UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
1201 NE Lloyd Boulevard, Suite 1100
PORTLAND, OREGON 97232

October 24, 2019

Dear Recipient:

In accordance with provisions of the National Environmental Policy Act (NEPA), we announce the publication of the Final Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) for Four Salmon Hatchery Programs in the Stillaguamish River Basin.

The proposed action is approval of four salmon hatchery programs under Endangered Species Act Section 4(d) Limit 6. The hatchery programs are described in Hatchery Genetic Management Plans prepared by the Stillaguamish Tribe of Indians and submitted collectively with the Washington Department of Fish and Wildlife.

The National Oceanic and Atmospheric Administration's (NOAA)'s *Policy and Procedures for Compliance with the National Environmental Policy Act and Related Authorities: Companion Manual for NOAA Administrative Order 216-6A* requires that NOAA prepare and publish a FONSI that concludes the NEPA process for an EA.

The National Marine Fisheries Service has made available the Final EA electronically through the NOAA Fisheries West Coast Regional salmon and steelhead hatcheries website. The FONSI is included as Appendix E of the Final EA.

Sincerely,

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FINAL ENVIRONMENTAL ASSESSMENT

Final Environmental Assessment for Four Salmon Hatchery Programs in the Stillaguamish River Basin

Prepared by the
National Marine Fisheries Service, West Coast Region

NOAA FISHERIES

In Cooperation with the
Bureau of Indian Affairs, Northwest Region

October 2019

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Cover Sheet

Title of Environmental Review:	Final Environmental Assessment for Four Salmon Hatchery Programs in the Stillaguamish River Basin
Responsible Agency and Official:	Barry A. Thom, Regional Administrator National Marine Fisheries Service, West Coast Region 7600 Sand Point Way NE, Building 1 Seattle, WA 98115
Cooperating Agency:	U.S. Department of the Interior, Bureau of Indian Affairs
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Location of Proposed Activities:	The Stillaguamish River Basin in Puget Sound, Washington State
Proposed Action:	The National Marine Fisheries Service (NMFS) would make a determination that the four hatchery and genetic management plans (HGMPs), submitted as resource management plans (RMPs) by the co-managers, meet the requirements under Limit 6 of the 4(d) Rule under the Endangered Species Act (ESA) for listed Puget Sound Chinook salmon and steelhead.
Abstract:	The Washington Department of Fish and Wildlife and the Puget Sound treaty tribes jointly submitted four HGMPs for salmon hatchery programs in the Stillaguamish River Basin in Puget Sound as RMPs. These plans describe each hatchery program in detail, including fish life stages produced and potential measures to minimize risks of negative impacts that may affect ESA-listed fish. NMFS' determination of whether the plans achieve the conservation standards of the ESA, as set forth in Limit 6 of the 4(d) Rule for listed salmon and steelhead, is the Federal action requiring National Environmental Policy Act (NEPA) compliance. The analysis within the environmental assessment informs NMFS, hatchery operators, and the public about the current and anticipated direct, indirect, and cumulative environmental effects of operating the four salmon hatchery programs under the full range of alternatives.

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Acronyms and Abbreviations

4(d) Rule	final rule pursuant to ESA section 4(d)
BIA	Bureau of Indian Affairs
BMP	best management practice
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWT	coded wire tag
DDT	dichlorodiphenyltrichloroethane
DEIS	draft environmental impact statement
DPS	distinct population segment
EA	environmental assessment
Ecology	Washington Department of Ecology
EFH	essential fish habitat
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
fpp	fish per pound
HGMP	for 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
PAHs	polycyclic aromatic hydrocarbons
PBDEs	polybrominated diphenyl ethers
PCBs	polychlorinated biphenyls
PFMC	Pacific Fisheries Management Council
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
RMP	resource management plan
SF	south fork
SIRC	Stillaguamish Implementation Review Committee
SIWG	Species Interaction Work Group
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WDFW	Washington Department of Fish and Wildlife

1 INTRODUCTION

The National Oceanic and Atmospheric Administration's (NOAA's) National Marine Fisheries Service (NMFS) is the lead agency responsible for administering the Endangered Species Act (ESA) (16 U.S.C. 1531 *et seq.*) as it relates to listed salmon and steelhead. Actions that may affect listed species are reviewed by NMFS under section 7 or section 10 of the ESA, or under section 4(d), which can be used to limit the application of take prohibitions described in section 9. On July 10, 2000, NMFS issued a final rule (65 Fed. Reg. 42422) pursuant to ESA section 4(d) (hereafter termed the 4(d) Rule), adopting regulations necessary and advisable to conserve threatened species of salmon and steelhead (50 CFR 223.203). The 4(d) Rule applies the take prohibitions in section 9(a)(1) of the ESA to salmon and steelhead listed as threatened, and it also sets forth specific circumstances when the prohibitions will not apply, known as 4(d) limits. Accordingly, section 9 take prohibitions do not apply under Limit 6[1] for hatchery and genetic management plans (HGMPs) submitted by tribal and/or state governments that meet the requirements as resource management plans (RMPs) under the 4(d) Rule. Criteria for the minimum requirements in an HGMP are outlined in Limit 5 of the 4(d) Rule, which also apply to HGMPs under Limit 6. The final decision on the HGMPs under the ESA will be made in separate ESA decision documents.

The Stillaguamish Tribe of Indians and Washington Department of Fish and Wildlife (WDFW) (the applicants; also collectively referred to as the co-managers) jointly submitted four HGMPs pursuant to Limit 6 of the 4(d) Rule for hatchery programs operated by the Stillaguamish Tribe of Indians within the Stillaguamish River Basin in Washington State. The four HGMPs (Stillaguamish Tribe of Indians 2018a,b,c,d) are:

- Stillaguamish Summer Chinook Natural Stock Restoration Program (updated October 18, 2018)
- Stillaguamish Fall Chinook Natural Stock Restoration Program (updated October 18, 2018)
- Stillaguamish Fall Coho Program (updated October 18, 2018)
- Stillaguamish Chum Program (updated October 18, 2018)

[1] The 4(d) Rule prohibits the take of listed threatened salmon or steelhead, except in cases where the take is associated with an approved program. The 4(d) Rule includes a set of 13 limits (including Limit 5 and Limit 6, regarding hatcheries) on the application of ESA take prohibitions for specific categories of activities that adequately limit the adverse impacts of those activities. Limit 5 identifies specific criteria for state and federal hatchery plans, whereas Limit 6 identifies criteria for joint tribal/state resource management plans developed under the *United States v. Washington* (1974) or *United States v. Oregon* (1969) court proceedings.

Three of the hatchery programs have a relatively long history of salmon production. The chum salmon and fall-run coho salmon hatchery programs began in 1978 and 1986, respectively, and they have operated continuously since that time. Small releases of summer-run Chinook salmon occurred during 1981 to 1983, while the Stillaguamish Summer Chinook Natural Stock Restoration Program began in 1986. The Stillaguamish Fall Chinook Natural Stock Restoration Program began in 2007.

NMFS seeks to consider, through National Environmental Policy Act (NEPA) analysis, how its pending actions may affect the natural and physical environment and the relationship of people with that environment. The NEPA analysis provides an opportunity to consider, for example, how the action may affect conservation of non-listed species and socioeconomic objectives that seek to balance conservation with the use of affected resources and other legal and policy mandates.

1.1 Description of the Proposed Action

The four hatchery programs listed above are being evaluated collectively in a single NEPA environmental assessment (EA) because they overlap in geography, the HGMPs were submitted to NMFS at approximately the same time, and they were all submitted for review under Limit 6 of the 4(d) Rule. Two of the proposed hatchery programs release fish listed as threatened under the ESA (Chinook salmon), and two release fish that are not listed (coho salmon and chum salmon). HGMPs for non-listed species are reviewed for ESA compliance to determine if program activities have an effect on listed species. All four hatchery programs are integrated[2] conservation programs (sometimes referred to as integrated recovery programs) designed to support salmon populations experiencing low productivity and abundance in the Stillaguamish River Basin. Harvest of salmon from the four hatchery programs is incidental to their primary objectives for population recovery of Chinook salmon, sustaining or rebuilding coho and chum salmon stocks, and providing harvest and demographic information to aid in the fisheries management of Chinook and coho salmon. Integrated conservation hatchery programs can contribute to the recovery of a listed salmon population by maintaining or increasing the abundance and genetic diversity of the naturally spawning population until it is self-sustaining. Hatchery programs can be especially beneficial when

[2] An integrated hatchery program relies on the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the natural environment. In such programs, differences between hatchery-origin and natural-origin fish are minimized, and hatchery-origin fish are integrated with the local populations included in an evolutionarily significant unit (ESU).

populations are in the preservation phase[3] of recovery (Hatchery Science Review Group [HSRG] 2014), such as the Chinook salmon populations in the Stillaguamish River Basin.

Under the Proposed Action, NMFS would make a determination that the submitted HGMPs meet the requirements of Limit 6 of the 4(d) Rule. The Proposed Action also includes funding from the Bureau of Indian Affairs (BIA) and Pacific Salmon Treaty provided to the Stillaguamish Tribe of Indians to operate the four hatchery programs. The effects of this funding action are fully subsumed in the effects of the proposed hatchery programs. Activities under the proposed HGMPs generally include:

- Broodstock collection
- Transport of adult and juvenile fish
- Broodstock collection methods and facility operation
- Holding, identification, and spawning of adult fish
- Egg incubation and juvenile rearing
- Marking of hatchery-origin juveniles
- Juvenile releases
- Adult management
- Monitoring and evaluation to assess program performance

Additional details describing the four hatchery programs can be found in Chapter 2, Alternatives.

1.2 Purpose of and Need for the Proposed Action

The purpose of the Proposed Action is to determine whether the above-mentioned salmon hatchery programs in the Stillaguamish River Basin, as described in the HGMPs submitted by the co-managers, meet the requirements of the ESA under Limit 6 of the 4(d) Rule. The need for the Proposed Action is to respond to the co-managers' request for approval of the hatchery programs under the 4(d) Rule; ensure the recovery of ESA-listed Puget Sound salmon and steelhead by conserving their productivity, abundance, diversity and distribution; and ensure NMFS meets its tribal trust responsibilities.

The BIA is a cooperating agency on this EA. The BIA provides funding for operation of the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatcheries considered in this EA that support the Stillaguamish Tribe of Indians' exercise of treaty fishing rights. The BIA's purpose is to

[3] HSRG (2014) described four recovery phases: preservation, re-colonization, local adaptation, and full restoration. The preservation phase occurs when ecosystem conditions are unable to support a self-sustaining population.

provide funding for the above-listed salmon hatchery programs to meet the Tribe's need to sustain listed and non-listed salmon species in the Stillaguamish River Basin at harvestable abundance levels.

The co-managers' objectives in developing and submitting the four HGMPs for the salmon hatchery programs in the Stillaguamish River Basin as RMPs under Limit 6 of the 4(d) Rule are to operate their hatcheries 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. WDFW and the Puget Sound treaty tribes strive to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound salmon and their ecosystems to sustain treaty ceremonial and subsistence fisheries, treaty and non-treaty commercial and recreational fisheries, non-consumptive fish benefits, and other cultural and ecological values.

Another objective of the co-managers' is the continued operation of salmon hatchery programs using existing facilities (Harvey Creek Hatchery, Brenner Creek Hatchery, and Whitehorse Hatchery) for conservation, mitigation, and providing fish for tribal and non-tribal fishing harvest pursuant to the Puget Sound Salmon Management Plan implemented under *United States v. Washington* and treaty rights preservation purposes while meeting ESA requirements. The Chinook salmon HGMPs were designed to be consistent with the strategies and actions specified in the Stillaguamish Watershed Chinook Salmon Recovery Plan (Stillaguamish Implementation Review Committee [SIRC] 2005) included as part of the Puget Sound Salmon Conservation Plan (Shared Strategy for Puget Sound 2007).

1.3 Project and Analysis Areas

The Project Area is the geographic area where the Proposed Action would take place (Figure 1). It includes the places in the Stillaguamish River Basin (Water Resource Inventory Area 5[4]) where salmon would be collected for broodstock, spawned, incubated, reared, acclimated, or released under the proposed HGMPs. Although primarily in Snohomish County, portions of the river basin are in Skagit County. Additional details of the environmental setting in the project area are provided in Chapter 3, Affected Environment.

Activities conducted as part of the hatchery programs would occur primarily at three facilities: Harvey Creek Hatchery (summer-run Chinook salmon, coho salmon, and chum salmon), Brenner Creek Hatchery

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

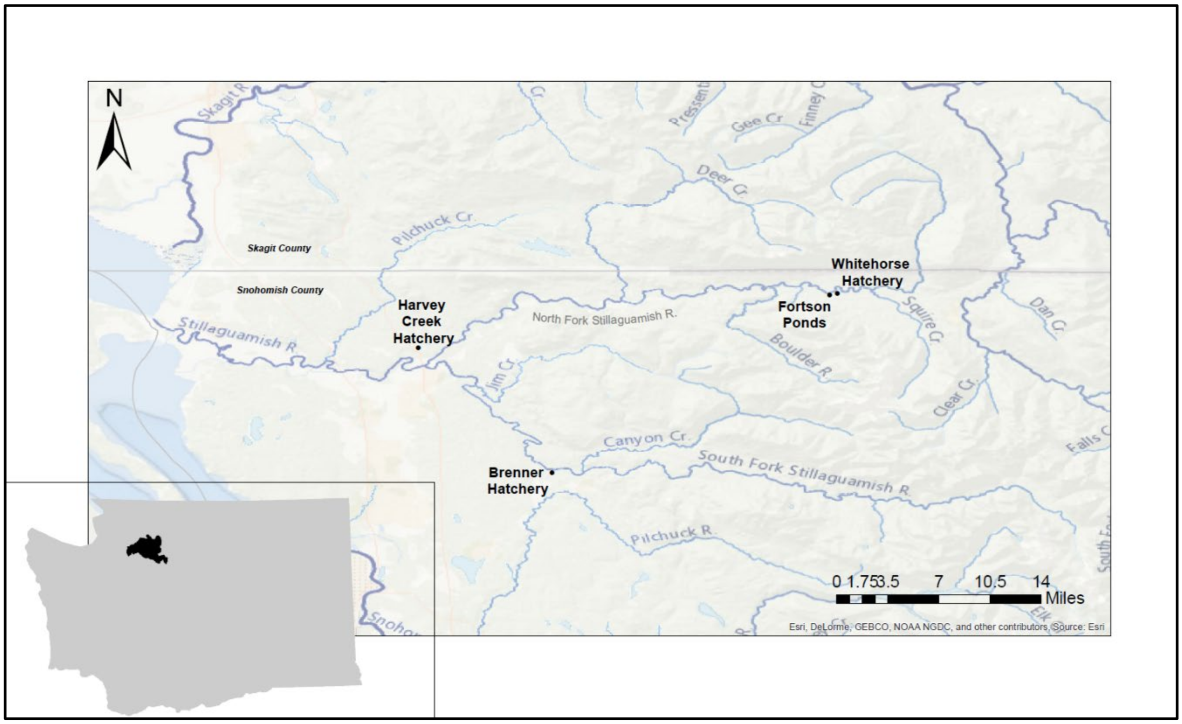

Figure 1. Location of facilities used by the Stillaguamish River Basin salmon hatchery programs.

(fall-run Chinook salmon), and Whitehorse Hatchery rearing ponds (summer-run Chinook salmon). In addition, broodstock for the two Chinook salmon hatchery programs would be collected annually by seining pools in the North Fork (NF) Stillaguamish River (adults) and the South Fork (SF) Stillaguamish River (juveniles). As part of the chum salmon hatchery program, eyed eggs would be placed into instream egg incubators located in Church Creek (not shown on Figure 1), or reared to the fry stage in circular rearing tanks then released into Church Creek, which drains into the lower mainstem of the Stillaguamish River at river mile (RM) 2.9 from the mouth of the river. The eyed eggs or fry releases are part of educational programs at two local schools.

The analysis area is the geographic extent that is being evaluated for a particular resource (e.g., water quantity and quality, wildlife). The total analysis area for this EA is the NF and SF Stillaguamish Rivers and tributaries downstream to the mouth of the mainstem Stillaguamish River and the marine areas of Port Susan and Possession Sound. While the broad analysis area is large due to the amount of habitat for the species being analyzed, impacts from the operation of the hatchery programs tend to be localized to areas immediately adjoining the hatchery facilities. As described in each resource subsection of Chapter 3, Affected Environment, the analysis area may be larger or smaller than the project area for some resources depending on where the effects of the alternatives would occur. In addition, a larger analysis area was defined to consider actions with effects that are potentially cumulative with the

Proposed Action. The evaluation of this larger analysis area for cumulative effects is described in Chapter 5.

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

In addition to the NEPA and the ESA, other plans, regulations, agreements, treaties, laws, and Secretarial and Executive Orders also affect hatchery operations, the outcome of fish released by hatcheries in the Stillaguamish River Basin, or the effect of hatchery operations on the human environment. They are identified below, and summarized in Appendix A, to provide additional context for the hatchery programs described by the HGMPs, and the analyses in Chapter 3, Affected Environment; Chapter 4, Environmental Consequences; and Chapter 5, Cumulative Effects, of this EA.

- Clean Water Act
- Bald and Golden Eagle Protection Act
- Marine Mammal Protection Act
- Executive Order 12898 – Federal Actions to Address Environmental Justice in Minority and Low-income Populations
- Title VI of the Civil Rights Act of 1964
- Treaties of Point Elliott, Medicine Creek, and Point No Point
- *United States v. Washington*
- The Federal Trust Responsibility
- Secretarial Order 3206 – American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA
- Tribal Policy for Salmon Hatcheries
- Recovery Plans for Puget Sound Salmon and Steelhead
- The Pacific Salmon Treaty
- Washington State Endangered, Threatened, and Sensitive Species Act
- Hatchery and Fishery Reform Policy
- Washington State Forest Practices Act (Revised Code of Washington [RCW] Chapter 76.09) and Habitat Conservation Plan
- Washington Shoreline Management Act (RCW Chapter 90.58) and Snohomish County Shoreline Management Program
- Washington State Water Pollution Control Act (RCW Chapter 90.48)
- Water Resources Act of 1971 (RCW Chapter 90.54)
- Washington State Water Code (RCW 90.03.247)
- Washington State Groundwater Code (RCW Chapter 90.44)
- Minimum Water Flows and Levels Act of 1967 (RCW Chapter 90.22)
- Instream Resources Protection and Water Resources Program for the Stillaguamish River Basin (Washington Administrative Code Chapter 173-505)

2 ALTERNATIVES

This chapter describes the four alternatives evaluated in this EA:

- **Alternative 1** (No Action)**:** NMFS would not make a determination under the 4(d) Rule
- **Alternative 2** (Proposed Action and Preferred Alternative)**:** NMFS would make a determination that the submitted HGMPs meet the requirements of the 4(d) Rule
- **Alternative 3** (Termination)**:** NMFS would make a determination that the submitted HGMPs would not meet the requirements of the 4(d) Rule
- **Alternative 4** (Reduced Production)**:** NMFS would make a determination that revised HGMPs with production levels 50 percent less than the currently submitted HGMPs meet the requirements of the 4(d) Rule

In addition, this chapter describes one alternative that was considered but eliminated from detailed analysis and the rationale for its elimination.

Actual broodstock and juvenile production levels may occasionally be higher or often lower than the maximum production levels identified for each alternative. As described in more detail within Chapter 3, Affected Environment, natural variability in salmon adult abundance, collection efficiency, hatchery survival, and other factors can contribute to over- or under-achieving production levels. Analysis of the alternatives in this EA is based on the maximum production levels. The potential for chronic exceedance of production levels within a NMFS-approved HGMP is addressed as part of the ESA section 7 consultation process. The maximum adult broodstock and juvenile production levels for all alternatives are summarized in Table 1.

2.1 Activities Common to All Alternatives Except Alternative 3 (Termination)

Activities for acquiring broodstock and releasing juveniles would be the same under Alternative 1, Alternative 2, and Alternative 4. Broodstock collection for the summer-run Chinook salmon hatchery program would be accomplished by seining in the NF Stillaguamish River and genetically screening for run-type. Broodstock for the fall-run Chinook salmon hatchery program would come from a combination of incidental catch from the summer-run broodstock collection effort, use of a V-trap installed at the Brenner Hatchery, and mature captive broodstock. Chum salmon broodstock would be collected from a trap at the Harvey Creek Hatchery, and coho salmon broodstock would be collected from a temporary trap installed at the upstream end of the Fortson Ponds fish ladder near the Whitehorse Hatchery.

Table 1. Maximum annual broodstock collection and hatchery release levels of juvenile salmon under the alternatives by program.

Hatchery Program	Facilities	Alternative 1 and Alternative 2		Alternative 3		Alternative 4	
		Broodstock	Juvenile Releases	Broodstock	Juvenile Releases	Broodstock	Juvenile Releases
Summer-run Chinook Salmon	Harvey Creek Hatchery, Whitehorse Hatchery	65 adult pairs	220,000 subyearlings	0	0	33 adult pairs	110,000 subyearlings
Fall-run Chinook Salmon	Brenner Creek Hatchery	Captive broodstock derived from 450 smolts plus 10 adult pairs[1]	200,000 subyearlings	0	0	Captive broodstock derived from 225 smolts plus 5 adult pairs[1]	100,000 subyearlings
Coho Salmon	Harvey Creek Hatchery	60 adult pairs	60,000 yearlings	0	0	30 adult pairs	30,000 yearlings
Chum Salmon	Harvey Creek Hatchery	300 adult pairs	50,000 eyed eggs/fry 250,000 fry[2]	0	0	150 adult pairs	25,000 eyed eggs/fry 125,000 fry[2]

Sources: Stillaguamish Tribe of Indians 2018a,b,c,d

[1] Adult pairs collected from the NF Stillaguamish River plus available mature captive broodstock. Up to 900 smolts (Alternative 1 and Alternative 2) or up to 450 smolts (Alternative 4) would be collected from the SF Stillaguamish River and genetically tested for run type. Non-fall-run smolts or excess fall-run smolts would be released back to the SF Stillaguamish River. The number of mature broodstock will vary annually depending on survival and maturity rates of captive broodstock, in addition to the number of genetically assigned fall-run smolts collected.

[2] The eyed eggs are supplied to local schools as part of educational programs and released as fry in Church Creek. The larger release value is for onsite fry released from the Harvey Creek Hatchery.

The fall-run Chinook salmon captive broodstock component uses smolts collected from the SF Stillaguamish River with a beach seine. Smolts would be genetically screened and those that are assigned with at least 90 percent confidence as fall-run Chinook salmon, generally about 50 percent of those collected, would be reared at the Brenner Creek Hatchery until mature. Collected smolts that are not assigned as fall-run Chinook salmon would be released back into the SF Stillaguamish River. The number of mature fall-run Chinook salmon broodstock could vary substantially from year to year depending on the number of smolts captured, the proportion that are genetically identified as fall-run, the survival rate to maturity, and the proportion of captive broodstock that mature in that year.

Juveniles from the summer-run Chinook salmon hatchery program would be trucked from the Harvey Creek Hatchery to the Whitehorse Hatchery ponds for acclimation and release. In contrast, all fall-run Chinook salmon, coho salmon, and chum salmon would be released onsite from the hatchery facilities.

Monitoring activities would be part of the provisions of approved HGMPs under Alternative 2 and Alternative 4, and would include, but not be limited to, obtaining information on smolt-to-adult survival, fishery contribution, natural-origin and hatchery-origin spawning abundance, juvenile out-migrant abundance and diversity, genetics, and juvenile and adult fish health when the fish are in the hatchery.

2.2 Alternatives Analyzed in Detail

2.2.1 Alternative 1 (No Action) – Do Not Make a Determination under the 4(d) Rule

Under this alternative, NMFS would not make a determination under the 4(d) Rule on any of the four HGMPs; thus, the hatchery programs would not be exempted from ESA section 9 take prohibitions and would not be authorized to operate. If the hatchery programs are not authorized, several possible outcomes could occur:

- The applicants could pursue obtaining an ESA section 10(a)(1)(B) incidental take permit to exempt the hatchery programs from take prohibitions.
- The applicants could choose to operate the hatchery programs without ESA authorization and be liable for ESA take violations.
- The applicants could choose to terminate the hatchery programs because they would not have ESA authorization.

The No-action Alternative assumes that NMFS would not make ESA section 4(d) determinations, but the programs would operate as described in the submitted HGMPs without the ESA authorization. NMFS made this assumption for a variety of reasons, including the lengthy history of ongoing operations and the importance of the hatchery programs to the co-managers and to the recovery of the populations. For this analysis, a maximum of 730,000 hatchery-origin salmon juveniles would be released annually with up to an additional 50,000 chum salmon eyed eggs or fry released as part of educational programs (Table 1). No new environmental protection or enhancement measures would be implemented. Monitoring as described in the HGMPs may or may not occur. The No-action Alternative represents NMFS' best estimate of what may happen in the absence of the Proposed Action.

2.2.2 Alternative 2 (Proposed Action and Preferred Alternative) – Make a Determination That the Submitted HGMPs Meet the Requirements of the 4(d) Rule

Under the Proposed Action and Preferred Alternative, NMFS would make a determination that the HGMPs submitted by the co-managers meet ESA requirements. The four salmon hatchery programs in the Stillaguamish River Basin would be implemented as described in the submitted HGMPs (Stillaguamish Tribe of Indians 2018a,b,c,d); Subsection 1.1, Description of the Proposed Action; and Table 1.

2.2.3 Alternative 3 (Termination) – Termination of Salmon Hatchery Programs in the Stillaguamish River Basin

Under this alternative, NMFS would make a determination that the HGMPs as proposed do not meet the criteria prescribed under Limit 5 and Limit 6 of the 4(d) Rule, and the four salmon hatchery programs in the Stillaguamish River Basin would be terminated. All salmon being raised in hatchery facilities (i.e., summer-run and fall-run Chinook salmon, coho salmon, and chum salmon) would be released or killed, and no broodstock would be collected.

This alternative would not allow NMFS to meet its purpose and need, which aims to meet the co-managers' request to operate their programs as described in the submitted HGMPs and to ensure the sustainability of Puget Sound salmon by conserving the productivity, abundance, diversity, and distribution of listed species of salmon in the Stillaguamish River Basin. This is because substantial progress toward Chinook salmon conservation and recovery in the Stillaguamish River Basin would be unlikely under this alternative. This alternative would also not allow NMFS to meet its tribal trust stewardship responsibilities or allow the BIA to support treaty fishing rights in the Stillaguamish River Basin. NMFS will analyze this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios, including those that do not achieve the purpose and need.

2.2.4 Alternative 4 (Reduced Production)

Under this alternative, revised HGMPs would be submitted reflecting reduced production levels, and NMFS would then make a determination that the revised HGMPs meet the requirements of the 4(d) Rule. The revised HGMPs would reduce the number of fish released from each of the four proposed hatchery programs by 50 percent (to 365,000 salmon juveniles and up to 25,000 chum salmon eyed eggs or fry) because it represents a midpoint between the Proposed Action (Alternative 2) and termination of the hatchery programs (Alternative 3) (Table 1). Under this alternative, broodstock collection levels would also be reduced to reflect the lower production levels, including a reduction in the number of natural-origin fall-run Chinook salmon smolts collected for the captive broodstock component.

NMFS' regulations under the 4(d) Rule do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs. NMFS' regulations under the 4(d) Rule require NMFS to make a determination that the HGMPs *as proposed* either meet or do not meet the standards prescribed in the rule. Nonetheless, NMFS will analyze this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios.

2.3 Alternatives Considered but Not Analyzed in Detail

The following alternative was carefully considered but is not analyzed in detail for the reasons provided.

2.3.1 Increased Production

Under this potential alternative, the applicants would submit revised HGMPs with substantially increased production levels than proposed and NMFS would determine whether the revised HGMPs meet the requirements of the 4(d) Rule. This alternative was not analyzed in detail because higher production levels would exceed the current production capacities for the hatcheries (K. Konoski, pers. comm., Fisheries Biologist, Stillaguamish Tribe of Indians, January 26, 2018) and specifically the fish-rearing density limits for the facilities. Constructing additional hatchery facilities to accommodate substantially increased production would not be feasible under existing program funding. In addition, higher production levels may not be technically feasible because more broodstock than naturally available under current conditions would need to be collected. Collection of broodstock for fall-run Chinook salmon is already an uncertain endeavor since the existing program has yet to achieve maximum production levels during any year of operation. Similarly, the number of broodstock collected for the coho salmon hatchery program is frequently a substantial amount below the maximum production level under existing conditions, which is similar to the proposed action. Overall, the maximum production levels under Alternative 2 (Proposed Action), are the highest feasible levels under the existing environmental and population conditions that could likely be collected on an annual basis.

3 AFFECTED ENVIRONMENT

Chapter 3, Affected Environment, provides a brief description of the Stillaguamish River Basin for context (Subsection 3.1, Environmental Setting) and describes existing conditions for eight resources that may be affected by implementation of the alternatives:

- Water quantity (Subsection 3.2)
- Water quality (Subsection 3.3)
- Salmon and steelhead (Subsection 3.4)
- Other fish species (Subsection 3.5)
- Wildlife (Subsection 3.6)
- Cultural resources (Subsection 3.7)
- Socioeconomics (Subsection 3.8)
- Human health (Subsection 3.9)

Environmental Justice populations (Subsection 3.10) are also described.

No other resources were identified during internal scoping that would potentially be affected by the alternatives. This chapter describes how hatchery programs may affect each resource under operations implemented in the recent past, which have production levels similar to Alternative 1 (No Action) (Table 1). Each resource's analysis area includes the project area as a minimum but may include locations other than the project area where effects would be expected to occur.

3.1 Environmental Setting

The Stillaguamish Watershed Chinook Salmon Recovery Plan (SIRC 2005) provides a detailed description of the basin. In summary, the Stillaguamish River Basin encompasses about 700 square miles and includes over 3,100 miles of marine shoreline, rivers, and streams. The lower river drains into Puget Sound at three locations near the city of Stanwood in Snohomish County. West Pass drains into the south end of Skagit Bay, while South Pass drains into the north end of Port Susan. Hat Slough, with most of the river's discharge, also drains into Port Susan about 2.3 miles south of South Pass. The Stillaguamish River has two major forks (north and south forks) that meet at approximately RM 18 in Arlington at an elevation of about 100 feet.

Stream flow in the NF Stillaguamish River is about 80 percent larger than in the SF Stillaguamish River. Stream flows in the analysis area, where the hatchery facilities are located, are driven primarily by rain at lower elevations and snow at higher elevations (above 3,000 feet), with contributions of snowmelt from the river's headwaters in the west slope of the Cascade Mountains (U.S. Army Corps of Engineers 2000). Typical annual discharge (daily flows averaged over the year) for the NF Stillaguamish River near Arlington was 1,959 cubic feet per second (cfs) from 2003 to 2017, whereas discharge for the SF Stillaguamish River near Granite Falls was 1,087 from 1966 to 1980, which represents the most recent 15 years of available flow data (U.S. Geological Survey [USGS] 2018a). The only lake of substantive size within the basin is Lake Cavanaugh (833 acres), which drains into Pilchuck Creek and is located upstream of any documented anadromous fish spawning (WDFW 2018a).

Maximum elevation within the basin is 6,854 feet at Three Fingers Mountain near the headwaters of Squire Creek, Canyon Creek, and Boulder River, which are tributaries to the NF Stillaguamish River. Snohomish County (1995 *in* SIRC 2005) indicates land use within the Stillaguamish River Basin is primarily forestry (76 percent) with some rural (17 percent), agricultural (5 percent), and urban (2 percent) use. However, recent regional population growth likely means urban and rural uses have increased somewhat and the other categories have decreased. Most of the forested areas are within the Mt. Baker-Snoqualmie National Forest, but there are also substantial amounts of state and private forested lands in the river basin.

3.2 Water Quantity

The analysis area for water quantity is the same as the project area (Subsection 1.3, Project and Analysis Areas), which is the Stillaguamish River Basin. Hatchery programs affect water quantity when groundwater from an aquifer is removed through a well or spring, or when surface water is removed from a neighboring river or tributary stream, for use in the hatchery facilities for broodstock holding, egg incubation, juvenile rearing, and juvenile acclimation. The description of existing conditions for water quantity focuses on water resources associated with the three hatchery facilities — Brenner Creek, Harvey Creek, and Whitehorse Hatcheries — where the action alternatives would occur. All water used from groundwater or surface water sources, minus evaporation, is discharged into the water course adjacent to the hatchery rearing location after it flows through the hatchery facility (non-consumptive use[5]). When hatchery programs use groundwater (i.e., from wells or springs), the amount of water available for other users in the same aquifer is reduced. When hatchery programs use surface water, the use may lead to dewatering of the stream between the water intake and discharge structures (called the bypass reach), which may impact fish and wildlife if migration is impeded or dewatering leads to increased water temperatures and a reduction in aquatic habitat quantity. Generally, water intake and

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[5] Unless otherwise noted, terms associated with analyses of water quantity (e.g., consumptive, dewater, benefit) are used in the EA specifically for the analysis, and are not intended to be synonymous with similar terms under Washington's water law (e.g., "consumptive," "beneficial uses").

discharge structures are located as close together as possible to minimize the area of the stream that may be affected by a water withdrawal.

Hatchery operations typically vary water use throughout the year based on the fish species, fish sizes, and numbers of fish being produced. More water is needed for hatchery rearing of yearlings and captive broodstock, and less water is needed for rearing of subyearlings and fry. In addition, water is needed for holding broodstock while they mature and egg incubation. For the salmon and their life stages that are released in the Stillaguamish River Basin, juveniles are released from March through June when higher stream flows are occurring from snow melt and rain. As a result, maximum water requirements for hatcheries within the Stillaguamish River Basin do not occur during low-flow stream conditions in late summer.

The Brenner Creek, Harvey Creek, and Whitehorse Hatchery facilities consist of both hatcheries and outdoor ponds near water sources; however, the summer-run Chinook salmon hatchery program only uses outdoor rearing ponds at the Whitehorse Hatchery, while the remainder of the facility is used by WDFW programs for other fish species. The hatchery facilities use surface and/or spring water, and two of the facilities are supplemented by wells (Table 2).

Table 2. Water source and permitted maximum use at hatchery facilities that support four salmon hatchery programs in the Stillaguamish River Basin.

