our response to comment 15.

Comment 21: There were six comments suggesting that the research, monitoring, and evaluation depicted in the HGMP and EA are inadequate. Issues raised were (1), no research or monitoring regarding reproductive success or overall fitness; (2), the genetic markers, methods, and techniques are not described; (3), the program standards, indicators, and associated monitoring and evaluation tasks fall short of the level needed to evaluate the hatchery program. One commenter suggested that the annual monitoring does not include natural-origin populations affected by the program. In addition, more detail was requested regarding when and where sampling will occur.

Response: Through previous consultations regarding monitoring and evaluation (see footnote 5 in EA), NMFS understands what monitoring and evaluation is taking place and the reasons for it taking place. Research regarding reproductive success studies is the topic of comment 22 below. Further, the determination of whether monitoring is adequate to meet the requirements of ESA is not a determination made in a NEPA document. The EA reflects the anticipated monitoring that has not been permitted previously (please see consultations where monitoring has been permitted in footnote 5 of the EA) and uses this information in analyzing the alternatives.

Comment 22: Some commenters suggested that there needs to be a relative reproductive success (RRS) study in the Skykomish to determine how well hatchery fish that are meant for conservation purposes are performing.

Response: Results are now available from many RRS studies throughout the Columbia River Basin and elsewhere where those results can be applied to the Skykomish or other steelhead populations. Further, NEPA relies on the best available science and does not prescribe future studies in and of itself. An EA considers past studies and used their findings to determine future anticipated impacts.

NMFS recognizes that the language concerning relative reproductive success may have been unclear and has added language to the EA in Section 3.3.5.5.

1.4 Potential impacts of the hatchery program on natural-origin fish

Comment 23: One commenter pointed out that negative impacts from hatcheries often result in changes in morphology and behavior of returning fish.

Response: NMFS is aware of changes to size and age structure of returning hatchery salmon and that this could affect the long-term productivity of certain populations. However, the mechanisms for these changes are still poorly understood. As the mechanisms become more apparent with additional research, the co-managers can adaptively manage the proposed hatchery program to reduce the effects of this phenomenon. Additional information concerning the effects of the hatchery program can be found in Section 3.3 in the EA.

Comment 24: Another commenter suggested that hatcheries do not determine prior to spawning whether spawners are related and therefore inbreeding depression is increased.

Response: NMFS agrees that inbreeding is a potential result from mating fish in a hatchery. However, measures to reduce the chance of inbreeding include collecting fish throughout the run period, randomized mating protocols, and using a 1:1 spawner ratio, as proposed in the HGMP. Another key factor is the size of the broodstock. A few conservation hatchery programs include genetic testing and exclusion of matings between close relatives, but typically these are programs dealing with very small populations, where the risk of inbreeding is high and the consequences likely severe. Additional information concerning the effects of a hatchery program can be found in Section 3.3 in the EA.

Comment 25: A commenter was curious about the rate at which deleterious alleles from Skamania and potentially hatchery-origin fish from new program will be purged from the NF Sky DIP.

Response: According to basic population genetic principles, deleterious alleles will decline according to the strength of selection against them but this is also moderated by genetic drift. Rates of genetic recombination, which are influenced by where the alleles are located on the chromosomes, will also play a role. The process can be sped up by gene flow of beneficial alleles, so it would be expected that supplementation of the North Fork Skykomish steelhead population, with fish having less Skamania influence, would reduce Skamania influence in the North Fork population faster, but at the risk of losing North Fork–specific genetic diversity. The influence of deleterious alleles from the proposed integrated program will most likely have less impact by maintaining a high PNI. Discussion on genetics (and PNI) can be found in Section 3.3.5.1 in the EA.

Comment 26: One commenter stated that it is not at all clear that the genetic markers used in the PEHC analysis provide sufficient coverage across the steelhead genome to determine population differentiation in fitness-related genetic characteristics in addition to providing estimates for differentiation at neutral markers

Response: The single nucleotide polymorphisms (SNPs) will likely be a mix of fitness-related and non-fitness related markers. The PEHC analysis should then overestimate gene flow of fitness-related alleles, so it is conservative. Additional information regarding an updated genetic analysis for Snohomish River Basin steelhead genetics (Warheit et al. 2021) can be found in the revised final EA in Section 3.3.5.1.

Comment 27: One commenter noted that the HGMP does not address the issue of the difference of chromosome numbers from the Skamania steelhead (58 chromosomes) and Puget Sound steelhead (60 chromosomes), and what effect introgression from Skamania stock means in chromosome numbers.