Hatchery Facility	Water Right Permit or Certificate	Permitted Maximum Surface Water Use (cfs)	Permitted Maximum Groundwater Use (cfs)	Water Source	Average Daily Surface Flow (cfs)[1]
Whitehorse Hatchery	S1-00825	5.0	N/A	Whitehorse Springs Creek	0.2 – 6.2
	G1-28153C	N/A	1.74	Well	N/A
Harvey Creek Hatchery	G1-23942C	N/A	0.27	Well	N/A
	S1-23214CWRIS	0.93	N/A	Harvey Creek	15.9[2]
Brenner Creek Hatchery	S1-02610	0.67	N/A	Spring	1.1

Sources: Whitehorse Hatchery water right permit and certificate and other data are from WDFW (2015), and Harvey Creek Hatchery water right permit and certificate numbers are from Stillaguamish Tribe of Indians Natural Resources Department (2016). Other maximum daily surface and groundwater use and surface water sources are from the HGMPs (Stillaguamish Tribe of Indians 2018a,b,c,d).

1 From nearest water source.

2 From Armstrong Creek (also known as Harvey Creek) with historical data from 1951 to 1957 (Gage Number 12167500) (USGS 2018b).

N/A = not applicable.

A water right permit from Washington Department of Ecology (Ecology) is required for all surface water and groundwater withdrawals except, in many cases, those supporting single-family homes or other legislatively excluded situations. All water use by hatchery facilities supporting the four salmon hatchery programs is permitted by Ecology. Water available for use under water right permits are maximums, and maximum withdrawals generally occur during winter and spring seasons when water flows are high.

Surface water and groundwater supplies to hatchery facilities are listed in Table 2. Surface water diversions for two of the facilities, Whitehorse Hatchery and Brenner Creek Hatchery, occur at the source of spring-fed creeks with no gaging stations to provide flow data. The third facility, Harvey Creek Hatchery, has flow data from a nearby downstream USGS stream gaging station for which discharges are available for a period spanning at least 5 years.

The Whitehorse Hatchery uses well and surface water. The hatchery is permitted to withdraw up to 5.0 cfs from Whitehorse Springs Creek and up to 1.74 cfs from a well to support all its hatchery programs, including the acclimation and release of Stillaguamish summer-run Chinook salmon subyearlings (Table 2). All water (minus evaporation) is returned to the creek a short distance away (approximately 650 feet) after flowing through the hatchery. There is no gaging station in Whitehorse Springs Creek, although WDFW (2015) estimates that the creek flow ranges from 0.2 to 6.2 cfs depending on the season. The summer-run Chinook salmon hatchery program is a small component relative to the overall operations at the Whitehorse Hatchery, and acclimation of subyearlings occurs in the spring when water flows are generally high. Water is diverted at its source and returned a short distance away, meaning the water withdrawal attributable to the summer-run Chinook salmon hatchery program has had a negligible effect on the available water supply. In addition, the withdrawal of a maximum of 1.74 cfs is permitted from a well at the Whitehorse Hatchery (Table 2); however, the well water is only used for egg incubation and broodstock attraction for other hatchery programs and not used for the summer-run Chinook salmon hatchery program (WDFW 2015).

The Harvey Creek Hatchery uses well and surface water. The hatchery is permitted to withdraw up to 0.93 cfs from Harvey Creek and 0.27 cfs from a well to support the summer-run Chinook salmon, fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs in the Stillaguamish River Basin (Table 2). All water (minus evaporation) is returned to the creek after flowing through the hatchery. Water quantity is only affected between water intake and discharge structures, a distance of about 33 feet. Water flows within Harvey Creek average 15.9 cfs.

The Brenner Creek Hatchery uses surface water from a spring. The hatchery is permitted to withdraw up to 0.67 cfs from the spring to support the Stillaguamish fall-run Chinook salmon hatchery program (Table 2). Well water is not used; consequently, this facility does not affect groundwater resources.

Well water withdrawals have the potential to reduce groundwater available for other uses, but the extent that this occurs at the Whitehorse Hatchery and Harvey Creek Hatchery is unknown. Furthermore, groundwater near streams may have complex interactions with surface water flows, such that groundwater withdrawals can result in reduced surface water flows, but the specific interactions at these hatcheries are also unknown. The relatively small amounts of well water used can result in higher outflows to surface waters than the amounts of surface water withdrawn. However, well water is primarily used for egg incubation during seasons when surface water flows are high (fall and winter) and precipitation can recharge groundwater levels. Consequently, well water contributions to surface water are minor compared to total surface water flows, and groundwater withdrawals are likely minor compared to groundwater recharge through precipitation.

In summary, water withdrawal at all three hatcheries is negligible because of the non-consumptive nature of the withdrawals, because surface flows are reduced over short distances, and because withdrawals primarily occur when precipitation levels are high (fall, winter, and spring).

3.3 Water Quality

The analysis area for water quality is the same as the project area (Subsection 1.3, Project and Analysis Areas), which is the Stillaguamish River Basin. Water quality in the Stillaguamish River Basin has been substantially affected by human-based disturbances resulting from agriculture, forest practices, and urban and rural development, especially in the lower reaches of the river basin (SIRC 2005; Northwest Indian Fisheries Commission [NWIFC] 2016).

Water quality has been negatively affected by hatchery programs because water enters hatchery facilities used for fish production; receives inputs of fish, fish food, and pharmaceuticals used for fish health; and is then returned after use as effluent to the natural environment. The affected environment from the hatchery facilities' discharge of effluent occurs from the point of discharge downstream until thorough mixing occurs in the receiving stream or river. As described in Subsection 3.6.1, Water Quality, and Appendix J, Water Quality and Regulatory Compliance for Puget Sound Hatchery Facilities, in the Puget Sound Hatcheries draft environmental impact statement (DEIS) (NMFS 2014), water quality parameters that can be altered by hatchery facility effluent include temperature, ammonia, organic nitrogen, total phosphorus, biochemical oxygen demand, pH, and solids levels. Hatchery facility effluents can also contain chemicals used to support hatchery production, including antibiotics, fungicides, disinfectants, anesthetics, herbicides, and feed additives, as well as pathogens (NMFS 2014).

Discharge of hatchery effluents is regulated by the U.S. Environmental Protection Agency (EPA) under the Clean Water Act through National Pollutant Discharge Elimination System (NPDES) permits that are required for facilities that release more than 20,000 pounds of fish per year or use more than 5,000 pounds of fish food during the month of maximum feeding. Hatchery facilities with lower levels are non-significant contributors to water pollution. For discharges from hatchery facilities not located on Federal or tribal lands, EPA has delegated its regulatory oversight to Washington State via Ecology. Washington State depends primarily on EPA to develop water quality standards, but different standards or standards for additional parameters can be implemented by the state with Federal approval. In addition, Indian tribes may adopt their own water quality standards for permits on tribal lands.

As part of administering elements of the Clean Water Act (i.e., Sections 303 and 305), Ecology is required to assess water quality in streams, rivers, and lakes and identify specific water bodies that are impaired, based on the number of exceedances of water quality criteria in a water body segment. Although hatchery facilities (including rearing ponds and acclimation ponds) under existing conditions, in general, are not identified as sources of water quality impairment to streams based on effluent discharges (Table 3), the effluent discharged from the facilities contributes to the total pollutant load of receiving and downstream waters (NMFS 2014). Segments of other water bodies downstream from the hatchery facilities are listed as impaired for several parameters (e.g., fecal coliform bacteria, dissolved oxygen, temperature, and turbidity) (Ecology 2004, 2005, 2015). Additionally, salmon carcasses may be placed into streams after being spawned at hatchery facilities to increase beneficial marine-derived nutrients (nitrogen and phosphorus) (Subsection 3.2.3.7, Benefits – Marine-derived Nutrients, in the Puget Sound Hatcheries DEIS [NMFS 2014]).

Table 3. Water quality permit compliance by hatchery facility and applicable 303(d) listed water bodies and impairments.

Hatchery Facility	Stream or River Adjacent to Hatchery Facility	Compliant with NPDES Permit?	Discharge Effluent into a 303(d) Listed Water Body?	Impaired Parameters	Cause of Impairment
Whitehorse Hatchery	Whitehorse Springs Creek (RM 1.5)	Yes	No	None	None
Harvey Creek Hatchery	Harvey/Armstrong Creek (RM 2)	N/A	No	None	None
Brenner Creek Hatchery	Brenner Creek (RM 0.04)	N/A	No	None	None

Source: Ecology 2015
N/A = Not applicable because the facility is not required to have an NPDES permit since it releases less than 20,000 pounds of fish per year and feeds fish less than 5,000 pounds of food during the month of maximum feeding.

All three hatchery facilities are in compliance with their NPDES permits or do not need an NPDES permit. Compliance with an NPDES permit generally indicates effluent discharges are within an acceptable level of a pollutant and make sure that a state's mandatory standards for clean water and the federal minimums are being met. Further, the receiving waters of these facilities are not listed as impaired because effluent is diluted through mixing with receiving waters, and many of the chemicals used in a hatchery setting degrade naturally such that concentrations decrease rapidly downstream from facilities (EPA 2015). Additionally, all hatchery facilities are required to comply with applicable Federal, state, and tribal water quality and groundwater standards, and are not expected to have contributed substantially to water quality impairments in the river basin.

3.4 Salmon and Steelhead

This subsection describes existing conditions for natural-origin salmon and steelhead that may be affected under the alternatives. The analysis area for salmon and steelhead is the total analysis area described in Subsection 1.3, Project and Analysis Areas, which includes the NF and SF Stillaguamish Rivers and tributaries downstream to the mouth of the mainstem Stillaguamish River and the marine areas of Port Susan and Possession Sound. These marine areas are where hatchery-origin juveniles from the Stillaguamish River Basin initially forage and congregate prior to moving to the ocean and where terminal fisheries occur on adult fish returning to the Stillaguamish River Basin. Information is provided on the general factors that affect the presence of these species, hatchery production in Puget Sound and its general effects on these species, and salmon hatchery programs associated with the Proposed Action. Additional information on salmon and steelhead in Puget Sound and effects associated with Puget Sound hatchery programs can be found in Subsection 3.2, Fish, in the Puget Sound Hatcheries DEIS (NMFS 2014).

Since 1999, NMFS has identified two salmon ESUs (Puget Sound Chinook Salmon and Hood Canal Summer Chum Salmon) and one steelhead 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 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 Stillaguamish River Basin and will not be discussed further in this EA. The Puget Sound Steelhead DPS was listed as threatened in 2001 (72 Fed. Reg. 26722, May 11, 2007) and reaffirmed in 2014 (79 Fed. Reg. 20802, April 14, 2014).

The most recent 5-year status review for the Puget Sound Chinook Salmon ESU and Puget Sound Steelhead DPS (Northwest Fisheries Science Center [NWFSC] 2015) found that the biological risks have not substantively changed since the two species were listed, or since the last status review (Ford 2011). The populations comprising the ESU remain well below the numerical planning ranges (or targets) for abundance used as part of delisting criteria in the Puget Sound Chinook salmon recovery plan (NMFS 2006). 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). Overall, NWFSC (2015) concluded that the most recent information on viability, including abundance, productivity, spatial structure, and diversity, suggested the biological risk category remained threatened for the Puget Sound Chinook Salmon ESU and the Puget Sound Steelhead DPS. The Stillaguamish River Basin includes critical habitat for Puget Sound Chinook salmon that consists of the mainstem Stillaguamish River, NF Stillaguamish River, SF Stillaguamish River, and portions of many of the larger tributaries (70 Fed. Reg. 52630, September 2, 2005).

NMFS has designated two Chinook salmon populations in the Stillaguamish River Basin for recovery (NF Stillaguamish and SF Stillaguamish). These populations are in the Whidbey biogeographical region (or major population group [NWFSC 2015]). NMFS has ranked the NF Stillaguamish and the SF Stillaguamish populations as Tier 2 for salmon recovery planning purposes (75 Fed. Reg. 82208, December 29, 2010). Tier 1 Chinook salmon populations are of primary importance for preservation, restoration, and ESU recovery and must be viable for the entire ESU to attain recovery status (75 Fed. Reg. 82208, December 29, 2010; Ruckelshaus et al. 2002). Tier 2 populations are less important than Tier 1 populations for recovery to a low-extinction risk status, and Tier 3 populations are the least important. For ESA recovery planning purposes under the Puget Sound salmon recovery plan (Shared Strategy for Puget Sound 2007), the equilibrium abundance targets roughly reflect the historical abundance potential for the NF and SF Stillaguamish Chinook salmon populations. The NF Stillaguamish population has a planning range of 18,000 to 24,000 spawners, while the SF Stillaguamish population has a planning range of 15,000 to 20,000 spawners (Ruckelshaus et al. 2002; NMFS 2006; Shared Strategy for Puget Sound 2007). Critical escapement thresholds, below which extinction risk increases substantially, are 300 fish for the NF Stillaguamish River population and 200 fish for the SF Stillaguamish River population (NMFS 2000).

The geometric mean number of naturally spawning Chinook salmon (hatchery-origin and natural-origin fish) from 1999 to 2017 was 1,147 fish per year for the NF Stillaguamish population and 111 fish per year for the SF Stillaguamish population, with the former population stable and the latter population in decline

(NMFS 2019). Natural-origin Chinook salmon contribute an average of 530 fish per year to the NF Stillaguamish population and 98 fish to the SF Stillaguamish population. The two populations are combined as a single management unit for harvest management purposes (Puget Sound Indian Tribes and WDFW 2017). Additional information on Chinook salmon viability in the Stillaguamish River Basin can be found in Subsection 3.4.2.7, Population Viability Benefits.

There are two run forms, or types, of Chinook salmon in the Stillaguamish River that differ in terms of the timing of their return from the ocean to fresh water for spawning. The summer-run Chinook salmon predominantly spawn in the middle and upper sections of the NF Stillaguamish River and some of its larger tributaries, arriving as early as late May with spawning beginning in late August (SIRC 2005; Stillaguamish Tribe of Indians 2018a). In contrast, the fall-run Chinook salmon predominantly spawn in the lower sections of the SF Stillaguamish River and several larger tributaries (Jim Creek and Pilchuck Creek) (SIRC 2005). While the arrival time of fall-run Chinook salmon is uncertain, spawning occurs from mid-September through early November (Stillaguamish Tribe of Indians 2018b). Genetic analysis has demonstrated that a small number of fall-run Chinook salmon spawn in the NF Stillaguamish River and a small number of summer-run Chinook salmon spawn in the SF Stillaguamish River (Stillaguamish Tribe of Indians 2018a,b). The vast majority (98 to 99 percent) of Chinook salmon juveniles of both run types typically spend 1 to 5 months rearing in fresh water before migrating to Puget Sound.

The two Chinook salmon hatchery programs in the Stillaguamish River Basin have been developed based on the Chinook salmon run types, summer-run or fall-run, rather than the ESA population designations (i.e., NF Stillaguamish and SF Stillaguamish populations). For this analysis, the EA also refers to the two listed Chinook salmon populations in the Stillaguamish River Basin as summer-run and fall-run populations. The summer-run type predominates in the NF Stillaguamish River and the fall-run type predominates in the SF Stillaguamish River.

Puget Sound Indian Tribes and WDFW (2017) reported the Stillaguamish summer-run and fall-run Chinook salmon populations to be at critical levels. Because of their relatively low abundance and productivity, the Stillaguamish summer-run and fall-run Chinook salmon populations, along with populations from the Dungeness, Nooksack, and Mid-Hood Canal River Basins, may constrain harvest rates for pre-terminal and terminal United States fisheries in Puget Sound (Puget Sound Indian Tribes and WDFW 2017). As indicator stocks in Puget Sound, objectives of the two Stillaguamish Chinook salmon hatchery programs include providing harvest rate and other information resulting from marked (clipped adipose fin) and tagged (coded wire tag [CWT]) fish being counted in a fishery or on the spawning grounds.

There are three independent populations of steelhead in the Stillaguamish River Basin: Canyon Creek summer-run steelhead, Deer Creek summer-run steelhead, and winter-run steelhead (NWFSC 2015). However, there is no available abundance information for the Canyon Creek and Deer Creek summer-run steelhead populations. From 2009 to 2016, a mean of 433 winter-run steelhead were counted per year but could not be allocated between natural-origin and hatchery-origin fish (WDFW 2018b). Most steelhead smolts out-migrate to marine waters after rearing in fresh water for 2 years, with a few spending 1 or 3 years in fresh water (Hard et al. 2007). Critical habitat for steelhead in the Stillaguamish River Basin includes all the critical habitat for Puget Sound Chinook salmon plus additional habitat within smaller tributaries that Chinook salmon do not use (81 Fed. Reg. 9252, February 24, 2016).

Four additional non-listed salmon species (coho salmon, fall-run chum salmon, sockeye salmon, and pink salmon) also occur in the Stillaguamish River Basin. NMFS reviewed the status of coho salmon in Puget Sound (Weitkamp et al. 1995), delineated the Puget Sound/Strait of Georgia Coho Salmon ESU, and determined that it did not warrant listing under the ESA, but there is concern or great uncertainty about its status. Consequently, the Puget Sound/Strait of Georgia Coho Salmon ESU was listed as a "species of concern[6]" due to declines in abundance and productivity, threats to genetic diversity, and reduced distribution (60 Fed. Reg. 38011, July 25, 1995; 75 Fed. Reg. 38776, July 6, 2010). Based on data provided by the Pacific Fisheries Management Council (PFMC) (2019), the geometric mean number of natural-spawning coho salmon in the Stillaguamish River Basin from 2013 to 2017 was 13,807 fish per year. Below average natural-origin coho salmon escapement[7] to the Stillaguamish River Basin has occurred during recent years: 2015 (2,914 fish), 2016 (13,048 fish), and 2017 (6,099 fish).

The Stillaguamish fall-run chum salmon (hereafter simply referred to as chum salmon) population is part of the Puget Sound/Strait of Georgia Chum Salmon ESU (Johnson et al. 1997). Based on a status review, the ESU was found to not warrant protection under the ESA (63 Fed. Reg. 11774, March 10, 1998; Johnson et al. 1997). From 2010 to 2014, the geometric mean number of spawning Stillaguamish chum salmon was 11,974 fish per year (Stillaguamish Tribe of Indians 2018c). Additional information on coho salmon and chum salmon viability in the Stillaguamish River Basin can be found in Subsection 3.4.2.7, Population Viability Benefits.

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[6] Species of concern are those for which the U.S. Fish and Wildlife Service (USFWS) or NMFS has some concerns regarding status and threats, but insufficient information is available to indicate a need to list those species under the ESA (69 Fed. Reg. 19975; April 15, 2004)

[7] Escapement is defined as adult salmon and steelhead that survive fisheries and natural mortality and return to fresh water to spawn.

The sockeye salmon that occur in the Stillaguamish River are of the river type that do not rear in a lake prior to out-migrating to the ocean. Their annual numbers are not substantial, with maximum peak adult fish counts of 34 fish (Gustafson and Winans 1999). Thus, effects on sockeye salmon are not analyzed in this EA.

Pink salmon populations in Puget Sound have not been petitioned for listing under the ESA and are generally healthy based on Hard et al. (1996) and recent adult return levels. Substantial returns of pink salmon occur only in odd-numbered years within Puget Sound. From 2005 to 2013, the geometric mean number of pink salmon spawners returning to the Stillaguamish River during odd-numbered years was 260,181 fish (WDFW 2018b).

In addition to the four salmon hatchery programs in the Stillaguamish River Basin, a variety of natural and human-caused factors have and will continue to affect the abundance, productivity, diversity, and distribution of salmon and steelhead in Puget Sound, including those in the Stillaguamish River Basin. NMFS salmon status reviews (Myers et al. 1998; Good et al. 2005; Ford 2011; NWFSC 2015) and the Puget Sound salmon recovery plan (Shared Strategy for Puget Sound 2007) described a range of past and current factors that have contributed to the decline of salmon and steelhead in Puget Sound, including habitat degradation, predation, dams and diversions, ocean conditions, and climate change. These natural and human-caused factors are described in substantial detail in Subsection 3.2.2, General Factors that Affect the Presence and Abundance of Salmon and Steelhead, in the Puget Sound Hatcheries DEIS (NMFS 2014). Habitat degradation, ocean conditions, and climate change are the primary factors that have negatively affected salmon and steelhead populations in the Stillaguamish River Basin (SIRC 2005; Shared Strategy for Puget Sound 2007). No major dams or diversions are currently present in the Stillaguamish River Basin.

Aquatic habitat is substantially degraded relative to historical conditions in the Stillaguamish River Basin, and habitat degradation is the most important of the general factors that have negatively affected salmon and steelhead populations (SIRC 2005; Shared Strategy for Puget Sound 2007). Forest practices, urbanization, and agricultural land use in flood plains were cited as the leading causes of habitat degradation in the Stillaguamish River Basin (NWIFC 2016). Changes in watershed hydrology, primarily increases in peak flow volumes, and fine sediment loads have been identified as the main factors contributing to low productivity of Chinook salmon in the river basin (Puget Sound Indian Tribes and WDFW 2017). Habitat improvement projects have been implemented in the Stillaguamish River Basin since completion of the Chinook salmon recovery plan; however, habitat degradation has outpaced the rate of improvements (NWIFC 2016). Out of eight key environmental indicators, all but one (water quality for shellfish) have declined since the river basin was last evaluated in 2012 (NWIFC 2016).

Aquatic habitat conditions have been affected by a recent large-scale geologic event important to the Stillaguamish River Basin. In March of 2014, the Oso Landslide (also known as the State Route 530 Landslide) occurred on the NF Stillaguamish River. The landslide began upslope of the NF Stillaguamish River and crossed the river to cover a 0.5-mile-wide area with 18 tons of sand, till, and clay. The landslide temporarily dammed the NF Stillaguamish River to a depth of 25 feet and formed a temporary lake 2.5 miles long. Within 2 months of the landslide, the river slowly eroded back to its pre-landslide elevation and drained the excess dammed water. The area is being actively monitored, and an additional slow landslide in the area was identified in 2017 that was of sufficient size to temporarily close State Route 530. Additional studies are being conducted to determine impacts to the aquatic ecosystem and changes to flood risk along the NF Stillaguamish River (USGS 2017).

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.

3.4.1 Stillaguamish River Basin Salmon Hatchery Programs

There are six salmon and steelhead hatchery programs within the Stillaguamish River Basin that contribute approximately 0.9 million juveniles or about 0.5 percent of the total Puget Sound hatchery production (approximately 167.8 million juveniles) (Appendix B, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities). Thus, the Stillaguamish River Basin is a very small contributor to salmon and steelhead hatchery production within Puget Sound.

In addition to the four salmon hatchery programs that are assessed in this EA (Stillaguamish Tribe of Indians 2018a,b,c,d), WDFW releases winter-run steelhead (130,000 yearlings) and summer-run steelhead (70,000 yearlings) into the river from rearing ponds at the Whitehorse Hatchery. Environmental impacts of the winter-run steelhead program were previously reviewed in an environmental impact statement (NMFS 2016a).

The four salmon hatchery programs in the river basin have generally operated according to HGMPs included as part of joint state and tribal RMPs for Puget Sound salmon and steelhead programs, which were submitted to NOAA Fisheries in 2004 for approval under the 4(d) Rule (NMFS 2014). Because of substantial changes in hatchery management, the RMPs were withdrawn. Nevertheless, the programs continued to follow the HGMPs as periodically updated since 2004 and re-submitted on June 23, 2017, for approval (Stillaguamish Tribe of Indians 2018a,b,c,d). The current programs are classified as integrated recovery (or conservation) programs to sustain or increase the abundance of the natural-spawning salmon using broodstock with a relatively high proportion of natural-origin fish. An integrated hatchery program relies on the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the natural environment. Differences between hatchery-origin and natural-origin fish are minimized, and hatchery-origin fish are integrated with the local populations.

As mentioned previously, fish from the Chinook salmon and coho salmon hatchery programs serve as indicator stocks to assess harvest rates and other demographic information associated with the populations via monitoring of CWT[8] data. In addition to insertion of a CWT, salmon released from the programs have the adipose fin clipped off to identify them as hatchery-origin fish. The co-managers have chosen to remove adipose fins because fish with CWTs would not otherwise be identified in some fisheries. However, in mark-selective fisheries, where only salmon with missing adipose fins are allowed to be harvested, program fish are vulnerable to harvest so that fewer hatchery-origin fish return to the Stillaguamish River and contribute to escapement. Based on data for return years 2010 to 2014, NMFS (2017a) estimated the removal of adipose fins results in an annual average of approximately 43 fewer hatchery-origin spawners from the two Chinook salmon hatchery programs due to harvest in mark-selective fisheries, which is about 9 percent of the hatchery-origin escapement (Jonathan Carey, NMFS, email sent to Alan Olson, Fish Biologist, NMFS Affiliate, March 28, 2019, regarding harvest due to marking fish).

Each of the salmon hatchery programs in the Stillaguamish River Basin has been operated in recent years with maximum juvenile production levels similar to how they plan to operate in the future. However, as discussed below, actual production has varied from year to year for each hatchery program. Numerous factors can affect annual production levels, including adult escapement, environmental conditions (e.g., river flow and temperature) affecting broodstock collection efficiency and pre-spawning mortality levels, and disease outbreaks in a hatchery. The chum salmon and coho salmon hatchery programs also rely on adults volitionally entering traps, with efficiency naturally varying from year to year. Annual hatchery production

[8] CWTs are inserted in the snout of a salmon, identify its specific release group, require a metal detector to locate, and are removed after death for reading under a microscope.

has varied substantially for the summer-run Chinook salmon, coho salmon, and chum salmon hatchery programs with both over- and under-achievement of maximum production levels. The fall-run Chinook salmon hatchery program has been chronically below its maximum production level because of the lack of broodstock.

The Stillaguamish Summer Chinook Natural Stock Restoration Program has targeted the collection of up to 150 combined hatchery-origin and natural-origin adult Chinook salmon by periodically (historically 4 to 12 times per year) seining pools in the NF Stillaguamish River from late July through September (Stillaguamish Tribe of Indians 2018a). Collected adults are held at the Harvey Creek Hatchery until sexually mature, and tissue samples are taken for genetic identification as either summer-run or fall-run Chinook salmon. From 2002 to 2014, an average of 143 (range 124 to168) genetically assigned summer-run Chinook salmon were collected for broodstock (Table 4). The broodstock collection target for the summer-run Chinook salmon hatchery program (65 pairs/130 fish) has usually been achieved each year. Up to 20 adults assigned as fall-run are targeted for retention as broodstock for the fall-run Chinook salmon hatchery program. From 2010 to 2013, between 4 and 12 adults assigned as fall-run fish were collected in the NF Stillaguamish River along with the summer-run fish and retained as broodstock, reflecting the natural variability in the numbers of fall-run fish collected. Additional information on the fall-run Chinook salmon hatchery program is provided below.

Adult summer-run Chinook salmon spawning, incubation of eggs, and rearing of fry occur at the Harvey Creek Hatchery. Typically, rearing continues until subyearling fish grow to target release size of approximately 3.3 inches[9] in length (90 fish per pound [fpp]) (Table 5). The first groups of juveniles usually reach that size in late March. As they reach the target release size, each fish's adipose fin is removed and a CWT is inserted. Subyearlings ready for release are transported to earthen ponds at the Whitehorse Hatchery (RM 28 of the NF Stillaguamish River) and allowed to migrate into the NF Stillaguamish River on a volitional basis. Nearly all fish enter the river by mid-June; after that time, any remaining fish are forced to leave the pond. The production level for the summer-run Chinook salmon hatchery program is 220,000 subyearlings released each year (Table 4). From 2011 to 2015, the average proportion of natural-origin fish in the broodstock was 48 percent. From 2002 to 2013, an average of 219,311 subyearlings (range 145,697 to 296,099) were released from the program each year (Stillaguamish Tribe of Indians 2018a) (Table 4).

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[9] The units used to report fish sizes in hatcheries are typically the number of fish per pound rather than units of length or weight. Hatchery fish lengths in this EA were estimated using the tables available in Appendix I of Piper et al. (1986).

Table 4. Maximum and annual broodstock collection and hatchery release levels of juvenile salmon under existing conditions.

Hatchery Program	Facilities	Maximum Level: Broodstock	Maximum Level: Juvenile Releases	Mean Actual Collected or Released (Range): Broodstock	Mean Actual Collected or Released (Range): Juvenile Releases	Mean Actual Collected or Released (Range): Years Included
Summer-run Chinook Salmon	Harvey Creek Hatchery, Whitehorse Hatchery	65 adult pairs	220,000 subyearlings	143 adults (124 – 168)	219,311 subyearlings (145,697 – 296,099)	2002 – 2014[1]
Fall-run Chinook Salmon	Brenner Creek Hatchery	Captive broodstock from 200 smolts plus 10 adult pairs[2]	200,000 subyearlings	127 smolts (25 – 241) 9 adults (4 – 12s)	Increasing to 115,020 subyearlings in 2018[3]	2011 – 2018[3]
Coho Salmon	Harvey Creek Hatchery	60 adult pairs	60,000 yearlings	63 adults (0 – 160)	39,482 yearlings (0 – 97,339)	2003 – 2014[4]
Chum Salmon	Harvey Creek Hatchery	300 adult pairs	50,000 eyed eggs or fry 250,000 fry[6]	358 adults (30 – 680)	321,584 fry (32,032 – 689,421)	2003 – 2014[5]

Sources: Stillaguamish Tribe of Indians 2018a,b,c,d; K. Konoski, pers. comm., Stillaguamish Tribe of Indians, Fish Biologist, August 7, 2018

1 Releases are included from 2002 to 2013.

2 Adult pairs collected from the NF Stillaguamish River plus available mature captive broodstock. Up to 400 smolts were targeted for collection from the SF Stillaguamish River and genetically tested for run type. Non-fall-run smolts were released back to the SF Stillaguamish River. Generally, about 50% of the smolts collected have been determined to be fall-run Chinook salmon.

3 Adults are included from 2010 to 2013. A mean number of juvenile fish released is not provided because releases generally increased each year, and therefore this statistic is not informative.

4 Releases are included from 2005 to 2014.

5 Releases are included from 2005 to 2014.

6 The smaller number of eyed egg or fry releases occurs in Church Creek as part of educational programs. The larger release is onsite from the Harvey Creek Hatchery.

Table 5. Length (inches) of hatchery-origin and natural-origin salmon and steelhead in the Stillaguamish River Basin.

Species	Life Stage	Hatchery Program Release Target	Average Length[1] (Minimum – Maximum): Hatchery-origin	Average Length[1] (Minimum – Maximum): Natural-origin	Lower River Smolt Trap[2]: Hatchery-origin	Lower River Smolt Trap[2]: Natural-origin
Chinook Salmon	Fry	-	-	1.6 (1.3 – 2.3)	-	-
	Subyearling/parr	3.3	3.1 (2.2 – 3.4)	3.0 (2.2 – 3.6)	2.4 – 3.3	1.6 – 3.1
	Yearling	-	-	4.7 (3.6 – 6.1)	-	-

Table 5. Length (inches) of hatchery-origin and natural-origin salmon and steelhead in the Stillaguamish River Basin (continued).

Species	Life Stage	Hatchery Program Release Target	Average Length[1] (Minimum – Maximum)		Lower River Smolt Trap[2]	
			Hatchery-origin	Natural-origin	Hatchery-origin	Natural-origin
Steelhead	Fry	-	-	2.4 (0.9 – 3.9)	-	-
	Subyearling/parr	-	-	3.8 (2.6 – 5.2)	-	-
	Smolt	-	-	6.5 (4.3 – 8.5)	-	-
Coho Salmon	Fry	-	-	1.2 (1.1 – 1.4)	-	-
	Parr	-	-	2.1 (1.5 – 2.9	-	-
	Yearling	5.4	5.5 (5.2 – 6.1)	4.2 (2.9 – 7.5)	-	-
Chum Salmon	Fry	2.0	2.0 (1.7 – 2.0)	1.5 (1.3 – 2.0)	-	-
Pink Salmon	Fry	-	-	1.3 (1.3 – 1.7)	-	-

1 Appendix C, Table 7.
2 Scofield and Griffith 2012, 2013, 2014.

The Stillaguamish Fall Chinook Natural Stock Restoration Program includes a captive broodstock component intended to provide most of the adult fish needed for maintaining the program (Stillaguamish Tribe of Indians 2018b). To achieve the program's maximum production levels, up to 400 smolts were targeted annually for collection in the SF Stillaguamish River by seining eddies twice weekly from early March through July. Collected smolts were the progeny of both unmarked natural-origin and marked hatchery-origin fish that spawned naturally and were genetically tested to identify run type. Fish other than fall-run Chinook salmon were returned to the river. The target number of smolts to be retained was 200 fish assigned as fall-run. Smolts were reared at the Brenner Creek Hatchery until they became sexually mature adults. From 2009 to 2016, the maximum number of genetically assigned fall-run Chinook salmon smolts collected was 241 fish (2016), with an average of 127 fish. The spawning of captive broodstock was supplemented by adults collected as part of the summer-run Chinook salmon hatchery program but genetically identified as fall-run fish. As indicated above, 4 to 12 genetically assigned fall-run adults were typically used in addition to the available captive broodstock.

The production level for the fall-run Chinook salmon hatchery program is the release of up to 200,000 subyearlings (Table 4). However, to date the largest release has been 115,020 fish in 2018 (K. Konoski, pers. comm., Stillaguamish Tribe of Indians, Fish Biologist, August 7, 2018). Considering both the captive broodstock and adult collections, the fall-run Chinook salmon hatchery program has not yet achieved the maximum production level because of limitations in the number of broodstock collected, survival rates to maturity, and fewer eggs from captive broodstock compared to natural-origin broodstock because captive broodstock have generally matured at a smaller size. Volitional release of marked and tagged subyearlings into Brenner Creek has occurred between late April and early June near Granite Falls, about 31 miles from the Stillaguamish River mouth.

The Stillaguamish Fall Coho Program is an integrated recovery program intended to sustain the productivity of Stillaguamish coho salmon, and to provide technical information from marking and tagging data that is representative of the biological characteristics and trends of coho salmon in north Puget Sound. The program targets the collection of up to 120 adults (60 pairs) of natural-origin coho salmon at a temporary trap located in the Fortson Ponds fish ladder, which is about 0.3 mile west of the Whitehorse Hatchery ponds, and approximately 27.7 miles from the mouth of the NF Stillaguamish River (Stillaguamish Tribe of Indians 2018d). The program has collected an average of 63 adult coho salmon (range 0 to 160 fish) each year for broodstock, but the number naturally varies from year to year because escapement numbers vary and capture depends on adults volitionally entering the trap. In addition, the coho salmon hatchery program was affected by a landslide at the Johnson Creek Hatchery (the original facility used for the program) that resulted in the loss of an entire brood year (2012). After that event, the Johnson Creek Hatchery was closed and all coho salmon hatchery operations moved to the Harvey Creek Hatchery. No broodstock were collected during 2013 when the program was transitioning to the new facility. The first release of coho salmon from the Harvey Creek Hatchery was in 2015. Typical coho salmon adult run timing is from late October through January, with a peak in mid-November.