Response: Skamania steelhead are known to have 58 chromosomes. Although chromosomal analysis of the native Snohomish steelhead has not been done, the general pattern seems to be for Puget Sound steelhead to have 60 chromosomes, so assuming Snohomish steelhead initially had 60 chromosomes is reasonable. Some level of interbreeding over the years with Skamania steelhead has likely led to a situation where the current Snohomish summer steelhead are a mix of fish with 58, 59, and 60 chromosomes (however this has not been verified). Interbreeding of organisms that differ in chromosome number can cause fitness problems in hybrids owing to chromosomal segments not pairing properly during meiosis, so the consequences of introducing 58-chromosome steelhead into a population of 60-chromosome steelhead is a reasonable concern.

The difference between the two chromosome types appears to be a fusion of chromosomes identified as #25 and #29 in 60-chromosome fish. NMFS does not know of controlled hybridization experiments between 58- and 60- chromosome *O. mykiss*, but hybridization studies have done between *mykiss* and cutthroat trout that differ chromosomally the same way as 58- and 60-chromosome *mykiss*, and chromosomal segments pair normally, so there should be no fitness problem based on chromosomal pairing. The only noteworthy result of the chromosome number mismatch was recombination of these chromosome segments being somewhat reduced relative to what it would be in fish without a hybrid chromosome configuration. NMFS's conclusion is that the chromosome number difference is a negligible contributor to whatever the overall fitness effect has been of releasing Skamania steelhead into Puget Sound streams. Additional information regarding an updated genetic analysis for Snohomish River Basin steelhead genetics (Warheit et al. 2021) can be found in the revised final EA in Section 3.3.5.1 and the biological opinion (NMFS 2021c).

Comment 28: Many commenters suggest that fish that do not migrate after release (residualize) could have negative impacts on natural-origin fish.

Response: NMFS recognizes the potential for fish that fail to migrate to compete with and potentially predate on, natural-origin fish. NMFS also recognizes that some portion of natural-origin fish do not migrate either. For most steelhead hatchery programs, the estimated residualism rate is less than 10 percent (Hausch and Melnychuk 2012; Snow et al. 2013; Tatara et al. 2019). Hausch and Melnychuk (2012) reviewed 48 estimates of residualism of hatchery-reared steelhead from 16 different studies and found that residualism ranged from 0 percent to 17 percent, averaging 5.6 percent.

In the hatchery environment, residualized steelhead may be produced from precocial maturation or failure to attain the proper size to initiate smoltification (immature parr) (Sharpe et al. 2007). More recent research (Larsen et al. 2017; Tatara et al. 2019) suggests that assessments of total length and visual development prior to releasing steelhead enables hatchery managers to better predict the number of juvenile hatchery steelhead that may residualize in freshwater. Tatara et al. (2019) suggest three methods to reduce the occurrence of residualism:

1. Volitional release
2. Sorting of potential residuals based on size and appearance
3. Rearing regimes can be designed to limit the number of residuals produced

The researchers discuss the pros and cons of these methods, and because this type of information is still developing, adaptive management of the proposed hatchery program will be used to minimize the numbers of hatchery steelhead that residualize. Additional information can be found in the biological opinion (NMFS 2021a). Residualization is discussed in Section 3.3.5.3 and Appendix A in the EA.

Comment 29: One comment asserted the use of hatchery-origin fish that are used to supplement marine-derived nutrients into the basin is expensive and cannot be quantified, and could pass disease to natural-origin fish.

Response: NMFS acknowledges in Section 3.3.5.6 of the EA that marine-derived nutrients are below historical levels, and because of steelhead life history (they do not necessarily die after spawning), the hatchery program is not expected to be a large source of marine derived nutrients. However, because nutrients are so much lower in the Skykomish River Basin than historically, it is presumed that there will still be some benefit to adding nutrients to streams.

To reduce the risk of spreading disease, placing spawned carcasses into rivers or streams is conducted in accordance with the Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State.

Adhering to this policy ensures that the likelihood of disease transference from hatchery carcasses is extremely low.

Comment 30: One commenter suggested that the water intakes at Reiter Ponds and Wallace River hatcheries are not in compliance with current NMFS criteria (NMFS 2011) and that Reiter Ponds has abnormally high mortality while rearing fish.

Response: The intake screens at Wallace River Hatchery are slated for upgrade to make them in compliance with the latest NMFS criteria. Because no anadromous fish are present in the water source for the Reiter Ponds facility, it is not prioritized for update at this time.

We are unclear what information or data the commenter is citing to suggest that mortality at Reiter Ponds is abnormally high. In the HGMP (Section 9.2.1, page 41) it states:

Fish mortality for the previous segregated program varied from year to year, and was largely attributed to cold water disease and columnaris, particularly during early rearing at Wallace River Hatchery, and due to river otter and avian predation during later rearing at Reiter Ponds. WDFW is evaluating potential methods and infrastructure upgrades to improve survival during these life stages for the South Fork Skykomish Summer Steelhead Program.

Comment 31: A commenter suggested the analysis area was inadequately small and should include the ocean.

Response: NMFS has considered whether the estuary and the ocean should be included in the analysis areas. Available knowledge and research abilities are insufficient to discern the role and contribution of the proposed hatchery program to density dependent interactions affecting salmon and steelhead growth and survival in the estuary and in the Pacific Ocean. NMFS' general conclusion is that the influence of density-dependent interactions on growth and survival is likely small enough compared with the effects of large scale and regional environmental conditions that effects of the proposed hatchery program in the analysis area may contribute to effects outside the analysis area, but this contribution would not be meaningful or discernible outside the analysis area. Baseline evidence that hatchery programs can impact salmon survival at sea is lacking, much less their degree of impact, level of influence, or predictability in occurring, nor is there any evidence that hatchery programs of this size have effects in the ocean.

Comment 32: Some commenters voiced concern on the potential of hatchery fish to transfer disease to natural-origin fish after release.

Response: The potential for hatchery fish to transfer pathogens to natural-origin fish is acknowledged (Section 3.3.5.4 of the EA): Hatchery-origin steelhead released into the natural environment may pose an increased risk of transferring diseases to natural-origin salmon and steelhead if not released in a disease-free condition. Because of the continuation of well-developed monitoring, diagnostic, prevention, and treatment programs already in place, NMFS concludes the proposed hatchery program would result in negligible negative disease effect on natural-origin salmon and steelhead. Also see HGMP Table 1.10.2.1, performance standard 3.7.4 for additional detailed information regarding potential disease transference from hatchery- to natural-origin fish.

Comment 33: One commenter suggested that because of lower reproductive success of hatchery fish in the wild, the fish that are taken for broodstock would have produced more fish returning if they had been allowed to spawn naturally.

Response: Typically, the reproductive success of hatchery fish in the wild is lower than wild fish spawning in the wild. But because rearing fish in hatcheries can bypass the heavy early mortality experienced by wild juveniles, fish taken into the hatchery as broodstock can typically produce many more adult fish per capita than fish spawning in the wild, and thus increase the abundance of natural spawners. Even if the hatchery-origin spawners are somewhat less effective at spawning in the wild on a per capita basis, the number of juveniles produced will likely be greater than if there were no hatchery-origin fish supplementing the natural spawners.

1.5 Miscellaneous

Comment 34: Many commenters in favor of the proposed steelhead hatchery program have suggested assisting the co-managers in capturing broodstock or with funding.

Response: These kinds of activities are beyond the scope of the EA and are left at the discretion of the co-managers to propose and implement.

Comment 35: A commenter suggested that it may be better to capture broodstock by hook and line because fish that are captured this way have a genetic component that makes them more vulnerable to angling (they bite more aggressively), and that by perpetuating these fish, the hatchery will produce more "biters" in the future as this genetic disposition is passed down.

Response: Information on this topic is limited, but vulnerability to angling appears to be heritable in largemouth bass (*Micropterus salmoides*) (Philipp et al. 2009). Whether this is true for salmonids is unknown at this time.

In a recent study in the Alsea River, Oregon, ODFW tested whether broodstock collected by anglers produce steelhead that are more frequently harvested than steelhead produced with passively trapped broodstock. Johnson et al. (2020) concluded that a consistent benefit in terms of angling vulnerability was not observed and in addition, fish used for broodstock that were caught by angling returned fewer adults than fish captured using other methods. Based on this information, implementing the program as suggested by the commenter does not appear to be warranted at this time, but additional information is needed.

Comment 36: Some commenters suggested that hatchery steelhead do not have any negative impacts on natural-origin steelhead.

Response: NMFS does not agree that hatchery steelhead have no potential effect on natural-origin steelhead. In Section 3.3.5 and 4.3.5 of the EA, the potential negative effects of hatchery fish on natural-origin fish fall under the categories of genetics, masking, competition and predation, disease transference, population viability, nutrient recycling, facility operations, and research, monitoring and evaluation.

Comment 37: There was a suggestion to tag adult steelhead to further understand their migratory patterns and longevity.

Response: NMFS agrees that understanding migratory patterns and longevity of fish is important information. However, changes to the program are outside the scope of the EA, and the request should be directed to WDFW. The associated biological opinion, and other consultations (see footnote at the bottom of page 48 in the EA) outline what research, monitoring, and evaluation is necessary to evaluate the hatchery steelhead program in the Skykomish River basin.

Comment 38: A commenter asked if there has been a study to determine if juvenile steelhead migrating past the falls survive the drop from the falls, and whether releasing fish upstream of Sunset falls is supported by science, and if so, it should be published.

Response: To date, there have been no empirical studies performed at Sunset Falls to measure survival of juveniles descending the falls. Previously, there was a proposed study to look at survival of juveniles over the falls, but that study was never completed.