The objectives for the coho salmon hatchery program are to have 120,000 fertilized eggs that would result in the release of 60,000 marked and tagged yearlings about 5.4 inches in length (18 fpp) (Table 5). From 2005 to 2014, an average of 39,482 yearlings were released each year (range 0 to 97,339) (Table 4). Annual releases substantially below the maximum production level have occurred because of insufficient broodstock or inadequate survival from egg to release. Coho salmon reared at the Harvey Creek Hatchery are released on a volitional basis into Harvey Creek, about 15.3 miles from the mouth of the Stillaguamish River. Yearling releases occur from late April through mid-June. Similar to hatchery-origin Chinook salmon, coho salmon from the hatchery program have their adipose fin removed to identify them as hatchery-origin fish. A portion of the released coho salmon yearlings also have a CWT embedded in their snout as part of hatchery program monitoring objectives.

The Stillaguamish Chum Program is an integrated recovery program intended to increase the abundance of Stillaguamish chum salmon. The program targets the collection of up to 600 adults (300 pairs) during mid-October to mid-January from a trap located at the outflow from the Harvey Creek Hatchery holding pond (Stillaguamish Tribe of Indians 2018c). From 2003 to 2014, the average number of chum salmon collected for broodstock was 358 adults (range 30 to 680 adults) (Table 4). The broodstock is an unknown mixture of both hatchery-origin and natural-origin fish. Program objectives are to release up to 250,000 unmarked fed fry into Harvey Creek (onsite releases) between March and May at a size of about 2.0 inches (350 to 400 fpp) (Table 5). Fed fry are reared for up to 2.5 months in the hatchery prior to release. From 2005 to 2014 an average of 321,584 fry were released on site each year (range 32,032 to 689,421 fry) (Table 4). Annual variation in the number of released fry occurred primarily because of natural variability in the number of adult chum salmon that volitionally entered the broodstock collection trap and variability in the survival rate from egg to release. Up to 50,000 eyed eggs are also supplied to local schools for educational programs. Eyed eggs are placed in instream incubators or incubated and reared in recirculating hatchery tanks. All the fry produced from the educational programs are released in Church Creek, a small tributary to the mainstem Stillaguamish River at RM 2.9; however, the actual numbers of fry released are unknown.

3.4.2 Salmon Hatchery Program Effects on Salmon and Steelhead

As described in NMFS (2014), salmon produced by hatchery programs may affect natural-origin salmon and steelhead. NMFS (2014) identified eight categories of potential effects: genetics, competition and predation, facility operations, masking, incidental fishing, disease, population viability, and nutrient cycling (Table 6). Organized by these eight categories, the following subsections describe how the four salmon hatchery programs have affected natural-origin Chinook salmon, steelhead, coho salmon, chum salmon, and pink salmon in the Stillaguamish River Basin.

Table 6. General categories through which hatchery programs can affect natural-origin salmon and steelhead populations.

Effect Category	Description of Effect
Genetics	• Interbreeding with hatchery-origin fish can change the genetic character of the local populations. • Interbreeding with hatchery-origin fish may reduce the reproductive performance of the local populations.
Competition and Predation	• Hatchery-origin fish can increase competition for food and space. • Hatchery-origin fish can increase predation on natural-origin salmon and steelhead.

Table 6. General categories through which hatchery programs can affect natural-origin salmon and steelhead populations (continued).

Effect Category	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: ➢ Isolation of formerly connected populations ➢ Limiting or slowing movement of migrating fish species, which may enable poaching or increase predation ➢ Alteration of stream flow ➢ Alteration of streambed and riparian habitat ➢ Alteration of the distribution of spawning within a population ➢ Increased mortality or stress due to capture and handling ➢ Impingement of downstream migrating fish ➢ 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
Masking	• Hatchery-origin fish can increase the difficulty in determining the status of the natural-origin component of a salmon or steelhead population.
Incidental Fishing	• Fisheries targeting hatchery-origin fish have incidental impacts on natural-origin fish.
Disease	• Concentrating salmon and steelhead for rearing in a hatchery facility can lead to an increased risk of carrying fish disease pathogens. When hatchery-origin fish are released from the hatchery facilities, they may increase the disease risk to natural-origin salmon and steelhead through pathogen transmission.
Population Viability Benefits	• Abundance: Preservation of, and possible increases in, the abundance of a natural-origin fish population resulting from implementation of a hatchery program. • Spatial Structure: Preservation or expansion of the spatial structure of a natural-origin fish population resulting from implementation of a hatchery program. • Genetic Diversity: Retention of within-population genetic diversity of a natural-origin fish population resulting from implementation of a hatchery program. • Productivity: Maintenance of or increase in the productivity of a natural-origin fish population from implementation of a hatchery program, if naturally spawning hatchery-origin fish match natural-origin fish in reproductive fitness and the natural-origin fish population's abundance is low enough to limit the productivity of the natural-origin fish (i.e., they are having difficulty finding mates).
Nutrient Cycling	• Returning hatchery-origin adults can increase the amount of marine-derived nutrients in freshwater systems.

3.4.2.1 Genetics

Hatchery programs can have a variety of genetic effects on natural-origin salmon and steelhead. This analysis addresses the existing conditions associated with three major types of genetic risks from hatchery programs: within-population genetic diversity effects, outbreeding effects, and hatchery-influenced selection effects. The following provides a summary of detailed information on genetic risks described in

Subsection 3.2.3.3, Risks – Genetics, and Appendix B, Hatchery Effects and Methods for Fish, in the Puget Sound Hatcheries DEIS (NMFS 2014).

Genetic differences among natural-origin salmon and steelhead populations arise as a natural consequence of their homing tendencies. Adult salmon and steelhead return with high fidelity (frequently greater than 90 percent) (Quinn 1997) to the streams of their birth. This leads to a relatively high degree of genetic separation among populations and to differences that are beneficial (adaptive) to fish survival in their dynamic local environments. The opposite of homing is called straying, and if strays successfully reproduce, this results in gene flow among populations. Straying is common in salmon and steelhead but varies in pattern and intensity among species and populations (Quinn 1993), including whether a population has a hatchery origin (Westley et al. 2013). Straying by natural-origin fish is thought to serve a useful purpose by providing opportunities to colonize or re-colonize vacant habitat. Straying is generally not beneficial when it results in gene flow from unnatural sources or occurs at unnatural levels, which can lead to loss of genetic diversity between populations and outbreeding depression.

Within-population genetic diversity is the suite of traits that allows populations to survive and adapt in response to environmental change. Within-population genetic diversity is gained through mutations or gene flow from other populations (e.g., from straying) and is lost primarily due to genetic drift, which is a random loss of diversity due to (small) population size. Some hatchery stocks have less genetic diversity and higher rates of genetic drift than natural populations, presumably resulting from the small number of spawners that may have been used at hatcheries (Waples et al. 1990). By maximizing the number of adults used for broodstock, balancing sex ratios, and maintaining age structures, the loss of within-population genetic diversity due to artificial propagation can be minimized. Integrated hatchery broodstocks ideally would represent the variation in run timing, age composition, size, and fecundity that is observed in local natural-origin populations.

When population abundance is low (less than a few hundred individuals) the potential for a loss of within-population genetic diversity increases (Waples et al. 1990). Allendorf et al. (1997) suggested populations with 250 or fewer individuals are at very high risk of reduced genetic diversity and those with fewer than 2,500 individuals would be at high risk. However, for integrated hatchery populations, the population size is a combination of both naturally spawning and hatchery-spawned fish (effective population size). Removal of adults from the naturally spawning population (i.e., broodstock mining) can reduce the combined effective population size, but can also result in increased overall production due to higher survival rates for life stages reared in the hatchery compared to the natural environment. Such a tradeoff can be warranted if the risk of extinction is high (Ryman and Laikre 1991). Captive broodstock programs that obtain natural-origin individuals at more abundant juvenile life history stages can reduce the need for the removal of adults for broodstock, thus reduce mining effects on effective population size. However, there is a trade-off that the resulting broodstock are reared for a long period in a hatchery setting that could increase hatchery-influenced selection effects.

Outbreeding effects are caused by high levels of gene flow from other populations and can reduce the fitness (i.e., survival) of populations in the first or subsequent generations after interbreeding. Natural straying at relatively low levels serves a valuable function in preserving diversity that would otherwise be lost through genetic drift and in re-colonizing vacant habitat. Unnatural levels of gene flow from other populations can increase genetic diversity (Ayllon et al. 2006), but it can also reduce a population's level of adaptation, a phenomenon called outbreeding depression (Edmands 2007; McClelland and Naish 2007). In general, the greater the geographic separation between the source or origin of hatchery-origin population and the recipient natural-origin population, the greater the genetic difference between the two populations (Interior Columbia Technical Recovery Team 2007) and the greater potential for outbreeding depression. Hatchery-origin fish from distant sources may, therefore, pose a greater risk to the genetic diversity of a local natural-origin population than hatchery-origin fish originating from the same local natural-origin population.

Hatchery-influenced selection occurs when selection pressures imposed by spawning and rearing practices under hatchery conditions differ greatly from those imposed by the natural environment and cause genetic change that is passed on to natural-origin populations through interbreeding with hatchery-origin fish, typically from the same population. Hatchery-influenced selection can range from relaxation of selection that would normally occur in nature, to inadvertent selection for different characteristics in the hatchery and natural environments, to intentional selection for desired characteristics (Waples 1999). Some level of hatchery-influenced selection is inherent in all hatchery programs, which by design relax natural mortality and selection related to at least egg incubation and may include a significant amount of freshwater rearing. In general, species that are reared in hatcheries for a relatively short time (e.g., Chinook salmon subyearlings and chum salmon and pink salmon fry) are less likely to be genetically changed by hatchery rearing than species with longer freshwater hatchery rearing times (e.g., Chinook salmon, steelhead, and coho salmon, yearlings) (Berejikian and Ford 2004).

NMFS considers available guidelines in analyzing genetic risks. For example, in 2004, the HSRG released recommendations for reform of hatcheries in Puget Sound (HSRG 2004, 2005) and in 2014 completed a review of advancements over the ensuing decade (HSRG 2014). HSRG guidelines include recommendations for minimizing the negative effects of hatcheries on genetics of salmon using three metrics. These metrics are the proportion of hatchery-origin spawners (pHOS), proportion of natural-origin adults in broodstock (pNOB), and an index called the proportionate natural influence (PNI) that is calculated using the pHOS and pNOB values[10]. For Tier 2 Chinook salmon populations, which are analogous to 'contributory' populations as used by the HSRG, recommended pHOS values less than 30 percent and PNI values greater than 0.5, which indicate that natural selection outweighs hatchery-influenced selection, would apply to the Stillaguamish salmon populations.

NMFS has not adopted any standards for pHOS, PNOB, or PNI but does consider them a useful screening tool for effects. For a particular salmon hatchery program, NMFS may consider a pHOS or PNI level to be a lower risk than the HSRG would, but generally, if a program meets the HSRG (2014) recommendations, NMFS will consider the risk it poses to be acceptable.

The following subsections discuss the specific genetic risks of the four Stillaguamish River Basin salmon hatchery programs as they have operated in the recent past to Chinook salmon, coho salmon, and chum salmon. Because the species do not interbreed, there are no genetic risks from these programs to steelhead or pink salmon.

Chinook Salmon

The integrated summer-run and fall-run Chinook salmon hatchery programs use substantial numbers of natural-origin fish annually as broodstock. Because these natural-origin populations overlap spatially and temporally on the spawning grounds, pHOS and PNI values for each population are confounded; consequently, genetic risks associated with these metrics under existing conditions are examined in combination. Using data from 2006 to 2015, NMFS estimated that PNI has often been above 0.50, with a 10-year average of 0.44 (range 0.31 to 0.62) which is acceptable for Tier 2 populations and suggests that broodstock collection practices for the programs appear to be mitigating for any possible domestication effects on the composite population (NMFS 2019). For both Chinook salmon hatchery programs, pHOS values during some years were above 30 percent, which is higher than the guidance for an integrated program. This occurred because the natural-origin spawning populations have been low, particularly for the fall-run Chinook salmon population. However, high pHOS values are acceptable for integrated recovery programs aimed at increasing the size of small populations at risk of extinction (HSRG 2004), and pHOS should decline if the program is successful in combination with habitat improvement and increased natural production.

[10] PNI is defined as pNOB/(pNOB + pHOS).

The recent broodstock collection target has been up to 65 pairs from the summer-run Chinook salmon population, which includes both hatchery-origin and natural-origin fish. In addition, up to 10 pairs from the fall-run Chinook salmon population are incidentally collected during summer-run Chinook salmon broodstock collection. Broodstock collections from 2005 to 2015 averaged about 11 percent of total Chinook salmon escapement in the Stillaguamish River Basin. However, based on demographic and genetic analysis, Eldridge and Killebrew (2008) concluded there were no significant genetic differences between hatchery-origin and natural-origin summer-run Chinook salmon in the Stillaguamish River Basin. The primary use of captive broodstock for the fall-run Chinook program is one of the techniques being used to minimize the potential for negative effects from removing adult spawners for broodstock. In contrast to the adult removals for the summer-run program, removal of 400 smolts for fall-run captive broodstock represents less than 0.07 percent of the total Chinook salmon smolt outmigration (NMFS 2019). In addition, outbreeding effects from out-of-basin strays have been minimized because hatchery-origin adults from locations other than the Stillaguamish River Basin, based on CWT information, are not included in hatchery broodstock.

Approximately 8.8 percent of the adults from the Stillaguamish summer-run and fall-run Chinook salmon hatchery programs stray to other river basins (Haggerty 2018). Populations receiving strays from the two Stillaguamish hatchery programs for Chinook salmon include populations in the Skagit and Snohomish River Basins, into which the Stillaguamish Chinook salmon hatchery programs generally contribute less than 0.3 percent of the pHOS (Haggerty 2018). Contributions were highest to the Tier 3 Snoqualmie fall-run Chinook salmon population for which they contributed a total of 3.4 percent of the pHOS from 2006 to 2015 (Haggerty 2018). Overall, the genetic risk from straying by Chinook salmon from the Stillaguamish River Basin hatchery programs has been negligible.

Coho Salmon

The natural-origin coho salmon population in the Stillaguamish River is a genetic mixture of locally adapted natural-origin fish, plus hatchery-origin fish released from the early 1950s to 1981 and derived from hatcheries in the Skagit River, Skykomish River, Samish River, Green River, and Issaquah Creek (Weitkamp et al. 1995; WDFW 2018b). The Washington Department of Fisheries (1975) reported an average of 358,000 hatchery-origin coho salmon juveniles were planted on an annual basis in the Stillaguamish River from 1966 through 1971. Consequently, there was likely some level of genetic effects on the natural-origin population from these historical releases prior to implementation of the current coho salmon hatchery program. The current integrated Stillaguamish Fall Coho Program began in 1986, and through 2002, a mixture of natural- and hatchery-origin fish used as broodstock were collected from a variety of Stillaguamish River tributaries, including Harvey Creek, Johnson Creek, Jim Creek, and Fortson Creek (Stillaguamish Tribe of Indians 2018d). Since 2003, the vast majority of broodstock used for the program have been natural-origin fish from Fortson Creek. However, 11 hatchery-origin coho salmon returning to the Harvey Creek Hatchery were also incorporated into broodstock during 2017 due to a shortfall of natural-origin coho salmon from Fortson Creek that year. No hatchery-origin coho salmon were needed for broodstock during 2015 or 2016.

Because broodstock include only natural-origin fish (i.e., a pNOB of 100 percent), it is unlikely that substantial negative effects on genetic diversity have occurred due to the program. Most escapement derived from hatchery-origin fish do not return to the hatchery (Stillaguamish Tribe of Indians 2018d). Based on preliminary data from PFMC (2019), an average of 38 hatchery-origin and 13,807 natural-origin fish returned annually to spawn from 2013 to 2017. This results in a pHOS of 0.2 percent that is well below the 30-percent threshold for an integrated population and a high PNI value (over 0.99) that is above the 0.50 threshold. No information is available about straying rates by hatchery-origin coho salmon to other basins or their potential effect on genetics.

Chum Salmon

Broodstock are collected from a trap at the Harvey Creek Hatchery (Stillaguamish Tribe of Indians 2018c). Because the chum salmon produced by the program are not marked, no empirical estimates of pHOS, pNOB, or PNI are available and no information on straying to other basins is available. Potential genetic effects on natural-origin chum salmon are primarily associated with reduction of genetic diversity by inadvertently reducing the effective breeding size of natural-origin spawners or by hatchery-influenced selection. However, the former effect is likely minor because of the small size of the program relative to the size of the naturally spawning population in the river basin (geometric mean of 11,974 fish per year), and the latter effect is minimized through best management practices (BMPs) and the short time that the juveniles are reared in the hatchery prior to release.

While no adult return survival rates specific to Stillaguamish chum salmon are available, using a typical survival rate of 0.7 percent for natural-origin chum salmon populations (Bradford 1995) and an average harvest rate of 3.2 percent between 2010 and 2014 (Stillaguamish Tribe of Indians 2018c), hatchery returns would be roughly 1,700 fish. Under these assumptions, a potential pHOS of 15 percent or less would result, which is low for integrated programs. Because all broodstock are derived from chum salmon that return to the hatchery, pNOB and PNI values are potentially low, but their values are unknown. Available studies of chum salmon genetic diversity (Small et al. 2009) and reproductive success (Berejikian et al. 2009) in other areas of Puget Sound have not found significant differences between natural-origin chum salmon and offspring of hatchery-origin chum salmon from hatchery programs using local broodstock. These findings are likely to be generally applicable to chum salmon in the Stillaguamish River Basin because of similarities in the chum salmon hatchery practices used (e.g., short time spent in hatcheries).

3.4.2.2 Competition and Predation

Competition and predation effects on natural-origin salmon and steelhead from hatchery-origin salmon may occur in both freshwater and marine areas, at juvenile and adult life stages, and among different species of salmon and steelhead. Depending on the species and circumstances, competition and predation from hatchery-origin fish can lead to reduced growth or increased mortalities that affect the abundance and productivity of natural-origin fish. Competitive interactions, such as agonistic behavior, typically do not directly result in mortality, but the growth or condition of individuals that lose repeatedly during interactions may be reduced, increasing the risk of other causes of mortality such as starvation, disease, or predation.

General information on competition risks from salmon hatchery programs to natural-origin salmon and steelhead, and the qualitative evaluation tool and its results for natural-origin Stillaguamish River Basin salmon assuming production levels are released, are presented in Appendix C, Competition and Predation Literature Summary and Qualitative Evaluation Methods. The main factors and criteria used in the evaluation tool are the relative size (length) of hatchery-origin and natural-origin fish, their relative abundance and capacity of the habitat, the duration of overlap in space and time when competitive or predatory interactions could occur, and the distance from release sites to the estuary. For competitive interactions, domination by a hatchery-origin fish may occur when it is larger, or no more than 1 inch smaller, than a natural-origin fish. Predation can occur when a hatchery-origin fish is at least two times the length of a natural-origin fish.

The following subsections summarize existing conditions based on these results for the natural-origin salmon and steelhead evaluated in this EA.

Chinook Salmon

There is an overlap in the presence and size of hatchery-origin and natural-origin Chinook salmon subyearlings from late March through late June (Scofield and Griffith 2012, 2013, 2014). Hatchery subyearlings are released relatively high in the river basin with 31 (fall-run) to 46 (summer-run) miles to out-migrate to the estuary. Hatchery-origin Chinook salmon juveniles captured by an outmigrant trap in the lower river (RM 6) typically range from 2.4 to 3.3 inches in length (weekly average), while natural-origin Chinook salmon outmigrants range from 1.6 to 3.1 inches (Table 5). Hatchery-origin and natural-origin Chinook salmon become larger over the migratory period, and the average size of hatchery-origin fish is generally 0.6 to 0.8 inch longer than natural-origin fish captured at the trap. Consequently, hatchery-origin Chinook salmon subyearlings typically have a slight size advantage over natural-origin Chinook salmon subyearlings.

The Species Interaction Work Group (SIWG) (1984) identified the potential risk of competition from hatchery-origin on natural-origin Chinook salmon to be high. The overlap in fish size and spatial distribution described in the previous paragraph supports this initial risk level, but this is moderated by the number of hatchery-origin Chinook salmon subyearlings released and the timing of releases. Appendix D in NMFS (2014) reported juvenile Chinook salmon capacity at 470,475 fish for the NF Stillaguamish River and 749,338 fish for the SF Stillaguamish River. Consequently, the hatchery production levels (220,000 and 200,000 subyearlings, respectively) are substantially below the estimated capacities.

The intent for integrated hatchery programs, such as the Chinook salmon recovery programs in the Stillaguamish River Basin, is for the size and outmigration timing of the hatchery-origin fish to mimic the natural-origin populations so that selective pressures are similar (Scofield and Griffith 2014). The hatchery-origin Chinook salmon compete with similarly-sized natural-origin Chinook salmon (HSRG 2014), but this competition is expected and accepted from integrated hatchery programs. Potential negative effects are more likely as combined numbers of hatchery-origin and natural-origin fish approach the carrying capacity of the environment.

Furthermore, hatchery-origin Chinook salmon juveniles tend to out-migrate later than natural-origin fish. For example, from 2006 to 2013, the 50-percent passage date at the lower river smolt trap of the natural-origin Chinook salmon juveniles was 1 to 25 days (average 12.6 days) earlier than hatchery-origin juveniles (Scofield and Griffith 2012, 2013, 2014). During the same years, more than two-thirds of the natural-origin fish had typically out-migrated past the trap by the time 50 percent of the hatchery-origin juveniles had out-migrated. In addition, both programs use volitional release strategies that reduce the potential for high concentrations of hatchery-origin fish to be present. Trapping data suggest that very few hatchery-origin or natural-origin Chinook salmon out-migrate as yearlings. Consequently, there is little to no risk of competition resulting from residual hatchery juveniles[11] from the two Chinook salmon hatchery

[11] Hatchery-origin fish that out-migrate slowly, if at all, after they are released.

programs. Overall, the potential for competitive encounters between hatchery-origin Chinook salmon subyearlings and natural-origin subyearlings, based on the above, is moderate. However, the risk is low that these encounters have substantially affected natural-origin Chinook salmon growth and survival because the combined numbers of hatchery-origin and natural-origin fish are below the estimated carrying capacity in the NF and SF Stillaguamish Rivers.

Hatchery-origin coho salmon yearlings are generally much larger than natural-origin Chinook salmon parr that could be encountered during outmigration (5.5 inches versus 3.0 inches) (Table 5), so coho salmon yearlings would be expected to dominate any interactions. However, the potential for competitive interactions between hatchery-origin coho salmon and natural-origin Chinook salmon is low because coho salmon are released from the Harvey Creek Hatchery relatively low in the river basin, about 15 miles from the estuary, the numbers of coho salmon released have been low (average of 38,482 fish), and the fish are released volitionally when they are physiologically ready to transition from fresh water to salt water and out-migrate quickly.

The potential for competitive interactions between hatchery-origin chum salmon fry and natural-origin Chinook salmon is avoided because of the disparity in size (2.0 inches versus 3.1 inches, respectively) and the location of the chum salmon release site at the Harvey Creek Hatchery, which is low in the watershed.

Thus, competitive encounters during the freshwater outmigration phase from fish produced by the Chinook salmon, coho salmon, and chum salmon hatchery programs on natural-origin Chinook salmon have likely occurred. These encounters may have resulted in reduced growth or a higher vulnerability by some individuals to other forms of mortality such as predation or disease. However, because of the relatively small size of the Chinook salmon and coho salmon hatchery releases and the factors that reduce the spatial and temporal overlap between hatchery-origin and natural-origin fish, population-level effects on natural-origin Chinook salmon have been low.

The potential for competitive interactions from hatchery-origin fish on natural-origin Chinook salmon juveniles in estuarine and nearshore waters are largely unknown because few studies of salmon and steelhead competition in these habitats have been conducted. Intraspecific interactions are most likely to occur (SIWG 1984), and if densities are high and food supplies low, negative effects could occur, primarily in areas adjacent to the river mouth where hatchery-origin fish may concentrate during migration to marine waters. 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 and steelhead in estuarine and marine shelf ecosystems were more likely to be affected by natural environmental variability than by hatchery release strategies.

Competition and density-dependent effects of hatchery-origin adult summer-run and fall-run Chinook salmon on listed natural-origin Chinook salmon via redd superimposition and competition for mates and spawning sites are not substantial. This is primarily because the hatchery programs have a recovery focus, whereby returning adults from the programs are intended to spawn naturally and interbreed with natural-origin fish. There is little risk of natural-original Chinook salmon redd superimposition by hatchery-origin coho salmon or chum salmon spawners because of substantial differences in spawning locations, habitat selection, timing, and depth of constructed redds that minimize the potential for the different species to interact during spawning.

Predation by hatchery-origin Stillaguamish Chinook salmon, coho salmon, and chum salmon on natural-origin Chinook salmon in fresh water could potentially occur. SIWG (1984) found risks from hatchery-origin Chinook salmon and coho salmon to natural-origin Chinook salmon were unknown because of the lack of empirical data, and risks from hatchery-origin chum salmon to natural-origin Chinook salmon were low (Appendix C, Table 2). More recent studies (e.g., Hawkins and Tipping 1999; Sharpe et al. 2008) suggest that coho salmon and steelhead yearlings released from hatcheries have low predation rates on Chinook salmon fry. Natural-origin Chinook salmon parr are generally too large (3.0 inches) (Table 5) to be eaten by any but the largest fish released from the salmon hatchery programs (e.g., coho salmon yearlings, which average 5.4 inches) (Table 5), and most natural-origin Chinook salmon juveniles reach the parr stage by the time hatchery-origin Chinook salmon and coho salmon are released. However, it is possible that some natural-origin Chinook salmon fry that emerge relatively late (i.e., late March through April) are vulnerable to predation by some of the larger hatchery-origin Chinook salmon subyearlings and coho salmon yearlings. The overall risk of predation in fresh water has been low because only a small portion of the natural-origin Chinook salmon were likely at a vulnerable size, the temporal overlap with hatchery-origin Chinook salmon and coho salmon has been short (less than 28 days and less than 14 days, respectively) (Appendix C, Competition and Predation Literature Summary and Qualitative Evaluation Methods), and hatchery-origin coho salmon have been released relatively low in the watershed, so the spatial overlap would have been small.

Predation on natural-origin Chinook salmon by hatchery-origin Chinook salmon, coho salmon, and chum salmon released in the Stillaguamish River Basin may also occur in estuarine and marine areas. However, SIWG (1984) found relatively little data on predation in nearshore marine areas (Appendix C, Table 5) and concluded that predation risks to natural-origin Chinook salmon in nearshore marine areas are low from hatchery-origin chum salmon and unknown for hatchery-origin Chinook salmon and coho salmon. It is possible that some predation by hatchery-origin fish on natural-origin Chinook salmon occurs in marine waters because of size differences and spatial and temporal overlap. However, predation risks from the Stillaguamish River Basin salmon hatchery programs in marine waters have likely been low because of the small number of hatchery-origin fish released.

Steelhead

Competitive interactions from summer-run and fall-run hatchery-origin Chinook salmon on natural-origin steelhead have likely been negligible to moderate depending on the steelhead life stage, primarily because most steelhead rearing occurs upstream of salmon hatchery release locations. Winter-run steelhead spawn in the mainstem and tributaries of the NF and SF Stillaguamish Rivers while summer-run steelhead spawn in the upper reaches of Deer Creek and Canyon Creek; consequently, most freshwater rearing of steelhead juveniles occurs upstream of salmon hatchery program release sites, with some overlap downstream of the Whitehorse Hatchery. The parr life stage for steelhead has the highest potential for competitive interactions because of their overlap in size with hatchery-origin Chinook salmon subyearlings; however, steelhead parr tend to be larger than hatchery-origin Chinook salmon subyearlings during the period of greatest overlap (late March through late June). Natural-origin steelhead smolts tend to be larger than the hatchery-origin Chinook salmon subyearlings (average 6.5 inches versus less than 3.4 inches, respectively) (Table 5) and are consequently at low risk of being adversely affected by competitive interactions.

Although hatchery-origin coho salmon yearlings are released at a size (about 5.4 inches in length) (Table 5) that is within the size range of natural-origin steelhead smolts (4.3 to 8.5 inches) (Table 5), the hatchery-origin coho salmon are released relatively low in the river basin from the Harvey Creek Hatchery, which reduces the potential for interactions with steelhead juveniles that are more prevalent farther upstream. The risk of competition between hatchery-origin chum salmon fry and natural-origin steelhead fry has been negligible because the location where hatchery-origin chum salmon fry are released, the locations where natural-origin steelhead fry occur, and the type of habitat used are different (nearshore marine versus stream).

Similar to effects on natural-origin Chinook salmon, the potential for competitive interactions from hatchery-origin coho salmon juveniles on natural-origin steelhead juveniles in estuarine and nearshore waters are largely unknown; however, steelhead smolts are relatively large and tend to move offshore into deeper marine waters relatively quickly. Consequently, the risk to natural-origin steelhead from competitive interactions with hatchery-origin salmon has been low in these areas.

SIWG (1984) found predation risks from hatchery-origin Chinook salmon and coho salmon to natural-origin steelhead in fresh water to be unknown because of the lack of empirical data, and risks from hatchery-origin chum salmon to natural-origin steelhead to be low (Appendix C, Table 3) because of size differences. The risk of predation by hatchery-origin Chinook salmon, coho salmon, and chum salmon from the Stillaguamish River Basin on natural-origin steelhead smolts and parr in fresh water has likely been negligible to low because of the small size of the hatchery-origin salmon compared to steelhead (Table 6) and the location and timing of releases. Some early-emerging steelhead fry (i.e., in June) may be vulnerable to predation by small numbers of larger hatchery-origin Chinook salmon subyearlings that fail to out-migrate promptly following release. The risk of predation on natural-origin steelhead fry and subyearlings from hatchery-origin coho salmon yearlings in fresh water has likely been negligible because they are released relatively low in the watershed from the Harvey Creek Hatchery. Predation risks to steelhead smolts in estuarine and nearshore waters by hatchery-origin coho salmon have also likely been negligible to low because steelhead smolts tend to move offshore quickly and they are too large to be eaten by the hatchery-origin juvenile salmon.

Coho Salmon

Competitive interactions between hatchery-origin Stillaguamish River Basin summer-run and fall-run Chinook salmon or hatchery-origin coho salmon have likely occurred with some natural-origin coho salmon life stages. Natural-origin coho salmon parr have a moderate potential for competitive interactions because they overlap in size (1.5 to 2.9 inches) (Table 5) and space with the hatchery-origin Chinook salmon subyearlings (2.4 to 3.3 inches) (Table 5). Hatchery-origin Chinook salmon subyearlings overlap temporally with coho salmon parr during late March to late June and spatially along 31 (SF Stillaguamish River) to 46 (NF Stillaguamish River) river miles of stream depending on the Chinook salmon release location. Natural-origin coho salmon yearlings are generally larger than the hatchery-origin Chinook salmon subyearlings, which reduces the potential for competitive interactions. Hatchery-origin coho salmon yearlings are released low in the watershed and consequently have a small spatial overlap with natural-origin coho salmon juveniles. Competitive interactions between hatchery-origin chum salmon fry and natural-origin coho salmon are unlikely to occur because of the disparity in size and location of the chum salmon hatchery release low in the watershed.

While some competitive interactions have likely occurred between hatchery-origin Chinook salmon, coho salmon, and chum salmon and natural-origin coho salmon, primarily smolts, the potential for reduced growth or higher vulnerability from other sources of mortality to coho salmon has ranged from negligible to low depending on life stage. This is because differences in fish size, and the location, timing, and magnitude of hatchery releases have reduced the potential for competitive interactions. Similar to Chinook salmon and steelhead, the potential for competitive interactions from hatchery-origin salmon juveniles on natural-origin coho salmon juveniles in estuarine and nearshore waters are largely unknown; however, the relatively large natural-origin coho salmon smolts generally move offshore into deeper marine waters relatively quickly, reducing the likelihood of competition.

SIWG (1984) considered predation risks from hatchery-origin Chinook salmon and coho salmon to natural-origin coho salmon in fresh water to be unknown because of the lack of empirical data (Appendix C, Table 3). The potential for hatchery-origin Chinook salmon, coho salmon, and chum salmon from the Stillaguamish River Basin to prey on natural-origin coho salmon smolts and parr in fresh water has been negligible to low because the hatchery-origin fish were too small. Some natural-origin coho salmon fry may be vulnerable to predation by larger hatchery-origin Chinook salmon subyearlings, but this is likely a relatively small number of fish because most natural-origin coho salmon juveniles are in the parr stage when hatchery-origin Chinook salmon are released. Risk of predation from hatchery-origin coho salmon yearlings has been negligible because they are released low in the watershed from the Harvey Creek Hatchery and most natural-origin coho salmon rearing occurs farther upstream. Risk of predation on natural-origin coho salmon smolts in estuarine and nearshore waters from hatchery-origin Chinook salmon, coho salmon, and chum salmon has been negligible to low because natural-origin coho salmon smolts tend to move offshore quickly and are usually too large to be eaten by hatchery-origin fish (Table 5).

Chum Salmon

Competitive interactions from Chinook salmon and coho salmon from the hatchery programs on natural-origin chum salmon are avoided because the hatchery-origin fish are released as subyearlings or yearlings and thus are much larger (more than two times larger) than natural-origin chum salmon that out-migrate as fry (Table 5). The risk of competition from hatchery-origin chum salmon fry on natural-origin chum salmon fry in fresh water is low because the hatchery-origin chum salmon fry are released low in the watershed, about 15 river miles from the estuary, so their spatial overlap with natural-origin chum salmon fry is small and the duration in fresh water is short because chum salmon fry tend to out-migrate rapidly (Fresh et al. 1980). Some competitive interactions could occur between hatchery-origin and natural-origin chum salmon juveniles in nearshore environments. However, the risk has been negligible because substantial mortality of hatchery-origin chum salmon following release is likely (Fresh et. al. 1980) and further reduces the relatively small number of fish recently produced by the chum salmon hatchery program (average 321,584 fry). Furthermore, hatchery-origin chum salmon are somewhat larger fed fry and tend to move into offshore waters quickly compared to smaller natural-origin chum salmon fry (Table 5) that may forage for a time in shallow, nearshore waters (Simenstad et al. 1980).

Some natural-origin chum salmon fry are likely to be eaten by hatchery-origin Chinook salmon and coho salmon in fresh, estuarine, and nearshore waters. However, the risk to natural-origin chum salmon has been negligible because of the generally large numbers of natural-origin chum salmon and pink salmon (even-numbered years) fry (on the order of millions to tens of millions from the Stillaguamish River Basin[12]) that can overwhelm predators, and the relatively low numbers of hatchery-origin Chinook salmon subyearlings (average 219,311 summer-run and generally fewer than 50,000 fall-run fish) and coho salmon yearlings (average 39,482 fish) that have been released from the Stillaguamish River Basin hatchery programs.

Pink Salmon

Similar to chum salmon, competitive interactions from the Chinook salmon and coho salmon hatchery programs on natural-origin pink salmon that return in odd-numbered years are avoided because the hatchery-origin fish are released as subyearlings or yearlings and thus are much larger (more than two times larger) (Table 5) than pink salmon, which out-migrate as fry during the spring of even-numbered years. The risk of competition between hatchery-origin chum salmon fry and natural-origin pink salmon fry in fresh water has been negligible because the hatchery-origin chum salmon fry have been released low in the watershed, so the spatial and temporal overlap with natural-origin pink salmon fry has been small. In addition, the number of hatchery-origin chum salmon recently produced by the hatchery program (average 321,584 fry) has been very small relative to the number of natural-origin pink salmon fry expected to be produced from adult returns during recent even-numbered years (260,181 adults). Similar to chum salmon, some competitive interactions could occur between hatchery-origin chum salmon fry and natural-origin pink salmon fry in estuarine and nearshore waters, but the risk has been negligible for similar reasons as described for chum salmon (i.e., relative magnitude of hatchery releases compared to natural production).

Similar to natural-origin chum salmon, some natural-origin pink salmon fry are likely eaten by hatchery-origin Chinook salmon and coho salmon in fresh, estuarine, and nearshore waters during even-numbered years. However, the risk to natural-origin pink salmon has been negligible because the numbers of pink

[12] Assuming chum salmon and pink salmon have 3,000 and 1,000 eggs per female, respectively, average recent adult returns (11,974 and 260,181) would produce 148 million eggs, resulting in the production of 7.4 million to 14.8 million fry based on an egg-to-fry survival rate of 5 to 10 percent.

salmon fry are generally large, and the numbers of hatchery-origin Chinook salmon subyearlings and coho salmon yearlings released from Stillaguamish River Basin hatchery programs have been relatively low.

3.4.2.3 Facility Operations

Operating hatchery facilities can affect instream fish habitat, such as EFH and critical habitat for ESA-listed salmon and steelhead, in the following ways (NMFS 2014): (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 and their effects on natural-origin salmon and steelhead as part of the Stillaguamish River Basin salmon hatchery programs.

As described in Subsection 3.2, Water Quantity, the Harvey Creek Hatchery, Brenner Creek Hatchery, and Whitehorse Hatchery include water intakes and outfalls that remove surface water from streams or springs for short reaches. The Harvey Creek Hatchery and Whitehorse Hatchery also use well water. The Brenner Creek Hatchery uses spring water from a source with no fish access (Stillaguamish Tribe of Indians 2018b); consequently, screening is not needed and fish habitat is not affected by the water withdrawals. For the Whitehorse Hatchery and Harvey Creek Hatchery, the lengths of bypass reaches (distances between the water intakes and outfalls) are about 650 feet or less. The Harvey Creek Hatchery complies with current NMFS fish screening guidelines (NMFS 2011), and the Whitehorse Hatchery surface water intake complies with older guidelines in place at the time of construction (NMFS 1995). Because of the use of well water, outflows to surface waters may be higher than the amounts of surface water withdrawn, but this has occurred primarily during seasons when surface water flows are generally above the annual average flow (fall, winter, and spring).

The Harvey Creek Hatchery and Fortson Ponds both have structures used for collecting broodstock, but they do not include the use of weirs, so all potential associated effects are avoided. The Harvey Creek Hatchery has a short ladder and trap at the outlet to the broodstock holding pond that is used to collect chum salmon and hatchery-origin coho salmon (if needed to make up for natural-origin broodstock collection shortfalls from Fortson Creek), and a trap at the upstream end of a fish ladder to Fortson Ponds is used to collect coho salmon. None of the broodstock facilities has restricted migration to natural spawning grounds, and straying by non-target species into the broodstock collection ponds has been rare (K. Konoski, pers. comm., Stillaguamish Tribe of Indians, Fish Biologist, May 9, 2018).

Several routine maintenance activities have occurred periodically in or near water that could impact fish at the hatchery facilities, including sediment/gravel removal from intake and/or outfall structures, pond cleaning, pump maintenance, debris removal from water intake and outfall structures, and maintenance and stabilization of existing bank protection associated with the facilities. All these maintenance activities have used BMPs to avoid or minimize negative effects on salmon and steelhead.

3.4.2.4 Masking

Masking occurs when unmarked hatchery-origin fish mix with and are included in population estimates of natural-origin fish, resulting in an overestimation of the abundance of natural-origin fish (Myers et al. 1998). Such masking hampers understanding of the composition of hatchery-origin and natural-origin fish in spawning areas, straying by hatchery-origin fish, performance of hatchery programs, and contributions of hatchery-origin and natural-origin fish to fisheries. All Chinook salmon subyearlings and coho salmon yearlings released by the Stillaguamish River Basin hatchery programs are marked with a clipped adipose fin; consequently, masking does not occur for these species. Because of their small size at release (fry), none of the chum salmon released from the Harvey Creek Hatchery are marked. However, the potential for masking by hatchery-origin chum salmon is negligible because of the relatively low numbers of hatchery-origin chum salmon that potentially return to the system compared to the larger number of natural-origin fish, as described in Subsection 3.4.2.1, Genetics. Natural-origin pink salmon are not affected by masking in the Stillaguamish River Basin because there are no hatchery programs for pink salmon in the analysis area.

3.4.2.5 Incidental Fishing

Fisheries (i.e., commercial, recreational, and tribal ceremonial and subsistence) targeting hatchery-origin fish may have incidental impacts on natural-origin fish. However, harvest management for fish returning to the Stillaguamish River Basin is based on natural production levels and there are no fisheries that specifically target the hatchery-origin adults returning from the conservation hatchery programs in the analysis area. Consequently, there is no incidental harvest of natural-origin salmon or steelhead resulting from fisheries targeting the harvest of fish produced by the Stillaguamish River Basin salmon hatchery programs. Ceremonial and subsistence fisheries targeting salmon returning to the Stillaguamish River Basin have occurred, but they have been limited in recent years and not directed specifically at hatchery-origin fish.

3.4.2.6 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 fish may be at increased risk of carrying pathogens because they are reared at relatively high densities in hatchery facilities, which can increase stress and their vulnerability to diseases. In turn, hatchery-origin salmon 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 salmon hatchery programs in the Stillaguamish River Basin.

Substantial losses due to disease outbreaks have occurred for the chum salmon and coho salmon hatchery programs at the Harvey Creek Hatchery, including bacterial kidney disease, coldwater disease (bacterial), and *Saprolegnia* sp. (fungus) and *Icthyobodo* sp. (also known as *Costia*, a parasite). All the hatchery programs in the Stillaguamish River Basin are operated in compliance with applicable fish health guidelines and, by policy, only healthy fish are released (Integrated Hatchery Operations Team 1995; NWIFC and WDFW 2006; Pacific Northwest Fish Health Protection Committee 2007). Monitoring for fish diseases by a NWIFC fish pathologist occurs once per month, and appropriate prophylaxis or remedy treatment measures are implemented when necessary, which promotes release of hatchery-origin fish in a healthy condition. If treatments do not remedy disease outbreaks, hatchery protocols require that affected fish be euthanized and disposed in a manner that avoids disease transfers.

3.4.2.7 Population Viability Benefits

NMFS assesses four viable salmonid population parameters (abundance, diversity, spatial structure, and productivity) to evaluate the recovery status of listed species and their component populations (McElhany et al. 2000). Hatchery programs may have both beneficial and negative effects on these parameters. All the salmon hatchery programs in the Stillaguamish River Basin are integrated programs that have conservation objectives and are intended to provide population viability benefits. The following subsections provide a qualitative assessment of benefits to the four viable salmonid population parameters for Chinook salmon, coho salmon, and chum salmon from their respective hatchery programs. Additional information on the viability of listed Puget Sound Chinook salmon is available in the most recent 5-year review of their status (NWFSC 2015). Coho salmon and chum salmon are not listed in Puget Sound; thus, information on those species is not included in status reviews.

Chinook Salmon

The integrated summer-run and fall-run Chinook salmon hatchery programs in the Stillaguamish River Basin have annual maximum production levels of 220,000 and 200,000 subyearlings, respectively. On average, the summer-run program has almost met its production level (219,311 subyearlings) while the fall-run program has released up to 115,020 fish and continues to build the program toward its maximum production level. Both programs supplement critically low natural-origin adult escapements to reduce the threat of extinction and facilitate monitoring of fisheries and population demographics. Total return abundances (escapements of natural spawners plus hatchery broodstock) for the NF Stillaguamish River (predominately summer-run) and SF Stillaguamish River (predominately fall-run) hatchery-origin and natural-origin Chinook salmon populations have averaged 1,147 fish and 111 fish, respectively, from 1999 to 2017 (NMFS 2019). Critical and rebuilding escapement thresholds for the NF Stillaguamish River population are 300 and 550 fish, respectively, and 200 and 300 fish for the SF Stillaguamish River population (NMFS 2019). The average combined escapement of summer-run and fall-run Chinook salmon from 2005 to 2015 was 1,435 fish (Puget Sound Indian Tribes and WDFW 2017).

Viable populations have an average productivity value of at least 1.0, meaning at least one adult returns for every natural spawner (Ruckleshaus et al. 2002). Overall productivity between 1990 and 2016 for natural-origin Chinook salmon in the Stillaguamish River Basin was 1.0 for the NF Stillaguamish River population and 0.97 for the SF Stillaguamish River population (NMFS 2019). Contributions from the hatchery programs increase the productivity values for the integrated hatchery-origin and natural-origin populations. Without contributions of spawners from the hatchery-origin Chinook salmon, under existing conditions, the trend in the NF Stillaguamish River population would be stable (productivity of 1.0) but at a low abundance, while the SF Stillaguamish River population would likely continue to decline (productivity below 0.97). Poor egg-to-migrant survival (5 percent or less) has been identified as a major contributor to the low productivity of natural-origin Chinook salmon in the Stillaguamish River Basin, particularly during years with relatively high peak-flow events (Puget Sound Indian Tribes and WDFW 2017).

All salmon hatchery programs have high egg-to-release survival objectives. For example, the summer-run Chinook salmon hatchery program has an egg-to-subyearling release survival objective of 70 percent and averaged 73 percent survival from 2002 to 2013 (Stillaguamish Tribe of Indians 2018a). Consequently, integrated hatchery programs, in general, have helped to improve viability through high survival rates during early life stages and particularly during life stages of concern in the Stillaguamish River Basin for natural-origin Chinook salmon. Based on a declining trend in the proportion of natural-origin Chinook salmon on spawning grounds, spatial structure and diversity are declining for the two Stillaguamish River Chinook salmon populations (NWFSC 2015), suggesting that improvements in factors other than hatchery contributions, such as habitat, are needed to reverse the trend in these viability parameters.

Coho Salmon

The integrated fall-run coho hatchery program in the Stillaguamish River Basin has two primary objectives: (1) develop technical information on harvest rates, locations, migration timing, and productivity of north Puget Sound coho salmon natural stocks and (2) sustain the naturally spawning Stillaguamish River population. The escapement threshold used by PFMC (2016) for applying management actions is 6,100 fish returning to the Stillaguamish River Basin, and the coho salmon hatchery program is intended to aid in maintaining the population above that threshold. Based on PFMC (2019) and WDFW (2018b), the geometric mean number of naturally spawning coho salmon was 13,807 fish per year from 2013 to 2017, compared to 25,031 fish per year during the preceding 5-year period. However, hatchery program contributions to coho salmon escapement have been minimal, ranging from 0 to 180 fish (average 38 fish) per year between 2013 and 2017 (PFMC 2019). The fall-run coho salmon hatchery program uses natural-origin broodstock consistent with the diversity present in the river basin but contributes little to the direct abundance or productivity of Stillaguamish coho salmon and does not affect their spatial structure. Consequently, the primary benefit of the program is to aid in managing fishery exploitation rates.

Chum Salmon

The integrated chum salmon hatchery program in the Stillaguamish River Basin has released an average of 321,584 fry annually with the objective of increasing the abundance of the naturally spawning chum salmon population, which has had adult returns below escapement goals during 7 of 12 years between 2003 and 2014 (Stillaguamish Tribe of Indians 2018c). Returns of chum salmon vary widely in odd- versus even-numbered years because of interspecific interactions with pink salmon, which return to spawn in odd-numbered years. The geometric mean number of spawning Stillaguamish chum salmon from 2005 to 2014 was 20,112 adults per year during even-numbered years and 9,265 adults per year during odd-numbered years (Stillaguamish Tribe of Indians 2018c). Both averages are below the escapement goals of 33,100 fish during even-numbered years and 13,100 fish during odd-numbered years (WDFW 2018b).

Because chum salmon from the program are not marked, there are no empirical data for estimating the contribution of the hatchery program to naturally spawning chum salmon in the Stillaguamish River Basin. Furthermore, it is unknown the extent to which hatchery-origin fish contribute to the spatial structure or productivity of chum salmon in the river basin. However, assuming a release of 321,584 fry, a typical survival rate of 0.7 percent for natural-origin populations (Bradford 1995), and a 3.2-percent fishery exploitation rate (2010 to 2014 average) (Stillaguamish Tribe of Indians 2018c), returns from the hatchery program are estimated as 2,179 fish after harvest, suggesting there is a small contribution to escapement that likely varies considerably from year to year. Chum salmon escapement estimates for the combined Snohomish and Stillaguamish River Basins from 2005 to 2009 (WDFW 2011) support this conclusion, with hatchery contributions representing about 2 to 22 percent of escapement (average 12 percent). In conclusion, the integrated chum salmon hatchery program includes natural-origin broodstock consistent with the diversity present in the river basin and contributes to the overall abundance of naturally spawning chum salmon.

3.4.2.8 Nutrient Cycling

Adult salmon that return from the ocean and spawn contribute marine-derived nutrients that can benefit the freshwater environment (Cederholm et al. 2000), including EFH and critical habitat for ESA-listed salmon and steelhead. This benefit can also be obtained from hatchery-origin salmon, although Compton et al. (2006) cautions that undesirable effects, such as reduced water quality and the spread of toxins and pathogens, should be considered when salmon carcasses are distributed artificially as part of nutrient enhancement projects. Hatchery-origin and natural-origin fish both contribute to the supply of marine-derived nutrients. Generally, hatchery-origin fish can provide nutrients to the river basin by naturally spawning and dying or, if adults return to the hatchery, by being surplus to broodstock needs and distributed as carcasses into stream channels or riparian zones by people. Generally, collection efforts end once sufficient female summer-run Chinook salmon are collected to meet broodstock objectives. Similarly, collection traps are closed once chum salmon and coho salmon broodstock objectives are met, so few surplus fish are retained. Any surplus is distributed to tribal elders or the local wildlife rehabilitation center, or disposed of at a landfill, depending on their condition and whether antibiotics had been applied (Stillaguamish Tribe of Indians 2018c,d). Based on recent return levels or typical smolt-to-adult survival and fishery exploitation rates described above, the Stillaguamish River Basin salmon hatchery programs typically contribute fewer than 3,000 salmon carcasses to the system annually through natural spawning, which is minor relative to natural-origin salmon contributions or other sources of nutrients to the river basin.

3.5 Other Fish Species

This subsection describes existing conditions for fish species other than salmon and steelhead that may be affected by the alternatives, specifically, how changes in salmon release numbers could affect other fish species. The analysis focuses on natural-origin fish species that are self-sustaining in the natural environment and depend on aquatic habitat for migration, spawning, rearing, and food. The analysis area for other fish species includes the geographic area where the Proposed Action would occur

(Subsection 1.3, Project and Analysis Areas) and marine areas between the outlet of Stillaguamish River and Whidbey Island (Port Susan and Possession Sound).

Additional information on other fish species in the analysis area and effects associated with Puget Sound salmon hatchery programs can be found in Subsection 3.2, Fish, in the Puget Sound Hatcheries DEIS (NMFS 2014). Many fish species in the Stillaguamish River Basin, other than salmon and steelhead, have a relationship with hatchery-origin salmon as prey, predators, or competitors (Table 7).

Table 7. Status of other fish species and their interaction with salmon that may be affected by salmon hatchery programs in the Stillaguamish River Basin.

Species	Federal/State Listing Status	Type of Interaction with Salmon[1]
Bull trout[2]	Federally listed as threatened (64 Fed. Reg. 58910, November 1, 1999)	• Predator of salmon eggs and juveniles • May compete with salmon for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Eulachon	Federally listed as threatened (75 Fed. Reg. 13012, March 18, 2010); Washington State candidate species	• May compete with salmon for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish • Potential prey item for adult salmon
Rainbow trout[2]	Not listed	• 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
Coastal cutthroat trout[2]	Not listed	• 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
Pacific, river, and western brook lamprey[2]	Not listed. Pacific lamprey, western brook lamprey, and river lamprey are federal species of concern, river lamprey is a Washington State candidate species.	• Potential prey item for adult salmon • May compete with salmon for food and space • May be a parasite on salmon while in marine waters • May benefit from additional marine-derived nutrients provided by hatchery-origin fish

Table 7. Status of other fish species and their interaction with salmon that may be affected by salmon hatchery programs in the Stillaguamish River Basin (continued).

Species	Federal/State Listing Status	Type of Interaction with Salmon[1]
White sturgeon	Not federally listed	• May compete with salmon for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Rockfish	One species is federally listed as endangered, one species is federally listed as threatened (75 Fed. Reg. 22276, April 28, 2010, and 82 Fed. Reg. 7711, January 23, 2017), and 13 species are Washington State candidate species[3]	• Predators of juvenile salmon • Juveniles are prey for juvenile and adult salmon • May compete with salmon for food
Forage fish	Pacific herring is a Washington State candidate species	• Prey items for juvenile and adult salmon • May compete with salmon for food

Sources: Krohn 1968; Horner 1978; Beamish 1980; Finger 1982; Maret et al. 1997; USFWS 2018; WDFW 2019

[1] Data on interactions specifically between other fish species and hatchery-origin salmon are limited. Therefore, this table identifies interactions between other fish species and salmon in general. In addition, the interactions of other fish species with hatchery-origin salmon are assumed to be similar to interactions between other fish species and natural-origin salmon.

[2] Fish species identified as present in the Stillaguamish River Basin (U.S. Army Corps of Engineers 2000).

[3] Georgia Basin bocaccio DPS (*Sebastes paucispinis*) — Federally listed as endangered and Washington State candidate species; Georgia Basin yelloweye rockfish DPS (*S. ruberrimus*) — Federally listed as threatened and Washington State candidate species; other Washington State candidate species are Georgia Basin canary, black, brown, China, copper, green-striped, quillback, red-stripe, tiger, widow, and yellowtail rockfish.

Pacific lamprey and western brook lamprey are Federal species of concern. In marine areas, one species of rockfish is listed as threatened under the ESA (Table 7). Pacific herring (a forage fish for salmon) is a Federal species of concern, as well as a state candidate species[13]. All these species, and other fish species (as shown in Table 7) have relationships with salmon and have ranges that include the analysis area. However, none of these species is located exclusively in the analysis area, and the analysis area is generally a very small part of their total range (NMFS 2014). Therefore, risks to these species, other than bull trout, from salmon hatchery programs in the Stillaguamish River Basin are not considered further.

In addition to Chinook salmon and steelhead, bull trout in the analysis area are also listed as a threatened species under the ESA. In the final recovery plan (U.S. Fish and Wildlife Service [USFWS] 2015a), bull trout in the Stillaguamish River Basin are part of the Coastal Recovery Unit, which is located in western Washington and Oregon and is composed of core areas. The Stillaguamish River is a bull trout core area

[13] State candidate species are those that will be reviewed by WDFW for possible listing as a State Endangered, Threatened, or Sensitive according to criteria in Washington Administrative Code 232-12-297.

(USFWS 2015a), and portions of the Stillaguamish River Basin are critical habitat for bull trout (75 Fed. Reg. 63898, October 18, 2010).

The Stillaguamish River supports bull trout populations at low abundances compared to other core areas, although the species is recorded as occurring throughout the river basin, except above natural migratory barriers. Both anadromous and fluvial life-history forms occur in the river basin, and their total population has been estimated at fewer than 1,000 fish (USFWS 2004). Primary threats to bull trout in the Stillaguamish River Basin include fish passage at the Cook Slough weir and the Granite Falls fishway, the potential for landslides, and habitat degradation on lands managed for commercial forestry (USFWS 2015b).

Studies in the Skagit River found that 50 percent of the adult bull trout sampled consumed salmon carcasses and eggs, with smaller percentages having consumed juvenile salmon, resident fish, and aquatic insects (Lowery and Beauchamp 2015). The authors suggested that large releases of hatchery-origin salmon may attract bull trout that likely would consume both hatchery-origin and natural-origin fish; however, the portion of hatchery-origin salmon consumed is unknown. Furthermore, USFWS (2019) summarized the direct and indirect value of salmon as bull trout prey, including eggs and juveniles produced by returning adult salmon, as well as spawners and carcasses that stimulate ecosystem productivity and support the nourishment and productivity of other bull trout prey species. USFWS (2019) states that the decline of salmon may limit the long-term abundance and productivity of bull trout prey and the bull trout's overall population. Consequently, bull trout have a relatively strong relationship to salmon compared to other fish species in Table 7.

Under existing conditions, bull trout may be affected by Stillaguamish River Basin salmon hatchery programs primarily through predation of hatchery-origin salmon and facility operations (juvenile and adult broodstock collection). Bull trout benefit by foraging on hatchery-origin juvenile salmon in addition to the diversity of other prey they consume. If encountered during broodstock collection, hatchery operational protocols require bull trout be returned to the affected stream as quickly as possible. Bull trout encounters during broodstock collection have typically involved six to seven juveniles as part of the fall-run Chinook salmon hatchery program and five to six adults as part of the summer-run Chinook salmon hatchery program annually, which are released alive as soon as possible.

3.6 Wildlife

This subsection describes existing conditions for wildlife. The analysis area for wildlife resources includes the geographic area where the Proposed Action would occur (Subsection 1.3, Project and Analysis Areas), plus marine areas in Puget Sound. The analysis area supports a variety of birds, large and small mammals, amphibians, marine mammals, and freshwater and marine invertebrates that may eat or be eaten by salmon, as described in the Puget Sound Hatcheries DEIS (NMFS 2014). Listed species that occur in the analysis area are shown in Table 8. Because only one of these listed species has a relationship with salmon, the discussion of listed species is narrowed to the Southern Resident killer whale (*Orcinus orca*), which may be affected by the alternatives, specifically, how changes in salmon release numbers and hatchery program type may affect this species.

Table 8. Federal and Washington State threatened and endangered species in Puget Sound that may be affected by salmon hatchery programs in the Stillaguamish River Basin.

Species	Current Federal Endangered Species Act Listing Status	Washington State Listing	Presence of Critical Habitat in Stillaguamish River Basin?	Relationship with Salmon
Oregon spotted frog (*Rana pretiosa*)	Threatened (79 Fed. Reg. 51658, 51710, August 29, 2014)	Endangered	Yes	None
Canada lynx (*Lynx canadensis*)	Threatened (65 Fed. Reg. 16052, March 24, 2000)	Endangered	Yes	None
Grizzly bear (*Ursus arctos horribilis*)	Threatened (40 Fed. Reg. 31734, July 28, 1975)	Endangered	No	None
North American wolverine (*Gulo luscus*)	Proposed Threatened (81 Fed. Reg. 71670, October 18, 2016)	Species of Concern	No	None
Marbled murrelet (*Brachyramphus marmoratus*)	Threatened (57 Fed. Reg. 45328, October 1, 1992)	Endangered	Yes	None
Northern spotted owl (*Strix occidentalis*)	Threatened (55 Fed. Reg. 26114, June 26, 1990)	Endangered	Yes	None
Streaked horned lark (*Eremophila alpestris*)	Threatened (78 Fed. Reg. 61452-61503, October 3, 2013)	Endangered	No	None
Yellow-billed cuckoo (*Coccyzus americanus*)	Threatened (79 Fed. Reg. 59992, October 3, 2014)	Endangered	No	None

Table 8. Federal and Washington State threatened and endangered species in Puget Sound that may be affected by salmon hatchery programs in the Stillaguamish River Basin (continued).

Species	Current Federal Endangered Species Act Listing Status	Washington State Listing	Presence of Critical Habitat in Stillaguamish River Basin?	Relationship with Salmon
Gray wolf (*Canis lupus*)	Endangered (43 Fed. Reg. 9607, March 9, 1978)	Endangered	No	None
Southern Resident killer whale DPS (*Orcinus orca*)	Endangered (70 Fed. Reg. 69903, November 18, 2005)	Endangered	Yes	Predator of adult salmon and steelhead, with preferred species being Chinook salmon followed by chum salmon

Sources: USFWS 2018; WDFW 2019

Hatchery operations have the potential to affect non-listed wildlife by changing the total abundance of salmon prey or predators in aquatic and marine environments (NMFS 2014). Many wildlife species consume salmon, which may benefit their survival and productivity. Increases or decreases in the abundance of juvenile and adult salmon associated with hatchery operations in the Stillaguamish River Basin may, therefore, affect the viability of wildlife species that prey on them. In general, hatcheries could affect wildlife through transfer of toxic contaminants from hatchery-origin fish to wildlife or through predator control programs (which may harass or kill wildlife preying on juvenile or adult broodstock salmon at hatchery facilities). As described in NMFS (2014), the effects of salmon hatchery programs on wildlife species have generally been negligible, and wildlife species in the analysis area have continued to occupy their existing habitats in similar abundances and feed on a variety of prey, including salmon. Therefore, risks to wildlife from salmon hatchery programs in the Stillaguamish River Basin (other than Southern Resident killer whale) are not considered further.

The Southern Resident killer whale is listed under the ESA as endangered (70 Fed. Reg. 69903, November 18, 2005) and is present in marine areas within the analysis area, which are also part of its critical habitat (Table 8). As of September 2018, the population had 74 individuals (NOAA Fisheries 2018a,b), and the projected trend in population growth over the next 50 years is downward (NMFS 2016b). During the spring, summer, and fall, the whales spend a substantial amount of time in the inland waterways of the Strait of Georgia, Strait of Juan de Fuca, and Puget Sound (Bigg 1982; Ford et al. 2000; Krahn et al. 2002; Hauser et al. 2007; Hanson and Emmons 2010). The species is known to expand its movement into Puget Sound, particularly during the fall months, and is occasionally observed near Port Susan and Possession Sound (NMFS 2008), which are closest to the mouth of the Stillaguamish River.

As described in Subsection 3.5.3.1.1, Killer Whale, in the Puget Sound Hatcheries DEIS (NMFS 2014) and references therein, Southern Resident killer whales' primary prey in inland marine waters during the summer months is adult Chinook salmon (also see Ford et al. 2016; Chasco et al. 2017a,b), even when other salmon species are more abundant. Based on preliminary results from genetic analysis of a limited number of samples collected during killer whale feeding events, Chinook salmon are also important to Southern Resident killer whales in Puget Sound during the winter (Michael Ford, Northwest Fisheries Science Center, email sent to Tim Tynan, NMFS, January 30, 2017, regarding killer whale diets). Adult coho salmon are important in the whales' diet in inland waters in late summer (Ford et al. 2016), whereas chum salmon are also important in the fall. Of all the Pacific salmon species, Chinook salmon are the most calorie rich (O'Neill et al. 2014). Switching by the whales to less calorie-rich salmon species as prey may be due to reduced availability of Chinook salmon at that time and area.

Adult hatchery-origin Chinook salmon represent 74 percent of the total number of Chinook salmon (hatchery-origin and natural-origin) returning to Puget Sound (NMFS 2014). There is no evidence that Southern Resident killer whales distinguish between hatchery-origin and natural-origin salmon. Therefore, it is highly likely that the hatchery-origin adult salmon (especially Chinook salmon) contribute to the diet of the whales in Puget Sound. Adults from hatchery releases have partially compensated for declines in natural-origin salmon and may have benefited Southern Resident killer whales (Chasco et al. 2017a). Other salmon and steelhead are also prey items during specific times of the year but at much less frequency than would be expected based on their relative abundances (NMFS 2014).

Adult Chinook salmon returning from hatchery programs in the Stillaguamish River Basin are high-priority components of the Southern Resident killer whale prey base (NOAA Fisheries and WDFW 2018). Although the numbers of hatchery-origin fish released from this river basin are relatively low (production levels of up to 780,000 total hatchery-origin salmon, including up to 420,000 Chinook salmon) compared to the total number of hatchery releases throughout Puget Sound (167.8 million salmon and steelhead released, including 49.0 million Chinook salmon) (Appendix B, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities), Chinook salmon (especially fall-run Chinook salmon) from northern Puget Sound, which includes the Stillaguamish River, have been observed in the whales' diet, are consumed by the whales at their time of greatest need, and have a high degree of overlap in space and time with the whales (NOAA Fisheries and WDFW 2018). Hatchery-origin salmon releases from the Stillaguamish River Basin represent about 0.5 percent of total hatchery production and less than 1 percent of Chinook salmon hatchery production from Puget Sound. Hatchery-origin adult returns to Puget Sound for Chinook salmon in the combined Stillaguamish and Snohomish River Basins fluctuated from 5,842 to 21,167 fish (average 10,737 fish) between 2011 and 2017 (PFMC 2019). Based on escapement data from WDFW (2018b), the Stillaguamish River Basin accounted for an average of about 10 percent of the adult Chinook salmon returns to Stillaguamish and Snohomish Basins, or an average of about 824 fish each year.

Available information indicates that salmon hatchery operations contribute minimally to introducing contaminants into the environment (NMFS 2014). Nevertheless, hatchery-origin and natural-origin salmon that reside in Puget Sound absorb water and consume prey contaminated with PCBs, PBDEs, DDT, PAHs[14], and other trace elements. These contaminants are typically from stormwater and wastewater discharges, nonpoint runoff, and air deposition. When Southern Resident killer whales prey on salmon and steelhead, the contaminants within the fish biomagnify within Southern Resident killer whales and can cause reproductive impairment, immunotoxicity, endocrine disruption, neurotoxicity, and cancer (Mongillo et al. 2016; Southern Resident Killer Whale Task Force 2018). In addition, mothers with offspring can pass the contaminants to their young during gestation and via milk during lactation (Mongillo et al. 2016). The heavy contaminant loads observed in Chinook salmon within Puget Sound waters (O'Neill et al. 2005; Cullon et al. 2009) likely contribute to the contaminant loads in Southern Resident killer whales. Because both hatchery-origin and natural-origin fish reside within Puget Sound for similar periods and eat the same prey, they are likely to have similar contaminant loads.

The estimated total annual abundance of adult Chinook salmon from northern California to central British Columbia Pacific Ocean coastal waters and the Salish Sea averages approximately 4 million fish (Jonathan Carey, NMFS, email sent to Alan Olson, Fish Biologist, NMFS Affiliate, December 13, 2018, regarding total abundance of adult Chinook salmon). Thus, even if none of the adult hatchery-origin Chinook salmon is used for other management purposes, the overall number of adult Chinook salmon produced by hatchery programs in the Stillaguamish River Basin available as prey for Southern Resident killer whales is very small (less than 0.1 percent) relative to the total abundance of Chinook salmon present in Puget Sound and British Columbia Pacific coastal marine areas. However, the number of Chinook salmon produced from the hatchery programs that overlap with the whales in time and space is meaningful during specific times and in localized areas (NOAA Fisheries and WDFW 2018). Southern

[14] Polychlorinated biphenyls, polybrominated diphenyl ethers, dichlorodiphenyltrichloroethane, polycyclic aromatic hydrocarbons

Resident killer whales have been observed near marine areas on either side of the Stillaguamish River Basin mouth, where Chinook salmon would gather prior to migrating up the Stillaguamish River to spawn. Therefore, although fish from hatchery programs in the Stillaguamish 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 hatchery programs constitute a small but meaningful contribution to the diet of Southern Resident killer whales.

In summary, considering all adult natural-origin and hatchery-origin salmon and steelhead in Puget Sound that are part of the food base for Southern Resident killer whales, the Stillaguamish River Basin salmon hatchery programs under existing conditions has provided a small, but positive, contribution to Southern Resident killer whales' well-being because the adult Chinook salmon from the hatchery programs represent a small but meaningful part of the Southern Resident killer whale food base during a critical period for the whales.

3.7 Cultural Resources

Impacts on cultural resources typically occur when an action disrupts or destroys cultural artifacts, disrupts cultural use of natural resources, or disrupts cultural practices. Hatchery programs have the potential to affect cultural resources if there is construction or expansion at hatchery facilities that disrupts or destroys cultural artifacts or if the hatchery programs affect the ability of Native American tribes to use salmon and steelhead in their cultural practices. The analysis area for cultural resources is the same as the project area (Subsection 1.3, Project and Analysis Areas), which is the Stillaguamish River Basin and its associated marine areas, including Port Susan and Possession Sound.

The Stillaguamish Tribe of Indians is composed of descendants of the Stoluck-wa-mish River Tribe, which originally resided on the Stillaguamish River and its tributaries (Stillaguamish Tribe of Indians 2016). The Stoluck-wa-mish River Tribe was a party to the Treaty of Point Elliott signed in 1855 that granted use of their usual and accustomed fishing area, which was defined as the Stillaguamish River Basin. No separate reservation was established for the Stoluck-wa-mish River Tribe, and some tribal members moved to the Tulalip Reservation, whereas others remained within the Stillaguamish River Basin. Currently, the tribe has 300 members. Bureau of Indian Affairs enrollment of Stillaguamish tribal members determines eligibility for the harvest of fish, shellfish, and wildlife for commercial and ceremonial purposes within its usual and accustomed fishing area.