However, there have been numerous studies in the Columbia River Basin that have measured survival as fish pass through spillways, many of which are taller than Sunset Falls. Fish survival through spillways is consistently near 100%, although various factors such as predation and the bathymetry of the river downstream of the spillway may influence the survival rate (Skalski et al. 2021). In addition, fish that have been released upstream of the three anadromous barriers on the South Fork Skykomish River (the trap and haul program) have consistently produced fish that return to Sunset Falls.

Comment 39: One recommendation was to release hatchery adults captured at the Sunset Falls trap downstream so they can be vulnerable to sport fishermen. Suggested program changes should be addressed to WDFW.

Response: "Recycling" adult hatchery fish for sportfishing is beyond the scope of this EA because it has not been proposed as part of the hatchery program. While, the potential of using broodstock captured in surplus of program needs to augment a mark-selective fishery above Sunset Falls is mentioned in the HGMP, such action is not part of the proposed hatchery program nor the Sunset Falls Trap and Haul program and is not addressed as part of this EA.

Comment 40: One comment regarded releasing summer steelhead into the Connecticut River.

Response: Releasing fish in other river systems is beyond the scope of this EA.

Comment 41: There were numerous comments regarding the potential negative effect of mixed-stock fisheries on natural-origin fish (where there is a fishery targeting hatchery-origin fish, but natural-origin fish are captured incidentally), including one commenter suggesting that the proportions of returning adult steelhead intended to be available to non-tribal sport and treaty tribal fishers should be provided. Another comment suggested that NMFS should provide quantitative methods to evaluate tradeoffs between meeting tribal trust responsibilities and conservation objectives. Another commenter suggested NMFS quantify how much of an increase in risk to listed species is allowable in order to provide a fishery.

Response: The comments are beyond the scope of this EA. Suggested changes to the program should be addressed to WDFW. Generally speaking, NMFS' analysis of impacts is based on the best available scientific information. Impacts to tribal fisheries are addressed in Sections 1.1, 3.6, 3.7, 4.6 and 4.7.

Comment 42: One commenter noted concerns about tribal harvest and encouraged NMFS to reach out to other tribes (beyond the Tulalip Tribes) party to *U.S. v. Washington* in order to assess whether or not tribal trust obligations are following the appropriate consultation processes.

Response: Harvest issues are addressed through the *U.S. v. Washington* process. Existing *U.S. v. Washington* fisheries are covered in (NMFS 2021b).

Comment 43: One commenter suggested that the HGMP provides no indication of where summer steelhead broodstock in surplus of program needs will be deposited, while another commenter pointed out that the HGMP does not describe whether fish collected for broodstock are sorted once they are captured.

Response: Section 7.5 of the HGMP states where fish in excess of program needs will be distributed. However, this information was absent from the EA, and NMFS has inserted language into the Proposed Alternative (Section 2.2.1.1). Discussion of the proposed disposition of fish in excess of program needs is also discussed in the biological opinion (NMFS 2021c), Section 1.3.1. Once fish are captured for broodstock they will be held in ponds at the appropriate facility. Because hatchery-origin fish have their adipose fin removed, they will be easily identified during spawning. In addition, tags will also be applied to fish released from the new program so those fish can be differentiated from fish returning from the former program (please see HGMP Section 7 for additional information).

Comment 44: One commenter suggested that there should be a consideration of using natural spawning techniques at the hatchery with immediate live release of all male fish back into the river & a reconditioning program for the female brood stock prior to release back into the river.

Response: The HGMP, Section 7.2 discusses live spawning, and this is reflected in Section 2.2.1.2 in the EA. Reconditioning has not been proposed by the co-managers, and is therefore out of scope of NEPA review. Suggested changes to the program should be addressed to WDFW.

Comment 45: One commenter felt the term “minimize” was inappropriate and subjective, which allows managers to not use objectives or levels of impacts to monitor performance.

Response: Noted. Regardless of terminology, activities that potentially reduce impacts are taken into account in impact analysis in EAs, including the current EA.

Comment 46: One commenter suggested that the term used in the HGMP, “effective harvest” be defined.

Response: Because this question is in regards to the HGMP, it will be addressed in the response to comments for the PEPD/HGMP.

Comment 47: A commenter inquired whether there is available and sufficient funding for the co-managers to conduct monitoring and evaluation of the hatchery program.

Response: It is beyond the scope of the EA to assess funding for monitoring and evaluation of this program.

Comment 48: A comment was received that noted that there was no mention of PNI in the HGMP or PEPD.

Response: The EA discusses the PNI concept in Sections 3.3.5.1 and 4.3.1.2.

2 References

To see references, please see Chapter 8 of the EA above.