The Tulalip Tribes are also federally-recognized and have a reservation adjacent to the marine waters of Port Susan and Possession Sound (which includes Port Gardner) and south of the Stillaguamish 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 2018a). 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 2018b). Since the Treaty of Point Elliott, the Swinomish, Upper Skagit, Sauk-Suiattle, and Stillaguamish Tribes have established federally recognized reservations separate from the Tulalip Reservation.

Salmon represent an important cultural resource to the Stillaguamish Tribe of Indians and 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 (Stillaguamish Tribe of Indians 2016; Tulalip Tribes 2018c). The tribes establish and enforce laws and regulations for conducting or curtailing commercial, subsistence, and/or ceremonial harvest by tribal members (Stillaguamish Tribe of Indians 2018e; Tulalip Tribes 2018d).

The Stillaguamish Tribe of Indians and Tulalip Tribes, like other Puget Sound treaty tribes, regularly consume salmon, which is served at gatherings of elders and to guests at feasts and traditional dinners. Salmon is a core symbol of tribal identity, individual identity, and the ability of Native American cultures to endure (NMFS 2004). The survival and well-being of salmon are inextricably linked to the survival and well-being of Native American people and tribal culture. Salmon is an important component of the annual Festival of the River and Pow Wow planned and organized by the Stillaguamish Tribe of Indians and the Return of the Salmon Celebration organized in part by the Tulalip Tribes.

Tribal ceremonial and subsistence uses pertain to fish that are caught non-commercially by members of Puget Sound treaty tribes, including the Stillaguamish Tribe of Indians and 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 (Meyer Resources Inc. 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 salmon for ceremonial and subsistence purposes generally occurs within a tribe's usual and accustomed fishing areas when forecasted returns of hatchery-origin and natural-origin fish are sufficient to provide for both a fishery and escapement for natural reproduction. The Stillaguamish Tribe of Indians' usual and accustomed fishing area primarily includes the freshwater portions of the Stillaguamish River and areas of Port Susan north of Kayak Point. The Tulalip Tribes' usual and accustomed fishing area includes the marine areas of Port Susan, Possession Sound, and Port Gardner where returning adult hatchery-origin and natural-origin fish from the Stillaguamish River Basin may be intercepted.

Members of the Stillaguamish Tribe of Indians and Tulalip Tribes prioritize their ceremonial and subsistence needs over commercial sales (Subsection 3.4.2.2, Ceremonial and Subsistence Uses, in NMFS 2014). Tribes may fish for ceremonial and subsistence uses when there are no concurrent commercial fisheries, and they may use some of their commercial harvest for ceremonial and subsistence purposes, but commercial fisheries targeting Chinook salmon from the Stillaguamish River Basin have not occurred recently. Many tribes feel their subsistence needs are not met by the available abundances of natural-origin and hatchery-origin fish (W. Beattie, pers. comm., NWIFC, Conservation Planning Coordinator, April 6, 2010). Adult fish returning from hatchery programs in the Stillaguamish River Basin are used for ceremonial and subsistence purposes, which provide substantial benefits because of the value of salmon to the cultural integrity of the tribe.

Due to a multitude of factors (e.g., habitat degradation from logging, agricultural practices, and other human disturbances), the abundance of salmon has declined in the Stillaguamish River Basin. In response, the Stillaguamish Tribe of Indians initiated the hatchery programs and own and operate two hatcheries (Harvey Creek Hatchery and Brenner Creek Hatchery) described in this EA. The Stillaguamish Tribe of Indians and Tulalip Tribes are also actively involved in natural resource protection within the Stillaguamish River Basin (Stillaguamish Tribe of Indians 2016; Tulalip Tribes 2018e), including supporting the Stillaguamish Watershed Chinook Salmon Recovery Plan (SIRC 2005). This support has included foregoing any directed Chinook salmon fishery in the Stillaguamish River since 1982. Overall, the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs have contributed to tribal ceremonial and subsistence harvest of salmon by the Stillaguamish Tribe of Indians and Tulalip Tribes.

3.8 Socioeconomics

The evaluation of Stillaguamish River Basin salmon hatchery program effects on socioeconomics focuses on the contribution of hatchery-origin fish to local and regional economies. This subsection describes the contribution of hatchery-origin Stillaguamish River Basin salmon to commercial (non-tribal and tribal) and recreational socioeconomic values and to the communities where the hatchery facilities operate. The analysis area for socioeconomics is the Stillaguamish River Basin and nearby marine areas where Stillaguamish River Basin salmon are harvested. Commercial reporting Marine Area 8A and recreational reporting Marine Area 8-2 include Port Susan, Possession Sound, and Port Gardner. In addition, marine harvest of Stillaguamish River Basin salmon outside these areas is reported when useful to help provide context for the fisheries in the analysis area.

In response to low and/or declining runs of Stillaguamish River Basin Chinook salmon and coho salmon, harvest opportunities have been constrained by management agencies (NMFS 2017b; Puget Sound Indian Tribes and WDFW 2017). Other than ceremonial and subsistence harvests described in Subsection 3.7, Cultural Resources, harvest of Stillaguamish River Basin Chinook salmon and coho salmon in recent years has been from incidental catch of Stillaguamish River Basin salmon in mixed-stock fisheries for other stocks as described below. While Puget Sound chum salmon are generally healthy, the abundance of chum salmon in the Stillaguamish River Basin has declined in recent years (Stillaguamish Tribe of Indians 2018c). Chum salmon harvest constraints may also be implemented by the co-managers depending on annual harvest management objectives. The trend of increasing constraints on commercial and recreational harvests of Stillaguamish River Basin salmon, including hatchery-origin fish, affects the potential socioeconomic benefits from the hatchery programs.

3.8.1 Hatchery Employment and Operations

In addition to providing fish for conservation and harvest, hatchery programs directly affect socioeconomic conditions within the communities where hatchery facilities operate. These facilities provide employment opportunities and procure goods and services for hatchery operations. The Harvey Creek Hatchery and Brenner Creek Hatchery are operated by the Stillaguamish Tribe of Indians and provide employment for four full-time staff with an annual operating budget of slightly under $800,000 (Stillaguamish Tribe of Indians 2018a). Hatchery operations expenditures provide substantial economic benefits to local economies, particularly small communities with commercial businesses close to the hatcheries, including Granite Falls and Arlington. Direct hatchery-related expenditures for labor and procurement of supplies also generate secondary economic activity, both locally and in more distant areas.

3.8.2 Fisheries

Salmon originating in the Stillaguamish River Basin (including hatchery-origin salmon) are harvested in coastal Alaska, British Columbia, Oregon, and Washington, as well as northern Puget Sound. Although commercial, tribal, and recreational harvests of salmon originating from the Stillaguamish River Basin are generally small, those harvests contribute to local economies through the purchase of goods and supplies associated with fishing (e.g., fishing gear) and by expenditures for local services such as outfitter and guide services. In addition, the purchase of travel-related goods and services for fishing may include food and drinks, fuel, and miscellaneous retail goods at local businesses. Angler expenditures on fishing-related goods and services likely contribute to both local and non-local businesses. Socioeconomic benefits from recreational fishing are more directly linked to the number of trips made, rather than the number of fish harvested. In contrast, benefits from commercial fishing are accrued from the number of fish harvested and their dockside value.

Commercial and recreational salmon and steelhead fisheries in marine and freshwater areas of Puget Sound are co-managed by the Puget Sound treaty tribes and WDFW under the Federal court proceeding *United States v. Washington*, which enforces and allocates harvest between the state and treaty tribes while addressing reserved treaty fishing rights for salmon and steelhead returning to Puget Sound. Each year the co-managers set seasons, locations, and gear restrictions for their respective tribal and non-tribal salmon fisheries within Puget Sound and associated terminal areas or river basins (e.g., WDFW and Puget Sound Treaty Tribes 2018). Commercial treaty and non-treaty fisheries targeting Stillaguamish River Basin Chinook salmon in Puget Sound have been closed since the 1980s (SIRC 2005; Stillaguamish Tribe of Indians 2018a). However, some level of directed tribal and non-tribal commercial and recreational fisheries for coho salmon and chum salmon from the Stillaguamish River Basin have occurred in Marine Areas 8A and 8-2 (primarily Port Susan, Possession Sound, and Port Gardner) (WDFW 2017; PFMC 2019). Mixed-stock commercial and recreational fisheries in Puget Sound that could harvest Stillaguamish River Basin hatchery-origin salmon as bycatch also occur in Admiralty Inlet.

Current economic values from commercial and recreational fishing in the analysis area are not available. However, data analysis conducted for the Puget Sound Hatcheries DEIS (NMFS 2014) is used here to provide a sense of the magnitude of the socioeconomic values of those fisheries. The analysis specific to North Puget Sound, which includes Marine Areas 8A and 8-2, had an average annual net economic value of $3.6 million (2007 dollars) from commercial harvest of Chinook salmon (average harvest of 26,305 fish), coho salmon (115,681 fish), and chum salmon (636,089 fish), and $25.5 million annually from recreational fishing for all salmon and steelhead from 2002 to 2006. For the commercial harvest, roughly 53 percent of the net economic value was produced by non-tribal fishermen and 47 percent by Puget Sound treaty tribe fishermen for Chinook salmon, coho salmon, and chum salmon. The portion of these net economic values contributed by the Stillaguamish River Basin salmon hatcheries under existing conditions has been uncertain but is likely to have been unsubstantial based on the discussions below.

Chinook Salmon. There have not been any commercial or recreational fisheries that target natural-origin Stillaguamish Chinook salmon since the early 1980s (SIRC 2005). Thus, all commercial and recreational harvest of Chinook salmon from the Stillaguamish River Basin has been incidental to other fisheries. In marine areas, fishing-related mortality for hatchery-origin Stillaguamish Chinook salmon was primarily within British Columbia (56 percent), followed by Washington and Oregon (38 percent) and Alaska

(7 percent) (Puget Sound Indian Tribes and WDFW 2017). From 2013 to 2017, commercial net fisheries in Puget Sound harvested a combined 861 to 11,561 hatchery-origin Chinook salmon (average 3,648 fish) per year from the Snohomish and Stillaguamish River Basins (PFMC 2019).

Within Puget Sound and the Strait of Juan de Fuca, most of the Stillaguamish Chinook salmon have been harvested in recreational fisheries, followed by commercial troll and net fisheries (Puget Sound Indian Tribes and WDFW 2017). Based on escapement data from the same period (WDFW 2018b), the Stillaguamish River Basin contributed about 10 percent of the combined returns of hatchery-origin adults to Marine Areas 8A and 8-2, which primarily includes fish from the Snohomish and Stillaguamish Rivers. Consequently, in recent years the Stillaguamish River Basin Chinook salmon hatchery programs likely contributed fewer than 400 fish per year to the commercial harvest in Puget Sound. For Marine Area 8-2, 949 Chinook salmon were harvested in recreational fisheries from 2015 to 2016 (Kraig and Scalici 2017), and based on the regulations for that period, the harvested Chinook salmon were hatchery-origin fish. Thus, the contribution from hatchery-origin Stillaguamish Chinook salmon to fisheries in Marine Areas 8A and 8-2 has been minor. Based on a net economic value of $17.60 per fish (2007 dollars from Appendix I in NMFS 2014), the average annual economic value from the commercial fishery has been less than $7,100. In contrast, recreational fishermen expend approximately $293 per fish captured, which would result in about $27,800 expended during the 2015–2016 season to harvest fewer than 100 hatchery-origin fish from the Stillaguamish River Basin.

Coho Salmon. Historically, harvest of coho salmon in the analysis area has been managed based on pre-season estimates of annual natural production levels. Harvest of coho salmon from 2011 to 2016 ranged from 21,561 to 77,202 fish (average 44,184 fish) for the Stillaguamish and Snohomish stocks combined (Puget Sound Indian Tribes and WDFW 2017). Preliminary estimates indicate that between 0 and 73 hatchery-origin Stillaguamish coho salmon were harvested annually by the Puget Sound commercial net fishery from 2013 to 2017 (PFMC 2019). Due to the decrease in coho salmon returns and highly variable recreational fishing regulations for this stock, the economic value from recreational fisheries on hatchery-origin Stillaguamish coho salmon has varied over the past 10 years and its contribution is difficult to quantify.

Chum Salmon. Hatchery-origin chum salmon from the Stillaguamish River Basin are not marked to distinguish them from natural-origin chum salmon or other hatchery-origin chum salmon; thus, their socioeconomic contribution to commercial and recreational fisheries is unknown. From 2011 to 2016, chum salmon were the most frequently harvested salmon in Puget Sound fisheries, averaging over 1 million fish, with contributions from the combined Stillaguamish and Snohomish River Basins averaging 10,322 fish per year (Puget Sound Indian Tribes and WDFW 2017). Hatchery-origin Stillaguamish chum salmon likely contributed to these commercial net fisheries at very small levels because of the limited number of hatchery-origin chum salmon released in the Stillaguamish River Basin (up to 300,000 fry and eggs). For comparison, the Tulalip Tribe's chum salmon hatchery program typically releases 8 million genetically marked fry into Tulalip Bay. Consequently, the potential harvest of returning hatchery-origin adults from the Stillaguamish River Basin is less than 4 percent. Additionally, chum salmon are not typically targeted by recreational fishermen. For example, 34 chum salmon were harvested in Marine Area 8-2 during 2015 and 4 chum salmon were harvested during 2014 (Kraig and Scalici 2016, 2017).

In summary, while hatchery employment provides an economic benefit under existing conditions, the contribution of the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs has provided minimal economic benefit in the analysis area, primarily due to the low level of recreational fishing and commercial harvest attributed to salmon from the Stillaguamish River Basin.

3.9 Human Health

As described in Subsection 3.7, Human Health, in the Puget Sound Hatcheries DEIS (NMFS 2014), operation of hatchery facilities under existing conditions may have affected human health from chemicals used at hatchery facilities, procedures used in handling of those chemicals, occurrence of potentially toxic contaminants in hatchery-origin fish, and potential diseases transmitted to people from handling hatchery-origin fish. Use of chemicals may include disinfectants, therapeutics, anesthetics, pesticides and herbicides, and feed additives (NMFS 2014).

Seafood consumption by humans is nutritionally beneficial in general; however, concerns may exist when fish contain toxic contaminants that pose health risks to people and these fish are a substantial component to a person's diet. The contaminants of primary concern are those that are persistent in the environment and are known to accumulate in the tissues of fish (e.g., methylmercury, dioxins, DDT, or PCBs) (NMFS 2014). Contaminants accumulated during hatchery rearing are expected to contribute very little to concentrations of contaminants in returning adult salmon. O'Neill et al. (2015) found most contaminant body burdens in salmon are acquired when salmon reside in offshore habitats and where pollutants are migrating outward from river systems. The Washington State Department of Health provides guidance on the quantity of fish, including salmon, that are safe to consume and regularly updates this guidance with new information to avoid this effect on human health.

Several pathogens (parasites, viruses, and bacteria) are potentially harmful to human health and can be transmitted to people if proper safety procedures are not followed (i.e., protective clothing, fish handling, and proper food preparation). Potential unsafe exposure to humans involved in hatchery operations would be from accidental skin contact and needle-stick injuries involving infected fish. Locally high concentrations of therapeutics may occur during control of disease outbreaks.

As described in Subsection 3.7, Human Health, and Appendix K, Chemicals Used in Hatchery Operations, in the Puget Sound Hatcheries DEIS (NMFS 2014), effects from operation of salmon hatchery programs in the Puget Sound area, including the Stillaguamish River Basin, on human health are not substantial under existing conditions, primarily because hatchery operations comply with worker safety programs, rules, and regulations; the use of therapeutics is minimal and in compliance with label requirements; and personal protective equipment is used that limits the spread of pathogens.

3.10 Environmental Justice

The environmental justice analysis complies with Presidential Executive Order 12898, Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 Fed. Reg. 7629, February 16, 1994), and Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d *et seq*.). While there are many economic, social, and cultural elements that influence the viability and location of such populations and their communities, the development, implementation, and enforcement of environmental laws, regulations, and policies can have impacts. Therefore, Federal agencies, including NMFS, must ensure fair treatment, equal protection, and meaningful involvement for minority populations and low-income populations as they develop and apply the laws under their jurisdiction.

Both Executive Order 12898 and Title VI address persons belonging to the following target populations, which are considered in this analysis:

- Minority – all people of the following origins: Black, Asian, American Indian and Alaskan Native, Native Hawaiian or Other Pacific Islander, and Hispanic[15]
- Low-income – persons whose household income is at or below the U.S. Department of Health and Human Services poverty guidelines.

The analysis area for environmental justice includes minority and low-income communities that may be affected directly, indirectly, or cumulatively by implementing the project alternatives. It is the same as for socioeconomics and includes the geographic area where the Proposed Action would occur

[15] Hispanic is an ethnic and cultural identity and is not the same as race.

(Subsection 1.3, Project and Analysis Areas). The environmental justice analysis evaluates communities and groups within the entire environmental justice analysis area, which includes communities and groups within the Stillaguamish River Basin and Snohomish County where the salmon hatchery programs analyzed in this EA raise and release fish. Harvest of salmon produced by these hatchery programs occur primarily in Puget Sound and adjacent Stillaguamish River Basin marine areas.

3.10.1 Environmental Justice Communities and Non-tribal Groups

In addition to the geographic scale of analysis, the environmental justice evaluation focuses on communities and user groups that may be disproportionately affected under the alternatives. Based on the socioeconomic analysis conducted for Puget Sound Hatcheries DEIS (NMFS 2014), the environmental justice group identified in the Stillaguamish River Basin was the commercial fishing port of Everett, while Snohomish County was identified as an environmental justice community. As a result, socio-demographic data were reviewed for Snohomish County and the City of Everett to represent minority and income status (Table 9).

Table 9. Identification of environmental justice communities based on population size, percent minority, per capita income, and percent below poverty level for the environmental justice analysis area and Washington State.

	Minority				Income		
Subregion and County	**Black (%)**	**Native American (%)**	**Asian (%)**	**Hispanic (%)**	**Per Capita Income ($)**	**Below Poverty Level (%)**	**Population Size**
Snohomish County	3.5	1.6	11.1	10.2	33,883	8.0	772,501
City of Everett	4.4	1.2	8.8	14.7	27,553	17.6	110,079
Washington State	**4.2**	**1.9**	**8.9**	**12.7**	**32,999**	**11.3**	**7,170,351**

Source: U.S. Bureau of Census 2017
Shaded cells represent values that meaningfully exceed (by 10 percent or greater) those of the reference population (Washington State), thus indicating environmental justice communities.

The analysis shown in Table 9 indicates that the minority Asian population in Snohomish County and the minority Hispanic population, per capita income, and poverty level for the City of Everett meaningfully exceed Washington State averages, and, therefore, are environmental justice communities. However, there are insufficient data and information on commercial salmon fishing within the analysis area that pertains directly to Asian and Hispanic populations or to per capita income levels for the City of Everett. Therefore, information regarding whether these minority and low-income user groups would be uniquely affected from commercial fishing contributions from the salmon hatchery programs in the Stillaguamish River Basin is unknown and is not analyzed further in the EA for environmental justice.

Although recreational fishermen may catch fish produced by Stillaguamish River Basin salmon hatchery programs, and recreational fishing can result in trip-related expenditures, based on socio-demographic data, recreational fishermen are not an environmental justice group. As described in Subsection 3.4.1.3, Approach to Identifying Non-tribal User Groups of Concern, in the Puget Sound Hatcheries DEIS (NMFS 2014), the assessment of recreational fishermen as a potential environmental justice user group focuses on two minority categories (non-white and Hispanic) and income thresholds to determine low-income status. The assessment was conducted using available statewide data because comprehensive socio-demographic data are not available at the local (county) or subregion level. However, the percentages of Washington's recreational fishermen that are non-white or Hispanic, and the percentage in low-income households, are less than the percentages for the overall statewide population (USFWS and U.S. Department of Commerce 2008). Thus, recreational fishermen are not an environmental justice group, and recreational fishermen are not analyzed further in this EA for environmental justice.

3.10.2 Native American Tribes

The Stillaguamish Tribe of Indians is directly associated with hatchery programs in the Stillaguamish River Basin. Their usual and accustomed fishing area includes the Stillaguamish River Basin and adjacent marine areas (north end of Port Susan). The Tulalip Tribes' usual and accustomed fishing area within Puget Sound includes the marine areas of Port Susan, Possession Sound, and Port Gardner, where adult Stillaguamish River Basin salmon may occur.

The environmental justice evaluation for Native American tribes includes:

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

Ceremonial and Subsistence Uses: As described in Subsection 3.7, Cultural Resources, ceremonial and subsistence harvest of salmon, including hatchery-origin fish, is an important cultural resource value that has priority over tribal commercial harvest. Salmon provide substantial benefits to cultural tribal integrity.

Tribal Commercial Fisheries: As described in Subsection 3.8, Socioeconomics, salmon fishing has been a focus for tribal economies, cultures, lifestyles, and identities for many millennia (Gunther 1950). These activities continue to be important today. Puget Sound treaty tribes, which include the

Stillaguamish Tribe of Indians and Tulalip Tribes, harvest salmon and steelhead in commercial fisheries, and they are entitled to up to 50 percent of the available harvest at available and accustomed grounds and stations (pursuant to *United States v. Washington*) (Appendix A, Plans, Regulations, Agreements, Laws, Secretarial Orders, and Executive Orders Related to the Stillaguamish Hatchery EA). However, due to the low returns of salmon to the Stillaguamish River Basin, the tribal commercial value of salmon from the Stillaguamish River Basin is limited to those salmon incidentally caught in Puget Sound. Although few in number, these returning adult fish provide a benefit to Puget Sound treaty tribes who are able to harvest fish from the Stillaguamish River Basin and throughout Puget Sound.

Economic Value to Tribes from Hatchery Operations: As described in Subsection 3.4.2.3, Economic Value to Tribes from Harvest and Hatchery Operations, in the Puget Sound Hatcheries DEIS (NMFS 2014), operation of tribal hatcheries provides personal income to tribal members, and tribes receive funds for routine operations (i.e., fish food and other supplies, administration, and required services such as mass-marking). All the hatchery facilities in the Stillaguamish River Basin are operated by the Stillaguamish Tribe of Indians, and the benefit is up to four full-time tribal jobs (with a preference for hiring Native Americans), as well as funding for administration and supplies for hatchery operations.

4 ENVIRONMENTAL CONSEQUENCES

The four alternatives being evaluated in this EA are described in Chapter 2, Alternatives. The existing conditions for the eight resources (water quantity, water quality, salmon and steelhead, other fish species, wildlife, cultural resources, socioeconomics, and human health) and environmental justice that may be affected by the alternatives (including the Proposed Action) are described in Chapter 3, Affected Environment. This chapter provides an analysis of the direct and indirect environmental effects that would be associated with the alternatives on these eight resources. In addition, effects of the alternatives on environmental justice are described.

4.1 Analysis Approach and Summary

The effects of Alternative 1 (No Action) are described in terms of how conditions are likely to appear into the future compared to existing conditions with the current salmon hatchery programs (Chapter 3, Affected Environment). The effects of the other alternatives are described relative to Alternative 1. Alternative 1 and Alternative 2 (Proposed Action) are discussed together because their effects would be the same for all resources and environmental justice. The only difference between Alternative 1 and Alternative 2 is that NMFS would not make a determination under Alternative 1, while NMFS would make a determination that the submitted HGMPs meet the requirements of Limit 6 of the 4(d) Rule under Alternative 2.

The relative magnitude of impacts is described using the following terms:

- 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.

4.1.1 Actual and Maximum Production Levels

Under Alternative 1 (No Action) and Alternative 2 (Proposed Action), the four salmon hatchery programs would be operated similar to existing conditions, except higher numbers of smolts would be collected (up to 900 fish) and retained (up to 450 fall-run assigned fish) from the SF Stillaguamish River for the captive broodstock component of the fall-run Chinook salmon hatchery program. To increase the potential to retain up to 450 fall-run smolts, collection efforts would increase from approximately twice-weekly under existing conditions to up to 5 days per week from early March through July, as long as environmental conditions, such as water temperature, are suitable. Those fish that are not retained (i.e., summer-run fish or excess fall-run fish) would be released back into the SF Stillaguamish River. Production levels would be similar to existing production levels and, as in the past, actual production would vary from year to year; however, actual production would rarely exceed maximum production levels. The effects analysis assumes that actual annual production would be at the maximum level for an alternative.

Compared to actual average annual releases under existing conditions, maximum production levels under Alternative 1 and Alternative 2 (Table 1) would likely be about the same for the summer-run Chinook salmon hatchery program (average 219,311 subyearlings under existing conditions), substantially higher for the fall-run Chinook salmon hatchery program (typically fewer than 50,000 subyearlings but up to 115,020 subyearlings under existing conditions), moderately higher for the coho salmon hatchery program (average 39,482 yearlings under existing conditions), and slightly lower for the chum salmon hatchery program (average 321,584 fry under existing conditions). While the likely increases in production from the fall-run Chinook salmon hatchery program and coho salmon hatchery program compared to existing conditions are relatively large on a proportional basis, the size of the conservation programs would remain relatively small compared to programs with harvest objectives, which often produce on the order of millions of Chinook salmon subyearlings or hundreds of thousands of coho salmon yearlings annually (Appendix B, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities). Under Alternative 3 (Termination), no salmon production would occur with hatchery facilities ending all operations. Under Alternative 4 (Reduced Production), production levels would be 50 percent of the maximum production levels under Alternative 1 and Alternative 2.

4.1.2 Summary of Effects

A summary comparison of the effects of the alternatives on each resource and environmental justice is provided in Table 10. A discussion of these effects for each resource and environmental justice is provided in the following subsections.

Table 10. Summary of effects on each resource and environmental justice under each alternative.

Resource	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Termination)	Alternative 4 (Reduced Production)
Water Quantity	Negligible negative effect since withdrawals would be non-consumptive and within permitted water rights	Same as Alternative 1	Negligible positive compared to Alternative 1 since the hatchery programs would be terminated	Negligible positive compared to Alternative 1 since the hatchery programs would be reduced in size
Water Quality	Negligible negative since hatchery facilities would meet NPDES permit conditions (as applicable), comply with water quality and groundwater standards, and not contribute substantially to water quality impairments	Same as Alternative 1	Negligible positive compared to Alternative 1 since the hatchery programs would be terminated	Negligible positive compared to Alternative 1 since the hatchery programs would be reduced in size
Salmon and Steelhead	Negligible to low negative effects on natural-origin populations, including EFH and critical habitat, due to genetics, competition and predation, facility operations, masking, and disease transfer depending on species; negligible to high positive effects on population viability; a negligible positive effect on nutrient cycling in EFH and critical habitat; no effects due to incidental fishing	Same as Alternative 1	Mixed effects ranging from high negative to low positive compared to Alternative 1 depending on the species and type of effect, since hatchery production would be terminated	Mixed effects ranging from moderate negative to low positive compared to Alternative 1 depending on the species and type of effect, since hatchery production would be reduced in size

Table 10. Summary of effects on each resource and environmental justice under each alternative (continued).

Resource	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Termination)	Alternative 4 (Reduced Production)
Other Fish Species	Negligible positive effect on bull trout since they consume hatchery-origin salmon and other prey species that benefit from ecosystem productivity stimulated by salmon; negligible negative effect on bull trout when encountered during broodstock collection, although fish would be quickly released alive; no effect on bull trout critical habitat	Same as Alternative 1	Negligible negative effect on bull trout because hatchery fish would no longer be available as prey or to stimulate ecosystem productivity compared to Alternative 1; negligible positive effect on bull trout from encounters during broodstock collection because these would not occur compared to Alternative 1; no effect on bull trout critical habitat	Negligible negative effect on bull trout since fewer hatchery-origin salmon would be available as prey or to stimulate ecosystem productivity compared to Alternative 1; negligible positive effect from fewer bull trout encounters from broodstock collection compared to Alternative 1; no effect on bull trout critical habitat
Wildlife	Negligible positive effect on Southern Resident killer whales that would feed on hatchery-origin salmon (particularly Chinook salmon) from the Stillaguamish River Basin	Same as Alternative 1	Negligible negative effect on Southern Resident killer whales since there would be no hatchery-origin salmon (particularly Chinook salmon) from the Stillaguamish River Basin to feed on compared to Alternative 1	Negligible negative effect on Southern Resident killer whales since there would be fewer hatchery-origin fish from the Stillaguamish River Basin (particularly Chinook salmon) to feed on compared to Alternative 1
Cultural Resources	High positive effect on the Stillaguamish Tribe of Indians and Tulalip Tribes since salmon from Stillaguamish River Basin hatcheries would be available for subsistence and ceremonial harvest	Same as Alternative 1	High negative effect on the Stillaguamish Tribe of Indians and Tulalip Tribes since no salmon from Stillaguamish River Basin hatcheries would be available for subsistence and ceremonial harvest compared to Alternative 1	Moderate negative effect on the Stillaguamish Tribe of Indians and Tulalip Tribes since fewer salmon from Stillaguamish River Basin hatcheries would be available for subsistence and ceremonial harvest compared to Alternative 1

Table 10. Summary of effects on each resource and environmental justice under each alternative (continued).

Resource	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Termination)	Alternative 4 (Reduced Production)
Socioeconomics	Negligible positive effect from hatchery operations and employment, procurement of goods and services from the local area, and commercial and recreational harvest of salmon from the Stillaguamish River Basin	Same as Alternative 1	Negligible negative effect from loss of hatchery operations and employment, procurement of goods and services from the local area, and commercial and recreational harvest of salmon from the Stillaguamish River Basin compared to Alternative 1	Negligible negative effect from reduced hatchery operations and employment, procurement of goods and services from the local area, and commercial and recreational harvest of salmon from the Stillaguamish River Basin compared to Alternative 1
Human Health	Negligible negative effect because hatcheries would comply with safe worker requirements, use therapeutics minimally, and use personal protective equipment to raise salmon	Same as Alternative 1	Negligible positive effects because there would be no use of therapeutics and no need for safe worker requirements or personal protective equipment to raise salmon compared to Alternative 1	Same as Alternative 1
Environmental Justice	No adverse effect on tribal hatchery employment, commercial tribal fishing, and ceremonial and subsistence harvest	Same as Alternative 1	High and disproportionate adverse effects on Native American tribes from reduced tribal hatchery employment, commercial tribal fishing, and ceremonial and subsistence harvest	Same as Alternative 3

4.2 Water Quantity

This subsection addresses effects of the alternatives on water quantity. Under existing conditions as described in Subsection 3.2, Water Quantity, use of surface water, springs, and groundwater by hatchery facilities is non-consumptive. Loss of water from existing sources may include water diversions from an adjacent stream, spring, or well to allow water flow through the hatchery facility or pond system and evaporation. Surface water used in hatchery facilities is then returned to its source at some location downstream of its diversion point; however, the portion of the surface water source between the diversion point and the hatchery discharge point (the bypass reach) may have less water.

The Whitehorse Hatchery, Harvey Creek Hatchery, and Brenner Creek Hatchery withdraw water from creeks, springs, and wells (Table 2). These withdrawals for non-consumptive use are within Ecology permit limits, and the bypass reaches constitute only short distances (650 feet or less). The combined water withdrawals from the three hatcheries under existing conditions have had a negligible effect on water quantity, including the potential for dewatering streams between water intake and discharge locations.

4.2.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the hatchery programs would operate the same as under existing conditions and produce up to the maximum number of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions. Increased water use may be required at the Brenner Creek Hatchery compared to existing conditions to rear additional fish retained for captive broodstock, if collection efforts are successful, and to incubate and rear higher numbers of fall-run Chinook salmon fry, but the overall amount of water used would remain small and within permit limits (up to 0.67 cfs). The magnitude of differences in actual hatchery production during recent years and the maximum production levels under Alternative 1 and Alternative 2 would not substantially change water use at the hatcheries. The Whitehorse Hatchery, Harvey Creek Hatchery, and Brenner Creek Hatchery would continue to withdraw water from creeks, springs, and groundwater (wells) for non-consumptive uses as occurs under existing conditions. Except for evaporation, water withdrawal by the hatcheries would be regularly returned to adjacent creeks. The potential for effects from dewatering between intake and discharge structures would be minimal because the distances between intake and discharge locations are short for all three facilities (650 feet or less) and the amount of water withdrawal would be small (up to 1.2 cfs used at the Harvey Creek Hatchery, up to 0.67 cfs used at the Brenner Creek Hatchery, and a small fraction of the up to 5.0 cfs used at Whitehorse Hatchery) (Table 2). Additionally, groundwater withdrawals primarily would occur during fall, winter, and spring when precipitation can recharge groundwater levels.

Consequently, water removal, use, and return would have a negligible negative effect under Alternative 1 and Alternative 2.

4.2.2 Alternative 3 (Termination)

Under Alternative 3, the hatchery programs would be terminated, no hatchery-origin salmon would be produced (Table 1), and no surface water or groundwater withdrawals would be needed (Table 2). Under Alternative 3, there would be a negligible positive effect on water quantity compared to Alternative 1 (No Action), because water use for salmon hatchery operations would no longer occur.

4.2.3 Alternative 4 (Reduced Production)

Under Alternative 4, production from the hatchery programs would be reduced 50 percent compared to Alternative 1 (No Action) (Table 1). Consequently, about 50 percent less water would be needed under Alternative 4 compared to Alternative 1, but the difference in volume used would be small because the maximum withdrawal amounts allowed under the water rights are small (up to 1.2 cfs used at the Harvey Creek Hatchery, up to 0.67 cfs used at the Brenner Creek Hatchery, and a small fraction of the up to 5.0 cfs used at Whitehorse Hatchery, as shown in Table 2). Thus, the potential for effects from dewatering between intake and discharge structures would be minimal because the distances between intake and discharge locations are short at all three facilities (650 feet or less) and the amount of water that would be withdrawn is small (0.67 to 5.0 cfs). Under Alternative 4, there would be a negligible positive effect on water quantity because water use would be slightly lower compared to Alternative 1.

4.3 Water Quality

This subsection discusses the effects of the alternatives on water quality, and the specific permit compliance of hatchery facilities as listed in Table 3. The effluent released from hatchery facilities (including rearing ponds and acclimation ponds) contributes to the total pollutant load of receiving and downstream waters (NMFS 2014). Of the three facilities described in the HGMPs, only the Whitehorse Hatchery requires a NPDES permit under the Clean Water Act, while production levels at the Brenner Creek and Harvey Creek hatcheries are smaller and do not require a permit. The effects on water quality from salmon hatchery programs in the Stillaguamish River Basin have been negligible under existing conditions, primarily because hatchery facilities limit their pollutant discharges in accordance with their NPDES permits or do not need an NPDES permit, the hatchery facilities comply with applicable water quality and groundwater standards, and the receiving waters are not on the 303(d) list as water-quality-impaired segments.

4.3.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the hatchery programs would operate the same as under existing conditions described in Subsection 3.3, Water Quality, and would produce up to the maximum level of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions and not substantially different from actual production in the recent past. Water quality parameters and stream segments that would be negatively affected by hatchery operations would be the same as under existing conditions. The three hatcheries would continue to discharge effluent that may contain fish, fish food, chemicals, and pharmaceuticals into receiving water and would continue to affect water quality parameters as under existing conditions because the amount of effluent discharged would be similar to the recent past. Hatchery operations would limit their pollutant discharges in accordance with their NPDES permit, where applicable (Whitehorse Hatchery), and continue to comply with applicable Federal, state, and tribal water quality and groundwater standards. Further, concentrations of effluents would decline rapidly downstream of hatcheries due to dilution and degradation. Thus, hatchery operations would not be expected to contribute substantially to water quality impairments in the river basin. Under Alternative 1 and Alternative 2, considering all potential water quality risks, the salmon hatchery programs overall would have a negligible negative effect on water quality in the Stillaguamish River Basin, which is the same as under existing conditions.

4.3.2 Alternative 3 (Termination)

Under Alternative 3, all salmon hatchery programs in the Stillaguamish River Basin would be terminated and no hatchery-origin salmon would be released (Table 1). Therefore, all negative water quality effects associated with salmon hatchery programs under Alternative 1 (No Action) would be eliminated. Consequently, compared to Alternative 1, termination of the salmon hatchery programs would have a negligible positive effect on water quality.

4.3.3 Alternative 4 (Reduced Production)

Under Alternative 4, production from the salmon hatchery programs would be reduced 50 percent compared to Alternative 1 (No Action) (Table 1). Consequently, lower amounts of food, disinfection chemicals, and pharmaceuticals would be used compared to Alternative 1. Therefore, compared to Alternative 1, water quality effects from the salmon hatchery programs would be slightly reduced under Alternative 4, a negligible positive effect compared to Alternative 1.

4.4 Salmon and Steelhead

The analysis of salmon and steelhead addresses the effects of salmon hatchery programs in the Stillaguamish River Basin under the alternatives. The analysis focuses on effects of the hatchery programs on natural-origin salmon and steelhead that are self-sustaining in the natural environment and are dependent on aquatic habitat for migration, spawning, rearing, and food. Pink salmon are included in the evaluation even though there are no existing or planned hatchery programs for pink salmon in the project area, because they can be affected by hatchery programs in the project area. Since only a small number of river-type sockeye salmon (maximum of 34 fish observed) and no lake-type sockeye salmon occur in the project area (Gustafson and Winans 1999), effects on sockeye salmon are not evaluated in this EA.

This subsection describes effects on salmon and steelhead associated with the alternatives for the categories described in Subsection 3.4.2, Salmon Hatchery Program Effects on Salmon and Steelhead, and listed in Table 6. In addition, the effects of monitoring directly associated with salmon hatchery operations and performance are also described. The effects on salmon and steelhead from other general factors (e.g., habitat, climate change) are described in Chapter 5, Cumulative Effects.

Monitoring and evaluation activities occurring under existing conditions have had a negligible negative effect on natural-origin salmon and steelhead. These activities include, but are not limited to, obtaining information on smolt-to-adult survival, fishery contribution, natural-origin and hatchery-origin spawning abundance, juvenile outmigrant abundance and diversity, genetics (DNA) and gene flow, and juvenile and adult fish health when the fish are in the hatchery. Much of this information is obtained by the recapture or observation of marked (clipped adipose fin) and tagged (CWT) hatchery-origin salmon. Recapture or observations of marked and tagged hatchery-origin salmon outside the hatchery programs' facilities (e.g., smolt traps, fisheries, spawning ground surveys) are addressed under separate approvals under the ESA and consequently not discussed further. Monitoring and evaluation activities occurring at the hatchery facilities would be the same under Alternative 1 (No Action), Alternative 2 (Proposed Action), and Alternative 4 (Reduced Production), but no monitoring and evaluation activities would occur under Alternative 3 (Termination). Consequently, effects from monitoring and evaluation would be negligible negative under Alternative 1, Alternative 2, and Alternative 4, which is the same as under existing conditions, and no monitoring and evaluation under Alternative 3 would be a negligible positive effect compared to Alternative 1.

4.4.1 Genetics

As described in Subsection 3.4.2.1, Genetics, the three major types of genetic effects on natural-origin salmon and steelhead from hatchery programs are within-population genetic diversity effects, outbreeding effects, and hatchery-influenced selection effects. The four salmon hatchery programs in the Stillaguamish River Basin are integrated recovery programs that use a high proportion of natural-origin fish in their broodstocks. In general, the major difference among the alternatives for Chinook salmon, coho salmon, and chum salmon hatchery programs would be the maximum production levels and the number of broodstock required to achieve them.

4.4.1.1 Chinook Salmon

Under all alternatives except Alternative 3 (Termination), the summer-run and fall-run Chinook salmon hatchery programs would use a combination of hatchery-origin and natural-origin fish as broodstock. The summer-run broodstock would be comprised entirely of adults netted in the NF Stillaguamish River, while the fall-run broodstock would be a combination of juveniles collected in the SF Stillaguamish River, genetically screened as fall-run fish, then reared to maturity in captivity, and adults incidentally captured during summer-run broodstock collections in the NF Stillaguamish River. Prior to spawning, broodstock for both programs would be genetically tested to determine each individual's run type and avoid cross-breeding of the two run types. As described in Subsection 3.4.2.1, Genetics, PNI and pHOS levels have been at acceptable levels for Tier 2 populations with integrated recovery programs. No significant genetic differences have been observed between hatchery-origin and natural-origin summer-run Chinook salmon, and strays from the programs have contributed little to spawning in other river basins. However, a change in genetics may still occur, resulting from reductions in within-population genetic diversity, outbreeding, and hatchery-influenced selection. Consequently, under existing conditions, the two Chinook salmon hatchery programs have had a negligible negative effect on natural-origin Chinook salmon.

Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the summer-run and fall-run Chinook salmon hatchery programs would operate similar to existing conditions, except higher numbers of smolts (up to 900 fish rather than up to 400 fish) would be collected from the SF Stillaguamish River with a target of up to 450 fall-run fish being retained for the captive broodstock component of the fall-run Chinook salmon hatchery program. Any smolts that are not genetically assigned as fall-run smolts, or are in excess of 450 fall-run smolts, would be released back to the SF Stillaguamish River. The higher number of smolts collected is anticipated to increase the likelihood that fall-run Chinook salmon maximum production levels can be achieved. In addition, adult fall-run Chinook salmon may be collected from a V-trap to be located at the Brenner Creek Hatchery. The total number of adult broodstock needed and juvenile production levels would be the same as under existing conditions. Average annual production of summer-run Chinook salmon under existing conditions (219,311 subyearlings) has been very near maximum production levels (220,000 subyearlings). In contrast, subyearling releases of fall-run Chinook salmon would likely be substantially higher than under existing conditions and should approach maximum production levels (200,000 subyearlings) within a few years.

There are potential negative genetic effects on summer-run and fall-run Chinook salmon populations from risks to within-population genetic diversity, outbreeding, and hatchery-influenced selection. However, these negative effects would be negligible under Alternative 1 and Alternative 2. NMFS believes that genetic effects under existing conditions are a good basis for estimating future program genetic effects for a composite of the fall-run and summer-run Chinook salmon hatchery programs (NMFS 2019). Under Alternative 1 and Alternative 2, the estimated PNI would often be greater than 0.5 for the summer-run Chinook salmon hatchery program because natural-origin spawners would represent an equal, if not higher, proportion of the spawning population than hatchery-origin fish. In addition, BMPs would provide adequate mixing of genes to minimize the likelihood of effects on within-population genetic diversity. Furthermore, broodstock would be genetically analyzed before spawning to prevent the use of out-of-basin strays and procedures would be followed to avoid mating of full- and half-siblings in the hatchery, thus minimizing effects from inbreeding and outbreeding within the Stillaguamish River Basin. Diversity in the fall-run Chinook salmon broodstock would also be maintained under Alternative 1 and Alternative 2 by the use of captive broodstock that would minimize risks from mining natural-origin adults for broodstock.

Regarding outbreeding effects on other river basins, contributions from straying by hatchery-origin Chinook salmon from the Stillaguamish River Basin has been low (2.4 percent or less) under existing conditions and would be similarly low under Alternative 1 and Alternative 2. Higher numbers of strays may result from the fall-run Chinook salmon hatchery program compared to existing conditions because production levels are more likely to be achieved under Alternative 1 and Alternative 2. However, these increases would be relatively small and unlikely to substantially increase pHOS values more than a couple of percentage points in nearby river basins. Consequently, negative outbreeding effects on other river basins from the Stillaguamish River Basin Chinook salmon hatchery programs would be negligible under Alternative 1 and Alternative 2.

Under Alternative 1 and Alternative 2, the removal of adults and/or juveniles from the naturally spawning populations for use as broodstock would not have a substantial impact. The removal of up to 150 adults for the summer-run and fall-run Chinook salmon hatchery programs represents an average of 11 percent of the total Chinook salmon escapement, and the removal of up to 450 fall-run Chinook salmon smolts represents about 0.07 percent of the total Chinook salmon smolt outmigration. However, if summer-run or fall-run Chinook salmon natural-origin escapements decline substantially, leading to a decrease in effective population size of the integrated hatchery-origin and natural-origin populations below a few hundred fish, Alternative 1 and Alternative 2 could result in adverse genetic effects. For example, recent returns of fall-run Chinook salmon, which averaged 111 fish from 1999 to 2017, are generally below the threshold of 250 breeders per year needed to maintain genetic variation and avoid a high risk of extinction in salmon and steelhead populations (Waples et al. 1990; Allendorf et al. 1997). If this trend continues, negative effects from reduced genetic diversity could result. However, under Alternative 1 and Alternative 2, monitoring activities, including spawning ground surveys and marking and tagging of hatchery-origin fish, would help detect and avoid these effects. For example, the low numbers of natural-origin and hatchery-origin fall-run Chinook salmon recently observed on the spawning grounds provide rationale for increasing the effort to capture smolts for the captive broodstock component of the program compared to existing conditions, and thus expand the size of the combined natural-origin and hatchery-origin breeding population.

In conclusion, the summer-run and fall-run Chinook salmon hatchery programs under Alternative 1 and Alternative 2 would have negligible negative genetic effects on natural-origin Chinook salmon in the Stillaguamish River Basin.

Alternative 3 (Termination)

Under Alternative 3, the summer-run and fall-run Chinook salmon hatchery programs in the Stillaguamish River Basin would be terminated, and most genetic effects would be eliminated compared to Alternative 1 (No Action). Termination of the hatchery programs would eliminate risks from outbreeding and hatchery-influenced selection because there would be no more hatchery-origin fish bred. However, elimination of the hatchery programs would increase risks to the viability of the natural-origin populations, especially for the critically low fall-run population. The risk of low population size would result in a high negative effect compared to Alternative 1 for the fall-run population because it would lead to a reduction in within-population genetic diversity and an increase in the risk of extinction. Under existing conditions, the SF Stillaguamish River (primarily fall-run) natural-origin spawning population averages 98 fish per year, which is substantially below the population size threshold of 250 breeders necessary to avoid reductions of within-population genetic diversity and a high risk of extinction (Waples et al. 1990; Allendorf et al. 1997; NMFS 2000). In contrast, the number of naturally spawning summer-run Chinook salmon would decline without the summer-run hatchery program but not to the same critical level as the fall-run population. Under existing conditions, the natural-origin NF Stillaguamish River (primarily summer-run) population has averaged 503 adults, which is well above the threshold of 250 breeders and which is expected to remain above the threshold under Alternative 1 and Alternative 2.

Overall, compared to Alternative 1, the summer-run and fall-run Chinook salmon hatchery programs under Alternative 3 would have a low negative genetic effect on natural-origin summer-run Chinook salmon and a high negative genetic effect on natural-origin fall run Chinook salmon in the Stillaguamish River Basin.

Alternative 4 (Reduced Production)

Under Alternative 4, annual production for the hatchery programs would be reduced by 50 percent compared to Alternative 1, and up to 110,000 summer-run and 100,000 fall-run Chinook salmon subyearlings would be released. Fewer adult broodstock would be needed under Alternative 4 compared to Alternative 1 (No Action). Similarly, fewer fall-run Chinook salmon smolts would likely be needed as captive broodstock to meet egg take requirements.

Under Alternative 4, the magnitude and direction of genetic effects would depend on the type of risk. For within-population genetic diversity, the PNI for the summer-run Chinook salmon hatchery program would often be 0.5 or higher because sufficient numbers of natural-origin broodstock would be used. PNI could decline below 0.5, but the magnitude of the decline is uncertain and would depend on the number of offspring that result from hatchery-origin fish spawning in the wild. Such a decline would likely be mitigated by adjusting broodstock collection procedures.

Under Alternative 1, pNOB and pHOS for the Chinook salmon hatchery programs would generally reflect the composition of escapement to the NF Snoqualmie River, and this would be the same under Alternative 4. Under Alternative 4, the number of hatchery-origin fish returning would be about 50 percent lower than under Alternative 1. In addition, the number of natural-origin fish returning that are the offspring of the combined naturally spawning hatchery-origin and natural-origin fish would be lower. Because of this complex intergenerational relationship, the relative abundance of hatchery-origin and natural-origin adults in the escapement under Alternative 4 is difficult to predict. However, the HGMP indicates spawning protocols would be followed to ensure the maximum effective spawner population needed to maintain genetic diversity (Stillaguamish Tribe of Indians 2018a). Consequently, pNOB and PNI would be adjusted as needed under Alternative 4 for the summer-run Chinook salmon hatchery program by preferentially selecting natural-origin adults for broodstock during collection, and thereby maintaining an adequate pNOB and maintaining PNI at 0.5 or higher.

Compared to Alternative 1, the risk of negative genetic effects due to a reduction of naturally spawning salmon under Alternative 4 would be negligible for summer-run Chinook salmon and moderate for fall-run Chinook salmon. Under existing conditions, approximately 600 summer-run hatchery-origin Chinook salmon adults return each year from the release of an average of 219,000 subyearlings under existing conditions, and a similar number is likely to return for the summer-run and the fall-run Chinook salmon hatchery programs under Alternative 1. Thus, the return of about 300 adults from 100,000 (fall-run Chinook salmon) to 110,000 (summer-run) Chinook salmon subyearlings released under Alternative 4 would be expected depending on the program. However, as described above, fewer natural-origin fish are likely to return under Alternative 4 compared to Alternative 1 because the naturally spawning population would be smaller. Under Alternative 4, the number of combined hatchery-origin and natural-origin fall-run Chinook salmon spawning naturally would have a moderate risk of being below 250 breeders during some years, which could result in reduced within-population genetic diversity. In contrast, the number of naturally spawning summer-run Chinook salmon would likely be above 250 breeders. Because fewer fish would be released under Alternative 4, the risk of negative genetic effects from outbreeding and hatchery-influenced selection would be reduced compared to Alternative 1. Overall, compared to Alternative 1, the summer-run and fall-run Chinook salmon hatchery programs under Alternative 4 would have a negligible positive genetic effect on natural-origin summer-run Chinook salmon and a moderate negative genetic effect on fall-run Chinook salmon in the Stillaguamish River Basin.

4.4.1.2 Coho Salmon

Under all alternatives except Alternative 3 (Termination), the coho salmon hatchery program would primarily use natural-origin fish as broodstock, collected from a fish ladder in the Stillaguamish River Basin, which would be the same as under existing conditions. In case of shortfalls, hatchery-origin fish would be incorporated into broodstock to meet maximum production levels; however, from 2014 to 2017 this occurred only 1 year and required 11 hatchery-origin fish. As described in Subsection 3.4.2.1, Genetics, the coho salmon hatchery program has had a very low pHOS (less than 1 percent) and high PNI (over 99 percent), which has helped maintain within-population genetic diversity and minimized the risk of hatchery-influenced selection, but still has had a negligible negative effect on these genetic indicators in natural-origin coho salmon in the Stillaguamish River Basin. Effects from outbreeding to out-of-basin populations due to straying are unknown under existing conditions.

Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the negative genetic effects on natural-origin coho salmon would be similar to existing conditions for within-population genetic diversity and hatchery-influenced selection because only natural-origin fish would be used as broodstock, PNI would be large (above 0.67), the number of natural-origin coho salmon used for broodstock would be small compared to the number spawning naturally in the river basin, and the proportion of hatchery-origin spawners interbreeding with the natural-origin fish would be very low (pHOS of about 0.4 percent). The number of hatchery-origin coho salmon returning would likely be higher than under existing conditions, assuming that maximum production levels would be achieved, but the higher numbers would not substantially increase pHOS unless the natural-origin population abundance declined substantially below the 2012 to 2016 average return of 31,430 fish. Effects from hatchery-influenced selection would occur, but these would be small (pNOB usually at 100 percent). The negative effects from outbreeding to out-of-basin populations would be unknown, but if they occur, the magnitude would be similar to or only slightly higher than existing conditions, if production levels are achieved, because coho salmon smolt release levels in recent years have, on average, been moderately below the maximum production level. Overall, Alternative 1 and Alternative 2 would have a negligible negative effect on natural-origin coho salmon genetics.

Alternative 3 (Termination)

Under Alternative 3, the coho salmon hatchery program would be terminated and all genetic effects (within-population genetic diversity, outbreeding, and hatchery-influenced selection) from the hatchery program would be eliminated compared to Alternative 1 (No Action). Consequently, compared to Alternative 1 there would be negligible positive genetic effects on natural-origin coho salmon.

Alternative 4 (Reduced Production)

Under Alternative 4, the coho salmon hatchery program would operate as under Alternative 1, except annual production levels would be reduced by 50 percent to 30,000 yearlings, and fewer fish would be needed as broodstock. The reduced broodstock needs would also mean that natural-origin coho salmon spawners should be available in all years. Consequently, all negative genetic effects (within-population genetic diversity, outbreeding, and hatchery-influenced selection) from the hatchery program would be reduced compared to Alternative 1 (No Action).

The genetic risk to natural-origin coho salmon would be less than under Alternative 1 but would be a similar negligible negative effect. This is because PNI would be above 0.67, as smaller numbers of natural-origin coho salmon would be used for broodstock compared to the number spawning naturally in the river basin, and the proportion of hatchery-origin spawners interbreeding with natural-origin spawners would be very low. Effects from hatchery-influenced selection would occur but would be very low because only natural-origin fish would be used as broodstock. Under Alternative 4, the coho salmon hatchery program would have a negligible positive genetic effect on natural-origin coho salmon compared to Alternative 1.

4.4.1.3 Chum Salmon

Under all alternatives, except Alternative 3 (Termination), the chum salmon hatchery program would use a combination of hatchery-origin and natural-origin fish as broodstock collected from a fish ladder in the Stillaguamish River Basin. Chum salmon produced by the hatchery program are not marked; consequently, it is not possible to determine, or deliberately manage, the proportion of natural-origin fish (pNOB) in the broodstock or hatchery-origin fish spawning naturally. As described in Subsection 3.4.2.1, Genetics, the chum salmon hatchery program has likely had a low pHOS (about 15 percent) under existing conditions, while PNI has been potentially lower than the 0.67 guidance threshold because broodstock is derived entirely from fish that return volitionally to the hatchery trap and may be predominantly of hatchery-origin. Actual pNOB and PNI values are unknown because hatchery-origin fish are not marked. Overall the program has had a low negative effect on natural-origin chum salmon in the Stillaguamish River Basin from reductions of within-population genetic diversity, outbreeding, and hatchery-influenced selection primarily because of the exclusive use of fish that return to the hatchery for broodstock. These genetic risks are ameliorated by the small size of the program, use of local broodstock for hatchery production, and the short time that the fish are reared in a hatchery.

Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the chum salmon hatchery program would operate similar to existing conditions and have similar total maximum production levels (up to 250,000 fry for onsite releases and up to 50,000 eyed eggs supplied to local schools for educational programs). Actual average annual chum salmon onsite release levels would likely be slightly lower under Alternative 1 and Alternative 2 than under existing conditions (321,584 fry released on site) to align with maximum production levels. The negative genetic effects (within-population genetic diversity, outbreeding, and hatchery-influenced selection) on natural-origin chum salmon would be the same (low) as existing conditions under both alternatives because the number of hatchery-origin chum salmon fry or eggs released would not be substantially different.

Alternative 3 (Termination)

Under Alternative 3, the chum salmon hatchery program would be terminated, and all genetic effects (within-population genetic diversity, outbreeding, and hatchery-influenced selection) would be eliminated compared to Alternative 1 (No Action). Consequently, there would be low positive genetic effects on natural-origin chum salmon under Alternative 3 compared to Alternative 1.

Alternative 4 (Reduced Production)

Under Alternative 4, the chum salmon hatchery program would operate as under Alternative 1 (No Action), except annual production levels would be reduced by 50 percent to 25,000 eyed-eggs supplied to local schools and 125,000 fry released on site, and fewer fish would be needed as broodstock. The reduction in the number of fry and eggs released would likely result in a lower pHOS compared to Alternative 1 (No Action). Consequently, the potential for negative genetic effects (within-population genetic diversity, outbreeding, and hatchery-influenced selection) would be slightly lower than under Alternative 1; thus, there would be a negligible positive genetic effect compared to Alternative 1.

4.4.2 Competition and Predation

Releases of hatchery-origin salmon from the hatchery programs may negatively affect natural-origin fish when the two groups compete for limited resources, such as food or space, or through predation. Repeated exposure to competition could result in reduced growth or a higher vulnerability to other sources of mortality such as starvation, disease, or predation.

4.4.2.1 Chinook Salmon

As described in Subsection 3.4.2.2, Competition and Predation, competition and predation effects in fresh water under existing conditions have resulted in negligible to low negative effects on natural-origin Chinook salmon from the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs depending on the species and type of interaction. Negative effects of the hatchery programs under existing conditions are largely ameliorated because of the timing of releases, which are generally after most natural-origin fish have emigrated, the location of releases that reduce the spatial overlap of hatchery-origin and natural-origin fish, and the relatively small size of the hatchery programs compared to harvest augmentation programs. The negative competition and predation effects on natural-origin Chinook salmon in estuarine and nearshore waters from the programs are uncertain.

Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, production levels would be the same as under existing conditions, except that the fall-run Chinook salmon hatchery program would be more likely to achieve the maximum production level because of increased collection of juveniles for the captive broodstock component. As described in the introduction to Chapter 4, Environmental Consequences, actual production levels under Alternative 1 and Alternative 2 may be different from those under existing conditions, but these differences are not likely to be large enough to result in substantial differences in the negative effects on natural-origin summer-run and fall-run Chinook salmon from competition and predation. Consequently, for the same reasons as the existing conditions described above and in Subsection 3.4.2.2, Competition and Predation, the negative effects from the hatchery programs would range from negligible to low depending on the species and type of interaction, which are the same as under existing conditions.

Alternative 3 (Termination)

Under Alternative 3, the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs would be terminated. Consequently, there would no risk of any effects from competition or predation on natural-origin summer-run and fall-run Chinook salmon. Compared to Alternative 1 (No Action), there would be negligible to low positive effects of competition and predation on natural-origin Chinook salmon depending on the species and type of interaction.

Alternative 4 (Reduced Production)

Under Alternative 4, the hatchery programs would operate as under Alternative 1 (No Action), except annual production levels would be reduced by 50 percent. Because of the reduced production levels, negative effects on natural-origin summer-run and fall-run Chinook salmon from competition and predation in fresh water would be reduced relative to Alternative 1 and thus would be negligible. Compared to Alternative 1, there would be negligible positive effects on summer-run and fall-run Chinook salmon from competition and predation.

4.4.2.2 Steelhead

Competition and predation effects in fresh water have resulted in negative effects on natural-origin steelhead from the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs depending on the species and type of interaction. Negative effects of the hatchery programs under existing conditions have been largely ameliorated because of size differences between the larger natural-origin steelhead smolts and the smaller fry and subyearlings released from the salmon hatcheries;

the timing of releases, which have been generally after most natural-origin fish have emigrated; the locations of releases that reduce the spatial overlap of hatchery-origin and natural-origin fish; and the relatively small size of the hatchery programs compared to harvest augmentation hatchery programs. The negative competition and predation effects on steelhead in estuarine and nearshore waters from the hatchery programs are uncertain, but steelhead tend to move offshore relatively quickly; thus, the potential for negative effects from interactions has been low under existing conditions.

Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Production levels under Alternative 1 and Alternative 2 would be the same as under existing conditions, except that the fall-run Chinook salmon hatchery program would be more likely to achieve its maximum production level. The differences in the number of fish to be released under Alternative 1 and Alternative 2 compared to existing conditions would not likely be large enough to result in substantial differences in the effects on natural-origin steelhead from competition and predation. Plus, any negative effects would largely be ameliorated because of differences in size and migration timing, as well as a limited spatial overlap. Consequently, the negative effects on natural-origin steelhead would range from negligible to low depending on the species and type of interaction, which is the same as under existing conditions.

Alternative 3 (Termination)

Under Alternative 3, the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs would be terminated. Consequently, there would no risk of effects from competition or predation on natural-origin steelhead. Compared to Alternative 1 (No Action), there would be negligible to low positive effects from reduced competition and predation on natural-origin steelhead.

Alternative 4 (Reduced Production)

Under Alternative 4, the salmon hatchery programs would operate as under Alternative 1 (No Action), except annual production levels would be reduced by 50 percent. Because of the reduced production levels, negative effects on natural-origin steelhead from competition and predation in freshwater and nearshore areas would be reduced relative to Alternative 1 and thus would be negligible from all salmon species released by hatchery programs in the Stillaguamish River Basin. Compared to Alternative 1, there would be negligible positive effects from reduced competition and predation on natural-origin steelhead.

4.4.2.3 Coho Salmon

Competition and predation in fresh water have resulted in negligible to low negative effects on natural-origin coho salmon from the existing summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs depending on the species and type of interaction. Low negative effects from competition and predation could occur from hatchery-origin coho salmon smolts if they encounter natural-origin coho salmon smolts or coho salmon in earlier life history stages. However, negative effects of the hatchery programs have been largely ameliorated because of size differences between the larger natural-origin coho salmon smolts and the smaller fry and subyearlings released from the Chinook salmon and chum salmon hatcheries, the timing of releases, which have been generally after most natural-origin fish have emigrated, the location of releases that reduces the spatial overlap of hatchery-origin and natural-origin fish, and the relatively small size of the hatchery programs. The negative effects from competition and predation on coho salmon in estuarine and nearshore waters from the hatchery programs are uncertain, but coho salmon smolts tend to move offshore relatively quickly; thus, the potential for negative effects from interactions has been low under existing conditions.

Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Maximum production levels under Alternative 1 and Alternative 2 would be the same as under existing conditions, except that the fall-run Chinook salmon hatchery program would be more likely to achieve its maximum production level compared to existing conditions. The differences in the number of fish to be released under Alternative 1 and Alternative 2 compared to existing conditions would not likely to be large enough to result in substantial differences in the effects on natural-origin coho salmon from competition and predation. Any negative effects would largely be ameliorated because of differences in size and migration timing, as well as a limited spatial overlap by salmon released from the hatchery programs. Consequently, the negative effects under Alternative 1 and Alternative 2 would range from negligible to low depending on the species and type of interaction, which would be the same as under existing conditions.

Alternative 3 (Termination)

Under Alternative 3, the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs would be terminated. Consequently, there would no risk of effects from competition or predation on natural-origin coho salmon. Compared to Alternative 1 (No Action), there would be negligible to low positive effects (the same magnitude but opposite direction) because competition and predation from hatchery-origin salmon on natural-origin coho salmon would be eliminated.

Alternative 4 (Reduced Production)

Under Alternative 4, the hatchery programs would operate as under Alternative 1 (No Action), except annual production levels would be reduced by 50 percent. Although the types of effects would be the same as under Alternative 1, because of the reduced production levels, the magnitude of negative effects on natural-origin coho salmon from competition and predation in freshwater and nearshore areas would be reduced relative to Alternative 1. Consequently, the effects would be negligible from all salmon species released by hatchery programs in the Stillaguamish River Basin. Compared to Alternative 1, there would be negligible positive effects from reduced competition and predation on natural-origin coho salmon.

4.4.2.4 Chum Salmon and Pink Salmon

Competition and predation in fresh water under existing conditions have resulted in negligible to low negative effects on natural-origin chum salmon and pink salmon from the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs depending on the species and type of interaction. Negative effects from competition by hatchery-origin chum salmon and predation by hatchery-origin coho salmon yearlings have been largely ameliorated under existing conditions because hatchery fry and yearlings are released low in the watershed and the size of the hatchery programs are small. In addition, because of their slightly larger size, hatchery-origin fed chum salmon fry tend to disperse into marine waters relatively quickly after release compared to natural-origin chum salmon and pink salmon fry; thus, the negative competition and predation effects on natural-origin chum salmon and pink salmon in estuarine and nearshore waters from the hatchery programs have been low under existing conditions.

Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Maximum production levels under Alternative 1 and Alternative 2 would be the same as under existing conditions, except that the fall-run Chinook salmon hatchery program would be more likely to achieve its maximum production level. The differences in the number of fish to be released under Alternative 1 and Alternative 2 compared to existing conditions would not likely be large enough to result in substantial differences in the effects on natural-origin chum salmon and pink salmon from competition and predation by hatchery-origin salmon. Consequently, the negative effects would range from negligible to low depending on the species and type of interaction, which is the same as under existing conditions.

Alternative 3 (Termination)

Under Alternative 3, the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs would be terminated. Consequently, there would no risk of effects from competition or predation on natural-origin chum salmon and pink salmon. Compared to Alternative 1 (No Action), there would be negligible to low positive effects (same magnitude but opposite direction) from competition and predation on natural-origin chum salmon and pink salmon due to the elimination of salmon hatchery production.

Alternative 4 (Reduced Production)

Under Alternative 4, the hatchery programs would operate as under existing conditions, except annual production levels would be reduced by 50 percent. Although the type of effects under Alternative 4 would be the same as under Alternative 1 (No Action), because of the reduced production levels, the negative effects on natural-origin chum salmon and pink salmon from competition and predation in freshwater and nearshore areas would be reduced in magnitude relative to Alternative 1. Consequently, the negative effects from competition and predation would be negligible from all salmon species released by hatchery programs in the Stillaguamish River Basin. Compared to Alternative 1, there would be negligible positive effects (lower magnitude and opposite direction) from reduced competition and predation on natural-origin chum salmon and pink salmon.

4.4.3 Facility Operations

The facility operations for the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs have had negligible negative to negligible positive effects on natural-origin salmon and steelhead under existing conditions depending on the operational component (i.e., broodstock trapping and water withdrawals; weirs are not used at these facilities). Broodstock collection traps for the fall-run Chinook salmon, chum salmon, and coho salmon hatchery programs have the potential to trap non-target salmon and steelhead, but this occurred rarely under existing conditions and non-target fish were returned to the stream; consequently, the traps have had a negligible negative effect on natural-origin salmon and steelhead. The negative effects on EFH and critical habitat for ESA-listed salmon and steelhead from surface water withdrawals for the hatcheries under existing conditions have also been negligible because of the short distance of the bypass reaches, low surface water withdrawal amounts relative to flows, the contribution of small amounts of well water to surface waters (a positive effect), or the absence of salmon or steelhead in reaches affected by surface or spring water withdrawals.

Under Alternative 1 (No Action), Alternative 2 (Proposed Action), and Alternative 4 (Reduced Production), production levels would be different from existing conditions, but facility operations would be similar. Therefore, both the type and magnitude of effects on natural-origin salmon and steelhead populations, EFH, and critical habitat would not be substantially different from existing conditions (negligible negative to negligible positive depending on the species and operational component). Under

Alternative 3 (Termination), the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs would be terminated. Consequently, facility operations would have a negligible positive effect on natural-origin salmon and steelhead and on EFH and critical habitat compared to Alternative 1 because broodstock traps would not be operated and water use at the facilities would cease.

4.4.4 Masking

There is no potential for masking effects from the summer-run and fall-run Chinook salmon and coho salmon hatchery programs under existing conditions because all fish are marked and thus distinguishable from natural-origin fish. Under Alternative 1 (No Action), Alternative 2 (Proposed Action), and Alternative 4 (Reduced Production), hatchery-origin salmon from the Chinook salmon and coho salmon hatchery programs would be marked, and under Alternative 3 (Termination) no salmon hatchery production would occur. Consequently, under all alternatives, there would be no masking effects on natural-origin summer-run and fall-run Chinook salmon and coho salmon.

Fish from the chum salmon hatchery program are not marked and cannot be distinguished from natural-origin chum salmon. However, under existing conditions, the potential for masking has had a negligible negative effect on natural-origin chum salmon because the magnitude of adult returns from the hatchery releases have been small (likely less than 15 percent) (Subsection 3.4.2.1, Genetics – Chum Salmon) compared to the total escapement to the river basin. Under Alternative 1 and Alternative 2, the production levels would be the same as under existing conditions. Actual average annual production levels under Alternative 1 and Alternative 2 will likely be slightly lower than under existing conditions, but these differences would not be large enough to further reduce the potential for masking, which would be a negligible negative effect. Under Alternative 4, production of hatchery-origin chum salmon from the program would be reduced 50 percent compared to Alternative 1. Consequently, there would be a lower potential for masking under Alternative 4 and a negligible positive effect compared to Alternative 1, which is the same magnitude but in the opposite direction. Under Alternative 3, no hatchery-origin chum salmon production would occur, and there would be no masking effects on natural-origin chum salmon. Compared to Alternative 1, the potential for masking would be a negligible positive effect under Alternative 3.

4.4.5 Incidental Fishing

As described in Subsection 3.4.2.5, Incidental Fishing, no fisheries target the harvest of fish produced by the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs in the

Stillaguamish River Basin under existing conditions. This is due in part because they are conservation programs and also because harvest management is based on natural production in the river basin. Consequently, there have been no incidental fishing effects on natural-origin summer-run and fall-run Chinook salmon, coho salmon, and chum salmon. Under Alternative 1 (No Action), Alternative 2 (Proposed Action), and Alternative 4 (Reduced Production), the salmon hatchery programs would continue as conservation programs, and it is assumed that the Stillaguamish River Basin would continue to be managed based on natural populations and the co-managers would only implement fisheries if natural-origin salmon production allows. Under Alternative 3 (Termination), there would be no salmon produced by the hatcheries and no potential for target fisheries on hatchery-origin fish. Consequently, there would be no incidental fishing effects on natural-origin salmon and steelhead under any alternative.

4.4.6 Disease

The summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs in the Stillaguamish River Basin have had a negligible negative effect on the transfer or amplification of diseases to natural-origin salmon and steelhead in the Stillaguamish River Basin under existing conditions because of health monitoring and implementation of BMPs. Under Alternative 1 (No Action), Alternative 2 (Proposed Action), and Alternative 4 (Reduced Production), the programs would use the same practices as under existing conditions and thus would have a negligible negative disease effect on natural-origin salmon and steelhead. Under Alternative 3 (Termination), there would be no hatchery-origin salmon produced and no potential for disease transmission to natural-origin fish. Consequently, there would be no disease effects on natural-origin salmon and steelhead under Alternative 3. Compared to Alternative 1, there would be a negligible positive effect on natural-origin salmon and steelhead from disease under Alternative 3.

4.4.7 Population Viability Benefits

4.4.7.1 Chinook Salmon

The summer-run and fall-run Chinook salmon hatchery programs have had a high positive effect on the natural-origin populations' viability under existing conditions because, as integrated recovery programs, they have increased the abundance and productivity of Chinook salmon in the Stillaguamish River Basin above the level that is provided solely from natural-origin spawners. Mass-marking of Chinook salmon produced in the two programs is important for meeting each program's indicator stock objective but results in fewer hatchery-origin fish contributing to the abundance of naturally spawning Chinook salmon (an annual average of 43 fish or 9 percent during 2010 to 2014). As described in Subsection 3.4.2.7, Population Viability Benefits, productivity of the natural-origin Chinook salmon populations is similar (ranging from 0.97 to 1.0), but the summer-run population's abundance is low, and the fall-run population's abundance is critically low. Under existing conditions, the viability benefits to summer-run Chinook salmon have been high because actual production has been close to the maximum production level and hatchery-origin fish have contributed substantially (average of 44 percent) to the abundance of naturally spawning fish. In contrast, viability benefits to fall-run Chinook salmon have been low, but increasing, as the program builds.

Under Alternative 1 (No Action) and Alternative 2 (Proposed Action), the summer-run and fall-run Chinook salmon hatchery programs would have similar maximum production levels as under existing conditions, except that the fall-run Chinook salmon hatchery program would have a higher likelihood of achieving its maximum production level. The difference in the number of summer-run Chinook salmon to be released under Alternative 1 and Alternative 2 compared to existing conditions would not likely be large enough to result in substantial differences in its viability because the average release under existing conditions is similar to the maximum production level. However, the viability benefits of the fall-run population should increase substantially as the program approaches its maximum production level. Under Alternative 1 and Alternative 2, the reductions in hatchery-origin escapement due to mass-marking (about 9 percent) are small and would be similar to existing conditions. Consequently, these programs would have a high positive effect on the natural-origin populations' viability, which is the same as under existing conditions for the summer-run population and a substantial increase in viability benefits for the fall-run Chinook salmon population.

In contrast, Alternative 3 (Termination) would have a high negative effect on population viability compared to Alternative 1 because the combined escapement of hatchery-origin and natural-origin fish for each of the summer-run and fall-run Chinook salmon populations in the Stillaguamish River Basin would be substantially less. Without the contributions to abundance and productivity from the hatchery-origin summer-run and fall-run Chinook salmon spawners, the viability of the populations would be at increased risk.

Under Alternative 4 (Reduced Production), production levels would be reduced 50 percent compared to Alternative 1. The viability benefits for the natural-origin summer-run and fall-run Chinook salmon populations would be reduced relative to Alternative 1 because fewer hatchery-origin fish would contribute to the abundance of the naturally spawning populations. Under Alternative 4, there would be a moderate negative effect on natural-origin summer-run Chinook salmon population viability compared to Alternative 1. In contrast, there would be a high negative effect on natural-origin fall-run Chinook salmon population viability under Alternative 4, compared to Alterative 1, because the spawning population size is often below the critical escapement threshold (200 fish) and its viability is more dependent on the contribution of hatchery-origin fish.

4.4.7.2 Coho Salmon

As described in Subsection 3.4.2.7, Population Viability Benefits, the integrated coho salmon hatchery program has contributed little to abundance or productivity of naturally spawning coho salmon in the Stillaguamish River Basin. With an average escapement level of 93 fish from 2012 to 2016, the hatchery program has had a negligible positive effect on natural-origin coho salmon population viability under existing conditions. Under Alternative 1 (No Action) and Alternative 2 (Proposed Action), production levels for the coho salmon hatchery program (up to 60,000 yearlings) would be the same as under existing conditions. Assuming the program regularly approaches maximum production levels, actual average annual production under Alternative 1 and Alternative 2 would be higher than existing conditions (39,482 yearlings) and would contribute additional natural spawners (up to a few hundred); however, the program would continue to have a negligible positive effect on viability, because the increase would not be substantial on either an absolute or proportional basis (about 2 percent of average returns from 2013 to 2017). Alternative 3 (Termination) would have a negligible negative effect on viability compared to Alternative 1 because no hatchery-origin salmon would be released. Under Alternative 4 (Reduced Production), production levels would be reduced 50 percent compared to Alternative 1 and, although lower, would have a negligible positive effect on viability, which is similar to Alternative 1.

4.4.7.3 Chum Salmon

The integrated chum salmon hatchery program has had a moderate positive effect on population viability under existing conditions by contributing several thousand adults to the overall abundance of naturally spawning chum salmon in the Stillaguamish River Basin, which have had poor returns in recent years. Under Alternative 1 (No Action) and Alternative 2 (Proposed Action), the maximum production levels (up to 250,000 fry and up to 50,000 eyed eggs) would be similar to existing conditions. Assuming production under Alternative 1 and Alternative 2 approaches the maximum production level, slightly fewer chum salmon would actually be produced compared to existing conditions, under which an average of 321,584 fry have been released annually. Assuming a 0.7 percent survival rate to adult and 3.2 percent harvest rate, production levels under Alternative 1 and Alternative 2 would contribute about 1,700 adults to escapement compared to about 2,179 adults (about 18 percent of the average escapement of 11,974 fish from 2010 to 2014) under existing conditions. Although a lower contribution than under existing conditions, the chum salmon hatchery program under Alternative 1 and Alternative 2 would continue to have a moderate positive effect on population viability because the lower contribution would be relatively small on a proportional basis (about 4 percent less). Alternative 3 (Termination) would have a moderate negative effect on viability because there would be no chum salmon hatchery production compared to Alternative 1. Under Alternative 4 (Reduced Production), the production level would be reduced 50 percent compared to Alternative 1 and about 850 adults would contribute to the naturally spawning population (about 8 percent of escapement). Consequently, the viability benefits would be reduced and there would be a low negative effect on natural-origin chum salmon population viability compared to Alternative 1.

4.4.8 Nutrient Cycling

As described in Subsection 3.4.2.8, Nutrient Cycling, the summer-run and fall-run Chinook salmon, coho salmon, and chum salmon hatchery programs have contributed fewer than 3,000 salmon carcasses annually. This has had a negligible positive effect on nutrient cycling within EFH and critical habitat for ESA-listed salmon and steelhead. The carcasses add marine-derived nutrients from hatchery-origin fish that die and decompose after spawning, but these contributions have been relatively minor compared to other nutrient sources, such as natural-origin spawners. Under Alternative 1 (No Action) and Alternative 2 (Proposed Action), the salmon hatchery programs would have the same production levels as under existing conditions, except that the fall-run Chinook salmon hatchery program would have a higher likelihood of achieving its maximum production level. The actual number of hatchery-origin adult salmon spawning naturally would likely increase by a few hundred fish compared to existing conditions, assuming actual program releases are near the maximum production level. Nevertheless, the increases from the hatchery programs would likely not be large enough to substantially change the magnitude of effects, which would continue to have a negligible positive effect on nutrient cycling. In contrast, Alternative 3 (Termination) would have a negligible negative effect in EFH and critical habitat compared to Alternative 1 because there would be no contribution of marine-derived nutrients from hatchery-origin fish. Under Alternative 4 (Reduced Production), production levels would be reduced 50 percent compared to Alternative 1. Consequently, naturally spawning hatchery-origin salmon would contribute marine-derived nutrients to the Stillaguamish River Basin but at a lower level than under Alternative 1. Compared to Alternative 1, the reduction in hatchery production levels would result in a negligible negative effect on nutrient cycling in EFH and critical habitat under Alternative 4.

4.5 Other Fish Species

This subsection discusses the effects of the alternatives on other fish species. As described in Subsection 3.5, Other Fish Species, the analysis focuses on bull trout, which consume hatchery-origin salmon. The low numbers of threatened bull trout in the Stillaguamish River Basin may be positively affected to the extent they prey on hatchery-origin salmon released from the hatchery programs; however, bull trout typically prey on a variety of food sources. The Stillaguamish River is a bull trout core area (USFWS 2015a), and portions of the Stillaguamish River Basin are critical habitat for bull trout (75 Fed. Reg. 63898, October 18, 2010).

Bull trout are potentially affected by hatchery operations through broodstock collection and use of fish traps, although all bull trout encountered (typically six to seven juveniles and five to six adults annually) are quickly returned alive to the stream. Under existing conditions, the salmon hatchery programs in the Stillaguamish River Basin have contributed to the prey base of bull trout; however, other sources of salmon (including chum salmon and pink salmon), steelhead, and trout, as well as aquatic insects, are also important prey items for bull trout.

4.5.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the salmon hatchery programs would operate the same as under existing conditions and would produce up to the maximum production level of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions. Production levels would remain small but would be somewhat different (both higher and lower) than actual production in the recent past. The largest difference would be that the fall-run Chinook salmon hatchery program would be more likely to achieve its maximum production level compared to existing conditions.

Under Alternative 1 and Alternative 2, the effects on bull trout from the hatchery programs would be similar to existing conditions, except there would likely be more encounters with juvenile bull trout during the collection of smolts for the captive broodstock component of the fall-run Chinook salmon hatchery program. This is because collection efforts would be increased from 2 to up to 5 days per week during the collection period. Although these collection activities would likely result in the handling of more juvenile bull trout (about 2.5 times more, assuming similar encounter rates as existing conditions), few (up to seven juveniles annually) have been captured in previous years and all have been quickly released alive. The collection of adult broodstock for the summer-run Chinook salmon hatchery program under Alternative 1 and Alternative 2 would be the same as under existing conditions, which has resulted in the incidental annual catch of up to six adult bull trout that were quickly released alive. Consequently, the magnitude of effects from both the summer-run and fall-run Chinook salmon broodstock collections would be only slightly higher than under existing conditions and would thus be a negligible negative effect.

As summarized by USFWS (2019), hatchery operations and broodstock collection would not result in any measurable decline in the abundance, reproduction, survival, or distribution of bull trout at the scale of the local populations, and USFWS does not anticipate any long-term changes in habitat or function under Alternative 1 and Alternative 2. Thus, hatchery operations and broodstock collection would not affect bull trout critical habitat.

As discussed in Subsection 3.5, Other Fish, salmon directly and indirectly contribute to the prey base of bull trout. Under Alternative 1 and Alternative 2, bull trout would benefit from moderately higher fall-run Chinook salmon hatchery releases that would increase availability of juvenile salmon as prey and stimulate ecosystem productivity that supports other bull trout prey species (other fish and aquatic insects), thus resulting in a negligible positive effect. As a result, Alternative 1 and Alternative 2 would have both negligible positive and negligible negative effects on bull trout.

4.5.2 Alternative 3 (Termination)

Under Alternative 3, the hatchery programs would be terminated, and no salmon would be produced by the hatcheries in the Stillaguamish River Basin (Table 1). Under Alternative 3, the termination of salmon hatchery releases would eliminate hatchery-origin fish as prey for bull trout in the Stillaguamish River Basin and reduce the abundance of salmon that would stimulate ecosystem productivity that supports other bull trout prey species; however, there would be no potential handling of bull trout during broodstock collection because this activity would no longer occur. Since bull trout have been found to benefit from salmon presence and abundance as described in Subsection 3.5, Other Fish Species, there may be minor negative effects on local ecosystem productivity and bull trout prey availability from termination of the hatchery programs. Similar to that described under Alternative 1, Alternative 3 would not affect bull trout critical habitat. Overall, compared to Alternative 1 (No Action), the effects on bull trout under Alternative 3 would be negligible negative from loss of hatchery-produced salmon as prey and reduced ecosystem productivity that supports other prey species and negligible positive due to the avoidance of handling bull trout.

4.5.3 Alternative 4 (Reduced Production)

Under Alternative 4, salmon hatchery production would be reduced 50 percent compared to Alternative 1 (No Action) (Table 1). Under Alternative 4, effects on bull trout from hatchery programs releasing salmon would be similar to, but less than, under Alternative 1, primarily because the number of fish released would be less and there would be fewer hatchery-origin salmon available as prey or to stimulate ecosystem productivity. Additionally, the potential for handling bull trout during broodstock collection would be lower than under Alternative 1 since fewer broodstock would be collected. As described under Alternative 3, there may be a decrease in salmon presence and ecosystem productivity corresponding to decreased hatchery production that may affect bull trout prey. Similarly, as described under Alternative 1, the hatchery programs under Alternative 4 would not affect bull trout critical habitat. Overall, under Alternative 4, the salmon hatchery programs in the Stillaguamish River Basin would have a negligible negative effect on bull trout due to loss of hatchery-origin salmon as prey and a negligible positive effect due to the decreased handling of bull trout during broodstock collection compared to Alternative 1.

4.6 Wildlife

The following subsection addresses the effects of the alternatives on wildlife. As described in Subsection 3.6, Wildlife, the effects of salmon hatchery programs on wildlife species other than Southern Resident killer whale would likely be unsubstantial and are not considered further.

Under the existing conditions described in Subsection 3.6, Wildlife, Southern Resident killer whales are listed as endangered under the ESA and are present in the analysis area. Adult Chinook salmon are a primary component of their diet during the summer and are also important during winter. Chum salmon are also important prey during fall months. Adult hatchery-origin Chinook salmon represent 74 percent of the total number of Chinook salmon (hatchery-origin and natural-origin) returning to Puget Sound (NMFS 2014, Table 3.2-1). Hatchery-origin Chinook salmon returning to the Stillaguamish River Basin are high-priority components of the prey base for Southern Resident killer whales; however, due to the small number of Stillaguamish River Basin Chinook salmon hatchery returns (on average about 824 fish annually) (Subsection 3.6, Wildlife), the hatchery-origin Stillaguamish Chinook salmon would not provide a substantial part of the whales' diet. Chinook salmon (especially fall-run Chinook salmon) from northern Puget Sound have been observed in the whales' diet, are consumed by the whales at their time of greatest need, and have a high degree of overlap in space and time with the whales. Overall, the Stillaguamish River Basin salmon hatchery programs have had a negligible positive effect on the diet, survival, and distribution of Southern Resident killer whales under existing conditions, primarily because returning hatchery-origin adult salmon (especially Chinook salmon) represent a small but meaningful part of the Southern Resident killer whale food base, particularly during the fall months.

4.6.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the salmon hatchery programs would operate the same as under existing conditions and would produce up to the maximum production level of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions. Production levels would remain small but would be somewhat different (both higher and lower) than actual production levels in the recent past. The largest difference would be that the fall-run Chinook salmon hatchery program would be more likely to achieve its maximum production level compared to existing conditions. Considering all potential effects, the salmon hatchery programs in the Stillaguamish River Basin would have a negligible positive effect on the diet, survival, and distribution of Southern Resident killer whales, which is the same effect as under existing conditions. This is because the returning hatchery-origin adult salmon (especially Chinook salmon) would represent a small but meaningful part of the prey base for Southern Resident killer whales relative to the total number of hatchery-origin and natural-origin salmon available from throughout the greater Puget Sound, Strait of Georgia, and Pacific Coast areas, particularly during the fall months.

4.6.2 Alternative 3 (Termination)

Under Alternative 3, the hatchery programs would be terminated, and no salmon would be produced by the Stillaguamish River Basin hatcheries (Table 1). The reduction in hatchery-origin salmon releases in Puget Sound would result in short- and long-term reductions in the number of adult salmon that would be available as food for Southern Resident killer whales. The direct effects (i.e., reduction of hatchery-origin Chinook salmon) would represent a loss of less than 1 percent of the total Chinook salmon prey base for the whales. Under Alternative 3, considering all potential effects, termination of the salmon hatchery programs in the Stillaguamish River Basin would have a negligible negative effect on the diet, survival, and distribution of Southern Resident killer whales, which would be in the opposite direction compared to Alternative 1 (No Action) (a negligible positive effect). This is because termination of the salmon hatchery programs in the Stillaguamish River Basin would result in a small but meaningful reduction to the overall prey base (especially Chinook salmon) for Southern Resident killer whales, particularly during the fall months.

4.6.3 Alternative 4 (Reduced Production)

Under Alternative 4, production from the salmon hatchery programs would be reduced by 50 percent compared to Alternative 1 (No Action) (Table 1). The reductions under Alternative 4 would result in short- and long-term reductions in the number of adult salmon that would be available as food for Southern Resident killer whales compared to Alternative 1. Under Alternative 4, considering all potential effects, the salmon hatchery programs in the Stillaguamish River Basin would still provide a small but meaningful contribution to the diet, survival, and distribution of Southern Resident killer whales, particularly during the fall months but would be less than under Alternative 1. Thus, the reduction in releases of hatchery-origin fish would result in a negligible negative effect on Southern Resident killer whales compared to Alternative 1.

4.7 Cultural Resources

The following subsection 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. Salmon are an important cultural resource for the Stillaguamish Tribe of Indians and the Tulalip Tribes. Although tribes prioritize subsistence and ceremonial harvest over tribal commercial harvest, the total number of adult salmon returning to the Stillaguamish River Basin is limited and has impacted the tribes' ability to harvest salmon altogether. Furthermore, some tribes believe that the abundance of fish under existing conditions is inadequate to meet their subsistence needs (Subsection 3.7, Cultural Resources). The Stillaguamish River Basin is the Stillaguamish Tribe of Indians' usual and accustomed fishing area. The Tulalip Tribes' usual and accustomed fishing area includes marine areas of Port Susan, Possession Sound, and Port Gardner. Within these areas, the tribes manage ceremonial and subsistence harvest and, along with the State of Washington, co-manage commercial harvests. As described in Subsection 3.7, Cultural Resources, salmon produced by the Stillaguamish River Basin hatcheries provide an important cultural benefit and have had a high positive effect on the Stillaguamish Tribe of Indians and Tulalip Tribes.

4.7.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the hatchery programs would operate the same as under existing conditions and would produce up to the maximum production level of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions. Production levels would remain small but would be somewhat different (both higher and lower) than actual production levels in the recent past. The largest difference would be that the fall-run Chinook salmon hatchery program would more likely achieve its maximum production level compared to existing conditions, and consequently more adult fall-run Chinook salmon would return and potentially be available to harvest for ceremonial and subsistence if allowed by the co-managers. The production of juvenile salmon and their potential for future adult salmon ceremonial and subsistence harvest would increase an important cultural benefit compared to existing conditions and have a high positive effect on the Stillaguamish Tribe of Indians and Tulalip Tribes.

4.7.2 Alternative 3 (Termination)

Under Alternative 3, the salmon hatchery programs would be terminated, and no salmon would be produced in the Stillaguamish River Basin (Table 1). The loss of salmon production from the hatchery programs would reduce the number of adult salmon returning to the Stillaguamish River Basin and diminish the potential for long-term harvest of salmon for ceremonial and subsistence uses by the Stillaguamish Tribe of Indians and Tulalip Tribes. Under Alternative 3, there would be a high negative effect on cultural resources compared to Alternative 1 (No Action).

4.7.3 Alternative 4 (Reduced Production)

Under Alternative 4, production from the salmon hatchery programs would be reduced 50 percent compared to Alternative 1 (No Action) (Table 1). The reduction in hatchery production under Alternative 4 would decrease the number of salmon available to the tribe for ceremonial and subsistence uses. Decreased numbers of adult salmon under Alternative 4 would result in a decrease in the amount of salmon available for subsistence and ceremonial harvest. Compared to Alternative 1, the reduced production levels under Alternative 4 would result in a moderate negative effect on cultural resources.

4.8 Socioeconomics

The following analysis discusses the effects of the alternatives on socioeconomics. As described in Subsection 3.8, Socioeconomics, the salmon hatchery programs provide employment opportunities and procure goods and services for hatchery operations under existing conditions. In addition, harvest of Chinook salmon, coho salmon, and chum salmon produced by the Stillaguamish River Basin hatcheries provide economic benefits to the local and regional economies.

In general, employment and expenditures associated with hatchery operations provide substantial economic benefits ($800,000 annually) to local economies, particularly to the small communities with commercial businesses in the local area. In contrast, as described in Subsection 3.8.2, Socioeconomics – Fisheries, economic contributions from fisheries targeting Stillaguamish River Basin salmon (including hatchery-origin fish) are generally unsubstantial. For example, commercial tribal and non-tribal fisheries targeting hatchery-origin Stillaguamish Chinook salmon in Puget Sound have been closed since the 1980s; thus, all harvest of Chinook salmon from the Stillaguamish River Basin has been incidental to other fisheries. Some level of non-tribal commercial and recreational harvest of coho salmon and chum salmon from the Stillaguamish River Basin has occurred in adjacent marine areas, as well as within the Stillaguamish River by tribal commercial fishermen, but both of these stocks are managed for natural production and fisheries occur when the natural production can support them. In-river Stillaguamish River tribal fisheries have generally only been for ceremonial and subsistence purposes in recent years. In addition, mixed-stock commercial and recreational fisheries for coho salmon and chum salmon occur elsewhere in Puget Sound and could potentially harvest hatchery-origin salmon from the Stillaguamish River Basin.

Overall, the minor economic contributions from hatchery employment and operations, including the resulting procurement of goods and services in the local area, as well as commercial and recreational harvests of hatchery-origin salmon from the Stillaguamish River Basin, have resulted in a negligible benefit to local socioeconomics under existing conditions.

4.8.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the hatchery programs would operate the same as under existing conditions and would produce up to the maximum production level of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions. Production levels would remain small but would be somewhat different (both higher and lower) than actual production levels in the recent past. The largest difference would be that the fall-run Chinook salmon hatchery program would be more likely to achieve its maximum production level compared to existing conditions. Economic contributions from hatchery operations and employment of staff would be the same as under existing conditions. Harvest of Chinook salmon, coho salmon, and chum salmon in commercial and recreational fisheries would not be substantially different because there are no fisheries that specifically target the hatchery-origin Chinook salmon from the Stillaguamish River Basin and the hatchery production levels would remain small compared to programs with harvest augmentation objectives (generally on the order of 1.0 million or more fish released) (Appendix B, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities). Consequently, the salmon hatchery programs would result in a negligible positive effect on socioeconomics.

4.8.2 Alternative 3 (Termination)

Under Alternative 3, the salmon hatchery programs would be terminated, and no salmon would be produced (Table 1). There would be no socioeconomic contributions from salmon hatchery operations, and staff would not be employed to raise salmon. In addition, no hatchery-origin salmon from the Stillaguamish River Basin would be available for commercial or recreational harvest. Consequently, under Alternative 3, there would be a negligible negative effect on socioeconomics, compared to Alternative 1 (No Action), because, although the socioeconomic benefit of the existing hatchery programs has been positive, its contribution to the local economy has been minimal.

4.8.3 Alternative 4 (Reduced Production)

Under Alternative 4, production from the salmon hatchery programs would be reduced 50 percent compared to Alternative 1 (No Action) (Table 1). The reduction in hatchery production under

Alternative 4 would decrease the economic contributions from hatchery operations and employment of staff, the procurement of goods and services, and contributions to commercial and recreational salmon fisheries. Under Alternative 4, there would be a negligible negative effect on socioeconomics compared to Alternative 1.

4.9 Human Health

The following analysis discusses the effects of the alternatives on human health. As described in Subsection 3.9, Human Health, operation of hatchery facilities in the Stillaguamish River Basin may affect human health through chemicals used at hatchery facilities, procedures used to handle those chemicals, toxic contaminants potentially present in hatchery-origin fish, and diseases potentially transmitted to people handling infected fish.

As described in Subsection 3.9, Human Health, effects of hatchery operations on human health under existing conditions within the Stillaguamish River Basin have not been substantial because hatchery operations comply with worker safety programs, rules, and regulations; the use of therapeutics is minimal and in compliance with label requirements; and personal protective equipment is used to limit the spread of pathogens.

Additionally, although fish are nutritionally beneficial, concerns may exist when fish contain toxic contaminants that pose health risks to people. However, contaminants accumulated during hatchery rearing are expected to contribute very little to contaminant concentrations in returning adult salmon (Subsection 3.9, Human Health). Toxic contaminants accumulated by individual hatchery-origin fish before and after release would be the same under all alternatives because the accumulation of toxic contaminants would not depend on changes in hatchery production levels.

4.9.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the hatchery programs would operate the same as under existing conditions and would produce up to the maximum production level of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions. Production levels would remain small but would be somewhat different (both higher and lower) than actual production levels in the recent past. The largest difference would be that the fall-run Chinook salmon hatchery program would be more likely to achieve its maximum production level compared to existing conditions. The negative effects of the hatchery programs on human health under Alternative 1 and Alternative 2 would be negligible because hatchery operations would comply with worker safety programs, rules, and regulations; the use of therapeutics would be minimal and in compliance with label requirements; and personal protective equipment would be used to limit the spread of pathogens.

4.9.2 Alternative 3 (Termination)

Under Alternative 3, the salmon hatchery programs would be terminated, and no hatchery-origin salmon associated with the HGMPs would be produced (Table 1). Therefore, all human health effects associated with the salmon hatchery programs would be eliminated compared to Alternative 1 (No Action). Under Alternative 3, considering all potential human health risks, there would be a negligible positive effect on human health, compared to Alternative 1.

4.9.3 Alternative 4 (Reduced Production)

Under Alternative 4, production from the salmon hatchery programs would be reduced 50 percent compared to Alternative 1 (No Action) (Table 1). Although fewer fish would be produced under Alternative 4, there would still be a negligible negative effect on human health, the same as under Alternative 1, because hatchery operations would comply with worker safety programs, rules, and regulations; the use of therapeutics would be minimal and in compliance with label requirements; and personal protective equipment would be used to limit the spread of pathogens.

4.10 Environmental Justice

This subsection determines if there would be disproportionately high and adverse human health or environmental effects from the salmon hatchery programs under the alternatives on minority and low-income environmental justice populations. In Subsection 3.10, Environmental Justice, Native American tribes (particularly the Stillaguamish Tribe of Indians and Tulalip Tribes) were identified as an environmental justice population. Subsection 3.10, Environmental Justice, also identifies the Asian community in Snohomish County, Hispanic and low-income communities in Everett, and recreational fishermen as potential environmental justice groups and communities; however, there are insufficient data and information available to evaluate whether these groups or communities would be uniquely affected by salmon hatchery programs in the Stillaguamish River Basin, and they are not further analyzed.

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, wildlife, and human health would not affect environmental justice populations or communities. However, effects under the alternatives on socioeconomics and cultural resources important to Native American tribes may affect environmental justice populations. Note that, although commercial fishing is currently not permitted for Chinook salmon due to the low numbers of fish returning to the Stillaguamish River Basin and fisheries for coho salmon and chum salmon vary annually depending on forecasted return levels of natural-origin fish, it is assumed that commercial and/or recreational fishing may occur in the future and hatchery-origin salmon could be harvested as part of these fisheries but would not be the primary target. Consequently, the analysis in this subsection assumes the potential for future commercial and recreational fishing.

As described in Subsection 3.10, Environmental Justice, harvest of fish for ceremonial and subsistence use provides important cultural resource values to Native American tribes. In addition, the Stillaguamish River Basin hatcheries provide salmon that contribute to socioeconomic benefits from tribal commercial fisheries and associated personal income, and they support employment of hatchery staff.

4.10.1 Alternative 1 (No Action) and Alternative 2 (Proposed Action)

Under Alternative 1 and Alternative 2, the hatchery programs would operate the same as under existing conditions and would produce up to the maximum production level of juvenile fish as shown in Table 1, which is similar to production levels under existing conditions. Production levels would remain small but would be somewhat different (both higher and lower) than actual production levels in the recent past. The largest difference would be that the fall-run Chinook salmon hatchery program would more likely achieve its maximum production level compared to existing conditions. Hatchery programs under Alternative 1 and Alternative 2 would support Native American cultural resource values. As a result, there would be no adverse effects on cultural resources important to Native American tribes under Alternative 1 or Alternative 2. Similarly, tribal commercial fishing and tribal hatchery employment would be the same as under existing conditions, and no adverse effects on socioeconomics would occur under Alternative 1 or Alternative 2.

4.10.2 Alternative 3 (Termination)

Under Alternative 3, the salmon hatchery programs would be terminated, and no hatchery-origin salmon would be produced in the Stillaguamish River Basin (Table 1). The loss of hatchery-origin fish would result in a substantial adverse effect on tribal cultural resources, specifically to their unique ceremonial and subsistence uses. Given the importance of salmon to Native American tribes, and given that this importance is not paralleled among other populations, these adverse effects would be high and disproportionate. This disproportionate effect cannot be quantified, as no metric can be attributed to the value of this resource to Native American tribes.

Socioeconomic effects on Native American tribes include those from the potential for future tribal commercial fisheries for fish returning to the Stillaguamish River Basin and operation and employment from tribal hatcheries. Although termination of salmon hatchery production under Alternative 3 would decrease harvest opportunities and result in an adverse effect, this decrease would not be disproportionate since all commercial and recreational fishermen, as well as Native American tribes, would be equally affected. However, since the salmon hatchery programs in the Stillaguamish River Basin have a preference to employ Indians, the loss of hatchery employment would result in both an adverse and disproportionate effect on Native American tribes (particularly the Stillaguamish Tribe of Indians) that would not occur for other affected populations in the analysis area.

4.10.3 Alternative 4 (Reduced Production)

Under Alternative 4, production from the salmon hatchery programs would be reduced 50 percent compared to Alternative 1 (Table 1); thus, the hatchery programs would contribute fewer salmon for subsistence and ceremonial uses and would decrease the number of salmon available for harvest under Alternative 4 compared to Alternative 1. Given the significance of salmon to Native American tribes and that this significance is not paralleled among other populations, these adverse effects would be high and disproportionate. This disproportionate effect cannot be quantified, as no metric can be attributed to the importance of this cultural resource to Native American tribes.

Socioeconomic effects on tribal commercial fishing from a reduction in the number of hatchery-origin fish produced in the Stillaguamish River Basin under Alternative 4 would be adverse, but would not be disproportionate to Native American tribes because any changes in the number of fish harvested, personal income, and jobs derived from commercial fishing under Alternative 4 would be the same for all commercial fishermen, including the Stillaguamish Tribe of Indians and Tulalip Tribes. However, the number of hatchery jobs would affect Native American tribes. Generally, there is a preference for hiring Indians when hatcheries are operated by Native American tribes (as occurs in the Stillaguamish River Basin). Under Alternative 4, hatchery employment opportunities would decrease for the Stillaguamish River Basin hatcheries, which would be an adverse and disproportionate effect specific to Native American tribes (particularly the Stillaguamish Tribe of Indians).

5 CUMULATIVE EFFECTS

This chapter discusses the cumulative effects 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 effects are the effects "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.

The cumulative effects analysis area includes the project area described in Subsection 1.3, Project and Analysis Areas, with attention to the freshwater, estuarine, and adjacent nearshore marine areas of the Stillaguamish River Basin. For some resources, the cumulative effects analysis area may be larger than the project area, since some of the effects may occur outside the project area. Each resource-specific analysis area is described in Chapter 3, Affected Environment, at the beginning of the subsection for each resource. The analysis area for environmental justice is also described at the beginning of Subsection 3.10, Environmental Justice.

The temporal scope of past and present actions for the affected resources and environmental justice encompasses actions that occurred prior to and after Puget Sound salmon and steelhead species were listed under the ESA. This is also the temporal context within which affected resources and environmental justice 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 at least 15 years. For example, the analysis of development and habitat restoration effects in this chapter encompasses 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 contrast, climate change is expected to occur over the long term. Thus, the analysis reflects shorter-term effects in relation to the scale of climate change. Considering this timeframe, the cumulative effects analysis provides expected trends but recognizes that enough 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. As described, past actions that contributed to the present condition of resources considered in this EA primarily include forest management practices, agricultural practices, development and urbanization, hatchery practices, and fisheries. In combination, but to varying degrees, these actions resulted in the loss and degradation of aquatic habitat, changes in salmon and steelhead genetic structure, or fisheries over-exploitation, which in turn have led to declines in salmon and steelhead populations in the Stillaguamish River Basin.

Climate change, development, habitat restoration, hatchery production, and fisheries are the primary factors contributing to the cumulative effects on the resources and environmental justice communities considered in this EA. The following subsections 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. Climate change studies have been conducted specific to the Stillaguamish River Basin (Hall et al. 2014; Krosby et al. 2016). Krosby et al. (2016) states that the following changes are anticipated to occur in the Stillaguamish River Basin: (1) rising air temperature; (2) increasing annual, seasonal, and extreme precipitation; (3) extreme high and low stream flows; (4) higher fresh and ocean water temperatures with increased probability of sea level rise and storm surges; (5) increased probability of landslides and sediment transport; (6) increased forest fire and insect risks; and (7) ocean acidification affecting adjacent marine areas of Port Susan (the Stillaguamish River Basin encompasses estuaries and 22 miles of shoreline). Trends observed in recent years, and expected to continue over time, include increasing peak flows driven by precipitation falling as rain rather than snow. Climate change studies by Ford (2011) and Hamlet (2011) for the Pacific Northwest predict similar changes throughout the region.

These changes will affect the human environment and biological ecosystems within the cumulative effects analysis area (Ecology 2012; Mauger et al. 2015; NWFSC 2015; King County 2016; Krosby et al. 2016). Changes to organisms and their habitats are likely to include shifts in timing of life history events, changes in growth and development rates, and changes in habitat and ecosystem structure (Littell et al. 2009; Johannessen and Macdonald 2009; Krosby et al. 2016). The most heavily affected ecosystems and 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 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 effects and pace of climate change will become clearer as evidence of change accumulates. However, the effects of climate change are likely to be less pronounced in the near term compared to the long-term projections, and annual weather patterns (variation in seasonal temperatures and precipitation) in the near term may mask long-term trends (Ecology 2012).

5.1.2 Development

As described in Subsection 3.1, Environmental Setting, land use in the Stillaguamish River Basin is primarily rural with a combination of forest management, agriculture, and urban land uses. Land within the project area is primarily in Federal ownership (Mount Baker-Snoqualmie National Forest) in the Stillaguamish River headwaters and privately owned below in the Stillaguamish River valley. Washington State-owned lands in the river basin include trust lands managed for timber harvest revenues, as well as natural preserves. 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 (Washington Department of Natural Resources 1997), respectively. The Mount Baker-Snoqualmie National Forest logging plans are currently focused on thinning second-growth forest, rather than logging old growth (U.S. Forest Service 2018).

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 2005), as implemented by private landowners that conduct forest practices 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. To decrease impacts from land use and development, the Stillaguamish Watershed Council (2015) initiated a land acquisition strategy to purchase lands that would be set aside from development to aid in Chinook salmon recovery. It is also anticipated that BMPs will evolve to reduce impacts to aquatic habitat. For example, the Stillaguamish Tribe of Indians is developing innovative techniques for managing dairy waste to minimize impacts to adjacent streams.

Much of the flood plain and adjacent riparian areas supporting the Stillaguamish River and aquatic habitat are under jurisdiction of the Snohomish County Shoreline Management Program, which is required under

Washington State's Shoreline Management Act. The most recent update to this program includes a cumulative impacts analysis (Snohomish County 2010) projecting reasonably foreseeable development through 2025. The analysis includes the NF, SF, and mainstem Stillaguamish Rivers and the saltwater areas of Port Susan, Possession Sound, and Port Gardner, which are all designated shorelines of statewide significance. The analysis also identifies seven areas within the Stillaguamish River Basin with high potential for development: three in the SF Stillaguamish River subbasin, two in the NF Stillaguamish River subbasin, and two in the Stillaguamish River/Portage Creek subbasin. Similar trends as those shown through 2025 would also be expected to occur over the next 15 years.

By 2025, the Snohomish County Shoreline Management Program Cumulative Impacts Analysis (Snohomish County 2010) projects 514 new primary structures, 37 acres of new impervious surface, and 48 acres of new vegetation clearing in areas under Shoreline Management Program jurisdiction within the Stillaguamish River Basin. Depending on the specific shoreline designations of these potential areas, development may be offset through specific use and modification regulations, critical area regulations, and accepted mitigation and/or restoration requirements. For the overall county and comparing the Stillaguamish River Basin with other areas within Snohomish County, development intensity for the Stillaguamish River Basin is considered low (Snohomish County 2010).

5.1.3 Habitat Restoration

Habitat restoration within the Stillaguamish River Basin has been conducted by several entities, including the Stillaguamish Tribe of Indians, Tulalip Tribes, Salmon Recovery Funding Board through the Washington State Recreation and Conservation Office, Snohomish Conservation District, and the U.S. Forest Service, among others (Washington State Recreation and Conservation Office 2018). For example, since 1990, the Stillaguamish Tribe of Indians has planted riparian vegetation, removed invasive plants, removed bank hardening, replaced or removed fish-blocking culverts and other aquatic barriers, installed log jams, and helped to increase habitat value in the Stillaguamish River Basin (Stillaguamish Tribe of Indians 2018). Altogether, since 1998, salmon recovery funding for the Stillaguamish River Basin has included 102 completed projects, 22 active projects, 2 conceptual projects, and 2 proposed projects focused on protecting and/or increasing salmon habitat and removing salmon migration barriers (Washington State Recreation and Conservation Office 2018). It is anticipated that past contributors to habitat restoration will continue to be active in the Stillaguamish River Basin.

The types of habitat restoration projects to be implemented in the future are likely to be similar to those implemented since 1990. In addition to the above, these activities may include land acquisition and preservation, road decommissioning, water quality improvements, and initiation of a valley protection initiative. For the years 2018 to 2022, Snohomish County (2018) identified 15 habitat restoration projects intended to increase fish habitat and access within the river basin. 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 Stillaguamish 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 (Washington State Department of Transportation 2018).

5.1.4 Hatchery Production

The type and extent of salmon and steelhead hatchery programs other than those considered under the alternatives and the numbers of fish released in the cumulative effects analysis area will likely change over time in response to new information and evolving management objectives. While it is possible that some hatchery programs in Puget Sound may reduce production in the future, it is also possible that some programs may increase production to increase the prey base for Southern Resident killer whales, provide additional harvest benefits, mitigate for new habitat degradation and climate change, or to bolster abundance temporarily while habitat is restored. In general, effects of such changes on natural-origin salmon and steelhead (e.g., genetic effects and competition and predation risks) would be reduced for those species listed under the ESA. For example, effects on natural-origin Chinook salmon and steelhead are expected to decrease over time to the extent that hatchery programs are reviewed and approved by NMFS under the ESA.

Hatchery program compliance with conservation provisions of the ESA will ensure that listed species are not jeopardized and that “take” under the ESA from salmon and steelhead hatchery programs is minimized or avoided. For example, the existing WDFW hatchery program producing early summer-run steelhead at the Whitehorse Hatchery may be submitted to NMFS for review and ESA compliance within the temporal scope of this cumulative effects analysis. It is possible that steelhead production from the Whitehorse Hatchery could change in the future as part of a submittal, but the direction or magnitude of any potential changes are currently not foreseeable. New conservation programs for Stillaguamish River fish may be proposed in the future to bolster natural-origin populations. Assuming future compliance with the ESA and continued implementation and/or expansion of conservation hatchery programs, such hatchery programs would be a benefit to help increase the size of salmon and steelhead populations in the future.

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 Stillaguamish River Basin and adjacent marine catch areas where hatchery-origin salmon produced by hatchery programs in the river basin are incidentally harvested. These fisheries have provided for tribal and non-tribal commercial fisheries and non-tribal recreational fisheries, as well as for tribal ceremonial and subsistence uses. However, due to conservation concerns, no commercial or recreational fisheries currently target hatchery-origin adult salmon returning to the Stillaguamish River Basin.

Effects on ESA-listed natural-origin Chinook salmon and steelhead from fisheries are expected to decrease over time to the extent that fisheries management programs continue to be reviewed and approved by NMFS. 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 salmon and steelhead 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 future fisheries may be considered.

A Chinook salmon harvest resource management plan is currently under development by Puget Sound Indian Tribes and WDFW (2017) and review by NMFS. The plan is intended to provide guidance for implementing fisheries in Washington for management years 2019–2020 through 2028–2029. In addition, annual pre-season planning will occur to develop a fishing regime (i.e., set exploitation rate ceilings for each management unit) that meets the guidance provided in the resource management plan.

5.2 Cumulative Effects by Resource

Below is an analysis of the effects on each resource and 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

Subsection 3.2, Water Quantity, describes existing conditions for water quantity. Under existing conditions, the salmon hatchery programs in the Stillaguamish River Basin have had a negligible effect on water quantity. The direct and indirect effects of the alternatives on water quantity are described in Subsection 4.2, Water Quantity, and would result in a negligible negative effect under Alternative 1 (No Action) and Alternative 2 (Proposed Action) and a negligible positive effect compared to Alternative 1 under Alternative 3 (Termination) and Alternative 4 (Reduced Production). Climate change and 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 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 Stillaguamish River Basin (WAC Chapter 173-505) established instream flows necessary to protect and preserve wildlife, fish, and other environmental values and uses established rules for 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 Subsection 5.1.4, Hatchery Production, changes in hatchery programs other than those considered under the alternatives may occur over time. These changes are unlikely to substantially change water quantity in the Stillaguamish 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 improve water quantity to the extent that less water is used in hatchery operations and thus, less water is removed from source locations, 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 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, restoration, hatchery operations, and fisheries would either be beneficial or have no effect on water quantity. These cumulative effects on water quantity, combined with the negligible effects under the alternatives, would not substantially change current trends. The negative trends in water quantity resulting from the cumulative effects of climate change, development, habitat restoration, hatchery production, and fisheries, combined with effects from the alternatives, would have the same result: a negligible negative effect. This results from the minimal use of water resources by Stillaguamish River Basin salmon hatchery programs (as described in Chapter 3, Affected Environment, and Chapter 4, Environmental Consequences), which would be the same under all alternatives and reasonably foreseeable future actions.

5.2.2 Water Quality

Subsection 3.3, Water Quality, describes existing conditions for water quality. Under existing conditions, the Stillaguamish River Basin salmon hatchery programs have had a negligible effect on water quality. The direct and indirect effects of the alternatives on water quality are described in Subsection 4.3, Water Quality. Alternative 1 (No Action) and Alternative 2 (Proposed Action) would have negligible negative effects on water quality, while Alternative 3 (Termination) and Alternative 4 (Reduced Production) would have negligible positive effects compared to Alternative 1. Climate change and 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 development, if past and present trends continue, the effectiveness of these regulations over time would likely vary. Future habitat restoration (such as helping to decrease water temperatures through stream shading and decreases in sedimentation) would likely improve water quality.

As discussed in Subsection 5.1.4, Hatchery Production, changes in hatchery programs other than those considered under the alternatives may occur over time. These changes are unlikely to change or improve water quality in the Stillaguamish River Basin because the non-salmon hatchery programs (i.e., steelhead and rainbow trout) at the Whitehorse Hatchery are the only ones that could potentially affect this resource. Water quality would be protected from changes in production within the existing non-salmon hatchery programs, or from new programs, by compliance with the NPDES permit issued for operations at the Whitehorse Hatchery, which is intended to avoid exceedance of water quality standards. Salmon and steelhead fisheries would not be expected to affect water quality because fishing activities, other than the potential for unintentional and generally minor oil and gas leakage from motorboat use, do not result in the release of any contaminants into the aquatic environment.

Overall, effects of climate change, development, and hatchery production on water quality may reduce water quality from the existing conditions described in Subsection 3.3, Water Quality. These negative effects may be offset to some extent by habitat restoration and decreases in production from non-salmon hatchery programs in the Stillaguamish River Basin, if any occur; however, these actions may not fully, or even partially, mitigate for the greater impacts of climate change and development on water quality, although this is the goal of many of the restoration programs. When combined with effects under Alternative 3 and Alternative 4, the negative trends of cumulative effects on water quality would be reduced because of the termination, or decrease in, hatchery-origin salmon production in the Stillaguamish River Basin. In contrast, effects under Alternative 1 and Alternative 2 (Proposed Action) would continue to contribute to the negative trends on water quality due to the production of hatchery-origin salmon. Nevertheless, the overall negative trends in water quality resulting from the cumulative effects of climate change, development, habitat restoration, hatchery production, and fisheries would be similar under all alternatives because the Stillaguamish River Basin salmon hatchery programs would have a negligible negative effect on water quality under all alternatives.

5.2.3 Salmon and Steelhead

Subsection 3.4, 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 Subsection 4.4, Salmon and Steelhead. Depending on the affected species and type of effect, the hatchery programs under Alternative 1 (No Action) and Alternative 2 (Proposed Action) would have negligible to low negative effects on natural-origin salmon and steelhead due to genetics, competition and predation, facility operations, masking, and disease transfer risks depending on species. There would be a negligible positive effect on marine-derived nutrients, negligible to high positive effects on population viability for natural-origin salmon and steelhead, and no effects due to incidental fishing. Under Alternative 3 (Termination), all positive and negative effects would be eliminated compared to Alternative 1, which would place the summer-run and fall-run Chinook salmon populations at a higher risk of decline in population viability. Under Alternative 4 (Reduced Production), the positive and negative effects would be reduced compared to Alternative 1.

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 11. The effects of climate change on salmon and steelhead are described in general by the Independent Scientific Advisory Board (2007) and would vary among species and among species' life history stages (NWFSC 2015). Climate change, particularly changes in streamflow and water temperatures over the near and long term (20 to 60 years), is the primary factor that would likely affect hatchery-origin and natural-origin salmon and steelhead.

In a vulnerability analysis that modeled the impacts from climate change on a wide variety of resources in the Stillaguamish River and watersheds in northern Puget Sound, Krosby et al. (2016) concluded that Chinook salmon, steelhead, coho salmon, and bull trout would be moderately vulnerable to the effects of climate change by the 2050s and extremely vulnerable to such effects by the 2080s because of the species' narrow thermal tolerances and sensitivity to disturbances. However, in the near term (next 15 to 20 years), the effects of climate change on salmon and steelhead are likely to be less pronounced compared to the long-term projections (Ecology 2012).

Table 11. Examples of potential impacts of climate change by salmon and steelhead life stage 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) Lower disease resistance may lead to lower survival. 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.
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 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: Independent Scientific Advisory Board 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 history stages under each alternative in the same manner. In other words, salmon hatchery production levels 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 1, Alternative 2, and Alternative 4 may partially offset some climate change effects on salmon and steelhead populations compared to Alternative 3, which would terminate all the salmon hatchery programs in the Stillaguamish 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.

In the past, the Stillaguamish River Basin has maintained a primarily rural character, and this is likely to continue in the future. Anticipated future development intensity, as described in Subsection 5.1.2, Development, is low relative to Snohomish County and Puget Sound. Such development results in environmental effects such as reduced forested area, sedimentation, impervious surface water runoff to streams, changes in stream flow because of increased consumptive uses, shoreline armoring, channelization in lower river areas, 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 development, both locally and on larger spatial scales, could be an increasing demand for natural resource extraction, such as forest products used in construction. Consequently, new development may indirectly contribute to habitat degradation from increased timber harvest in the Stillaguamish 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 development on salmon and steelhead in fresh and marine waters, 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 from development are expected to be similar, because development would impact fish habitat and life history stages under each alternative in the same manner. In other words, salmon hatchery production levels would not change the effects of development on aquatic habitat conditions (e.g., changes in sedimentation and stormwater runoff from impervious surfaces); however, the effects of Alternative 1, Alternative 2, and Alternative 4 may partially offset some development effects on salmon populations compared to Alternative 3, which would terminate all the salmon hatchery programs in the Stillaguamish River Basin. For example, salmon 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 development.

Habitat restoration efforts described in Subsection 5.1.3, Habitat Restoration, are anticipated to occur in the cumulative effects 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 for the impacts of climate change and development on fish and their associated habitats. In part, this is because climate change and 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, especially for listed species, as hatchery programs are reviewed and approved under the ESA (Subsection 5.1.4, Hatchery Production). For example, reduction of genetic risks may occur through application of new research results that lead to improved BMPs, increased use of integrated hatchery programs, and reductions in production levels, where appropriate. Over time, changes like these would also be expected to reduce the ecological risks of competition and predation because BMPs would increase the efficiency of hatchery operations, and reduced production would decrease the potential for encounters between hatchery- and natural-origin fish in migration, rearing, and spawning areas. In general, continued hatchery releases within the cumulative effects 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 Stillaguamish River Basin salmon hatchery programs would have an unsubstantial contribution to the overall cumulative effects from hatchery production in the analysis area because the numbers of fish released would be relatively small. Under existing conditions and all alternatives, salmon hatchery releases from the Stillaguamish River Basin represent less than 0.5 percent of total Puget Sound hatchery production of about 167.8 million fish (Appendix B, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities). Consequently, only in the event of massive future reductions in other Puget Sound salmon hatchery programs would the Stillaguamish River Basin salmon hatchery programs represent a substantial contribution to cumulative effects from hatchery production.

As described in Subsection 5.1.5, Fisheries, management of Washington State's fisheries resources is expected to continue into the indefinite future and would change over time, based on pre-season forecasts of fisheries returns, 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 information provided by hatchery indicator stocks, such as those in the Stillaguamish River Basin, is considered.

The summer-run Chinook salmon, fall-run Chinook salmon, and coho salmon hatchery programs in the Stillaguamish River Basin serve as indicator stocks to estimate survival and harvest rates and understand dispersal patterns for fisheries management purposes under existing conditions. This role would be unaffected under Alternative 1 and Alternative 2. In contrast, under Alternative 3 and Alternative 4, the role of the programs as indicator stocks for harvest management purposes would be eliminated or reduced, respectively. Nevertheless, effects of fisheries on ESA-listed natural-origin salmon and steelhead are expected to decrease over time to the extent that fisheries management programs continue to be revised by WDFW and Puget Sound treaty tribes and reviewed and approved by NMFS. 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 salmon and steelhead fisheries is minimized or avoided.

In summary, effects from climate change and development would likely continue to degrade aquatic habitat over time, and abundance and productivity of natural-origin salmon and steelhead populations may be reduced relative to existing conditions considered in Subsection 3.4, Salmon and Steelhead. Hatchery-origin salmon and steelhead may be similarly affected. Habitat restoration and associated (mostly localized) benefits to salmon and steelhead would be expected to continue but may not fully mitigate for all habitat degradation. In addition, effects on abundance and productivity of ESA-listed natural-origin salmon and steelhead from changes in hatchery production and fisheries would be expected to continue but may decrease over time. Under all alternatives, the negative trend in cumulative effects on salmon and steelhead would not be substantially affected. Alternative 3 would add to the negative trend of cumulative effects on salmon due to the loss of hatchery-origin salmon from the Stillaguamish River Basin and the higher risk of declines in the viability of the natural-origin Chinook populations. In contrast, Alternative 1, Alternative 2, and Alternative 4 (to a lesser extent) would partially offset the negative trend of cumulative effects on salmon and steelhead due to the availability of salmon from the hatchery programs in the Stillaguamish River Basin.

5.2.4 Other Fish Species

Subsection 3.5, Other Fish Species, describes the existing conditions of fish species other than salmon and steelhead, narrowed to bull trout. The direct and indirect effects of the alternatives on bull trout are described in Subsection 4.5, Other Fish Species. Alternative 1 (No Action) and Alternative 2 (Proposed Action) would have both negligible negative effects (due to encounters during broodstock collection) and negligible positive effects (due to juvenile salmon available as prey and stimulation of ecosystem productivity that supports other prey species) on bull trout. In contrast, Alternative 3 (Termination) and Alternative 4 (Reduced Production) would have negligible negative effects due to reduced salmon prey abundance and ecosystem productivity compared to Alternative 1 and negligible positive effects due to reduced bull trout encounters during broodstock collection compared to Alternative 1. Hatchery operations and broodstock collection would not affect bull trout critical habitat under any of the alternatives.

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). Climate change and resulting warmer stream temperatures would have a negative effect on the distribution and abundance of bull trout. Development would also have a negative effect since development often leads to a loss of or decrease in complex habitats, clean stream substrates, and interconnections among habitats. 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.

Effects from climate change, development, and fisheries (incidental catch of bull trout) would likely result in a negative trend for bull trout, while habitat restoration and hatchery production in Puget Sound would partially offset this trend. As discussed in Subsection 5.1.3, Habitat Restoration, the extent to which habitat restoration actions may mitigate impacts from climate change and development is difficult to predict. These actions may not fully mitigate for the effects of climate change and development. Changes in overall hatchery programs within Puget Sound over time may also affect bull trout. For example, reductions in hatchery production or terminations of hatchery programs may decrease the prey base available for bull trout, while increases would have the opposite effect.

These cumulative effects over the next 15 years would be more pronounced for bull trout compared to salmon and steelhead because of a higher sensitivity to aquatic habitat degradation. The contribution of the conservation hatchery programs under the alternatives to the diet of bull trout, although small compared to programs with harvest augmentation objectives (Appendix B, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities), is of value. On the other hand, negative effects from encounters with bull trout during broodstock collection in the Stillaguamish River Basin are negligible. On balance, Alternative 3 would not provide any offset to the negative trend of cumulative effects on bull trout due to the termination of hatchery-origin salmon from the Stillaguamish River Basin. The higher risk of declines in the viability of the natural-origin Chinook salmon populations under Alternative 3 would also affect bull trout prey availability. In contrast, Alternative 1, Alternative 2, and Alternative 4 (to a lesser extent) would partially offset the negative trend of cumulative effects on bull trout due to the availability of hatchery-origin salmon from the Stillaguamish River Basin as prey and a higher potential for maintaining or increasing the abundance of natural-origin salmon available as prey.

5.2.5 Wildlife

Subsection 3.6, Wildlife, describes the existing conditions of wildlife narrowed to Southern Resident killer whale. The direct and indirect effects of the alternatives on Southern Resident killer whales in Puget Sound are described in Subsection 4.6, Wildlife. Alternative 1 (No Action) and Alternative 2 (Proposed Action) would result in a negligible positive effect on Southern Resident killer whale, while Alternative 3 (Termination) and Alternative 4 (Reduced Production) would have a negligible negative effect compared to Alternative 1. As described in Subsection 3.6, Wildlife, Stillaguamish Chinook salmon are high-priority components of the prey base for Southern Resident killer whales. Cumulative effects on Southern Resident killer whales include changes in their distribution and abundance in response to changes in the distribution and abundance of their food supply.

Subsection 5.2.3, Salmon and Steelhead, describes how climate change and development in the cumulative effects analysis area may reduce the abundance and productivity of natural-origin salmon and steelhead, which are prey for Southern Resident killer whales. Survival rates of hatchery-origin salmon may be similarly affected, but increases in hatchery production, should they occur, could mask such effects because more hatchery-origin salmon would be available as prey for Southern Resident killer whales. The potential benefits of habitat restoration actions within the cumulative effects analysis area may not fully, or even partially, mitigate for the effects of climate change and development on salmon and steelhead abundance. As discussed in Subsection 5.1.4, Hatchery Production, and Subsection 5.1.5, Fisheries, changes in hatchery programs and fisheries, respectively, may occur over time. For example, reductions in hatchery production or terminations of hatchery programs in Puget Sound would decrease the prey base available for Southern Resident killer whales, whereas increases in hatchery production of Chinook salmon would help increase Southern Resident killer whales' prey base. Fisheries may affect the extent that Southern Resident killer whales have access to salmon and steelhead as prey. Consequently, the trend in cumulative effects on the total number of salmon and steelhead available as prey to Southern Resident killer whale may increase or decrease from existing conditions.

Effects from climate change, development, habitat restoration, hatchery production, and fisheries would likely affect Southern Resident killer whales. The overall trend in cumulative effects on Southern Resident killer whales has been negative, as reflected in their declining abundance. The contributions of the alternatives to overall cumulative effects on Southern Resident killer whales would be small but meaningful because, although the salmon hatchery programs contribute relatively few fish to the whales' prey base, the fish are a high-priority component. Alternative 3 would contribute to the negative trend of cumulative effects on Southern Resident killer whales due to the loss of hatchery-origin Chinook salmon from the Stillaguamish River Basin and the higher risk of declines in the viability of the natural-origin populations. However, these reductions would constitute a small component of the overall salmon and steelhead prey base for Southern Resident killer whales in the analysis area. In contrast, Alternative 1, Alternative 2, and Alternative 4 (to a lesser extent) would partially offset the negative trend of cumulative effects on Southern Resident killer whale due to the availability of hatchery-origin Chinook salmon from the Stillaguamish River Basin hatchery programs.

5.2.6 Cultural Resources

Subsection 3.7, Cultural Resources, describes existing conditions for cultural resources. The direct and indirect effects of the alternatives on cultural resources are described in Subsection 4.7, Cultural Resources. Stillaguamish River Basin salmon hatchery programs would have a high positive effect on cultural resources under Alternative 1 (No Action) and Alternative 2 (Proposed Action), while Alternative 3 (Termination) would have a high negative effect compared to Alternative 1, and Alternative 4 (Reduced Production) would have a moderate negative effect.

Although unquantifiable, climate change and development may reduce the number of salmon and steelhead, which provide an important cultural value and are harvested for ceremonial and subsistence uses 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. Changes in hatchery production (decreases or increases) from locations outside the Stillaguamish River Basin would not substantially affect in-river ceremonial and subsistence fishing by the Stillaguamish Tribe of Indians because few of these hatchery fish would likely stray into the Stillaguamish River Basin and be harvested. As discussed in Subsection 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.

Overall, effects from climate change and development would likely affect cultural resources by decreasing the number of salmon and steelhead available for ceremonial and subsistence harvest relative to existing conditions. Increases in salmon availability from habitat restoration and hatchery production would partially offset these effects, and changes in fisheries may occur that also affect the availability of salmon for harvest in terminal areas. Alternative 3 would not provide any offset to the negative trend of cumulative effects on cultural resources due to the termination of salmon hatchery programs in the Stillaguamish River Basin and the higher risk of declines in the viability of the natural-origin Chinook salmon populations. In contrast, Alternative 1, Alternative 2, and Alternative 4 (to a lesser extent) would partially offset the negative trend of cumulative effects on cultural resources due to the availability of hatchery-origin salmon from the Stillaguamish River Basin hatchery programs.

5.2.7 Socioeconomics

Subsection 3.8, 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 salmon are described in Subsection 4.8, Socioeconomics. Stillaguamish River Basin salmon hatchery programs under Alternative 1 (No Action) and Alternative 2 (Proposed Action) would result in a negligible positive effect on socioeconomics, while Alternative 3 (Termination) and Alternative 4 (Reduced Production) would have a negligible negative effect compared to Alternative 1.

Although unquantifiable, climate change and 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 effects of climate change and development. Reductions in hatchery production or terminations of hatchery programs within Puget Sound (outside the salmon hatchery programs considered under the alternatives) may decrease the number of fish available for harvest by commercial fisheries, decrease the number of trips and expenditures from recreational fishing, and decrease fishing and hatchery-related employment and income, while increases may have the 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.

Overall, effects from climate change and development would likely affect socioeconomic resources by decreasing the number of salmon and steelhead available for harvest and reducing associated expenditures and economic values relative to existing conditions described in Subsection 3.8, Socioeconomics. Likewise, there may be reductions in the number of salmon and steelhead available to tribal members for subsistence use. Alternative 3 would not provide any offset to the negative trend of cumulative effects on socioeconomics due to the termination of hatchery employment and expenditures, as well as the abundance of hatchery-origin and natural-origin salmon from the Stillaguamish River Basin available for future harvest. In contrast, Alternative 1, Alternative 2, and Alternative 4 (to a lesser extent) would partially offset the negative trend of cumulative effects on socioeconomics due to the availability of salmon from the hatchery programs for harvest, maintenance of or increase in the abundance of natural-origin salmon, and the contribution to hatchery employment and related expenditures in the Stillaguamish River Basin. The overall trend in cumulative effects would not likely change substantially regardless of the alternative because the programs are a small component of the overall economic activity associated with salmon and steelhead production and harvest in the cumulative effects analysis area.

5.2.8 Human Health

Subsection 3.9, Human Health, describes the existing conditions for human health. The direct and indirect effects of the alternatives on human health are described in Subsection 4.9, Human Health. The Stillaguamish River Basin salmon hatchery programs under all alternatives, except Alternative 3 (Termination), would have a negligible negative effect on human health from exposure to chemicals used in hatcheries or disease transfer from handling fish. Under Alternative 3, there would be a negligible positive effect on human health compared to Alternative 1 (No Action), since there would be no use of therapeutics or the need for safe worker requirements or personal protective equipment to raise salmon. Although hatchery rearing would have a negligible negative effect on human health, contaminants accumulated during hatchery rearing are expected to contribute very little to concentrations of contaminants in returning adult salmon and steelhead. O'Neill et al. (2015) found most contaminant body burdens in salmon are acquired when salmon reside in offshore habitats and where pollutants are migrating outward from river systems.

Effects of climate change and development on water quantity (Subsection 5.2.1, Water Quantity), water quality (Subsection 5.2.2, Water Quality), and salmon and steelhead habitat (Subsection 5.2.3, Salmon and Steelhead) could increase the risk of susceptibility of salmon to disease and pathogens that can be transferred to humans handling the fish. Habitat restoration would likely improve human health in the future by reducing some contaminants at localized areas in the environment, but these reductions may only partially offset any fish consumption impacts to human health from climate change and development. Future hatchery operations may reduce risks to human health from handling chemicals and fish to the extent that improved BMPs for worker protection are implemented over time relative to existing conditions described in Subsection 3.9, Human Health. In addition, reductions in hatchery production or terminations of hatchery programs may decrease the use of chemicals in hatchery operations and reduce effects on human health.

Under all alternatives, it is likely that cumulative effects from climate change, development, habitat restoration, and hatchery production would impact human health in the cumulative effects analysis area in a similar way relative to existing conditions described in Subsection 3.9, Human Health. None of the alternatives would be expected to affect the overall trend in cumulative effects associated with the use of hatchery chemicals, the transfer of toxic contaminants from fish to humans, or the transmission of diseases from fish to humans. Under Alternative 1, Alternative 2 (Proposed Action), and Alternative 4 (Reduced Production), there would be a negligible negative contribution to the cumulative effects on human health because of the use of chemicals in hatcheries; however, under Alternative 3, there would be a negligible positive contribution to cumulative effects because chemical use for salmon production in the hatcheries would be eliminated.

5.2.9 Environmental Justice

Subsection 3.10, Environmental Justice, describes environmental justice communities and user groups in the analysis area. As discussed in Subsection 4.10, Environmental Justice, high and disproportionate effects were identified for cultural resources, specifically ceremonial and subsistence harvest and the socioeconomic benefits from tribal salmon hatchery employment, under Alternative 3 (Termination) and Alternative 4 (Reduced Production). Such high and disproportionate effects would not occur under Alternative 1 (No Action) and Alternative 2 (Proposed Action) because ceremonial and subsistence harvest and tribal salmon hatchery employment would continue as occurs under existing conditions.

As described in Subsection 5.2.3, Salmon and Steelhead, and Subsection 5.2.6, Cultural Resources, the overall effects from climate change, development, habitat restoration, and fisheries would likely decrease the number of salmon and steelhead available for ceremonial and subsistence uses. When considering effects of the alternatives in addition to those from climate change, development, habitat restoration, and fisheries, the adverse cumulative effects would be high and disproportionate for cultural resources and socioeconomics (specific to tribal salmon hatchery employment for Native American tribes) under Alternative 3 and Alternative 4 due to the loss or decrease, respectively, of hatchery production. These cumulative effects would not occur under Alternative 1 and Alternative 2 because hatchery production would continue to occur and partially offset decreases in salmon and steelhead from climate change, development, habitat restoration, and fisheries. Hatchery production under Alternative 1 and Alternative 2 would contribute to the abundance of salmon available for ceremonial and subsistence fishing, as well as salmon hatchery employment that has a preference for hiring Indians.

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7 AGENCIES CONSULTED

Stillaguamish Tribe of Indians

Washington Department of Fish and Wildlife

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Appendix A

Relationship to and Summary of Plans, Regulations, Agreements, Laws, Secretarial Orders, and Executive Orders Related to the Stillaguamish Hatchery EA

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In addition to the National Environmental Policy Act (NEPA) and Endangered Species Act (ESA), other plans, regulations, agreements, treaties, laws, and Secretarial and Executive Orders also affect hatchery operations in the Stillaguamish River Basin. These are summarized below to provide additional context for the hatchery programs described by the proposed hatchery and genetic management plans (HGMPs) and the analyses within this environmental assessment (EA).

1 CLEAN WATER ACT

The Clean Water Act (33 U.S.C. 1251, 1977, as amended in 1987), administered by the United States (U.S.) Environmental Protection Agency (EPA) and state water quality agencies, is the principal Federal legislation directed at protecting water quality. Maintenance of high water quality consistent with the Act is essential for ensuring the survival and productivity of natural-origin salmon and steelhead. The Act also helps ensure that the hatchery-origin fish produced under the Proposed Action are supplied with clean water during rearing in the hatcheries, and after their release into the natural environment, to protect their health and foster their survival to return as adults. Each state implements and carries forth Federal provisions, approves and reviews National Pollutant Discharge Elimination System (NPDES) applications, and establishes total maximum daily loads for rivers, lakes, and streams. The states, with EPA approval, are responsible for setting the water quality standards needed to support all beneficial uses, including protection of public health, recreational activities, aquatic life, and water supplies.

The Washington State Water Pollution Control Act (see Subsection 13, below), codified as the Revised Code of Washington (RCW) Chapter 90.48, designates the Washington Department of Ecology (Ecology) as the agency responsible for carrying out the provisions of the Federal Clean Water Act within Washington State. The agency is responsible for establishing water quality standards, making and enforcing water quality rules, and operating waste discharge permit programs. These regulations are described in Washington Administrative Code (WAC) Title 173. Hatchery operations are typically required to comply with the Clean Water Act by maintaining active NPDES permits.

2 BALD AND GOLDEN EAGLE PROTECTION ACT

The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668c) was enacted in 1940 and amended several times since. The Act prohibits the taking of bald eagles, including their parts, nests, or eggs. The Act defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.” The U.S. Fish and Wildlife Service (USFWS), who is responsible for carrying out provisions of this Act, defines “disturb” to include “injury to an eagle; a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior; or nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior." Hatchery production has the potential to affect the productivity of eagles protected under this Act through changes in the number of salmon and steelhead available as prey.

3 MARINE MAMMAL PROTECTION ACT

The Marine Mammal Protection Act of 1972 (16 U.S.C. 1361) as amended, establishes a national policy designated to protect and conserve wild marine mammals and their habitats. This policy was established so as not to diminish such species or populations beyond the point at which they cease to be a significant functioning element in the ecosystem, nor to diminish such species below their optimum sustainable population. All marine mammals are protected under the Act.

The Act prohibits, with certain exceptions, the take of marine mammals in waters of the United States s and by citizens of the United States on the high seas, and the importation of marine mammals and marine mammal products into the United States. The term "take," as defined by the Act, means to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The Act further defines harassment as "any act of pursuit, torment, or annoyance, which (i) has the potential to injure a marine mammal or marine mammal stock in the wild; or (ii) has the potential to disturb a marine mammal or marine mammal stock in the wild by causing a disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild."

The National Marine Fisheries Service (NMFS) is responsible for reviewing Federal actions for compliance with the Act. Hatchery production has the potential to indirectly affect marine mammals, including Southern Resident killer whales that are protected under the Act, through changes in the number of salmon and steelhead available as prey.

4 EXECUTIVE ORDER 12898

On February 11, 1994, the President issued Executive Order 12898, Federal Actions to Address Environmental Justice in Minority and Low-income Populations (59 Fed. Reg. 7629, February 16, 1994) (https://www.archives.gov/files/federal-register/executive-orders/pdf/12898.pdf). The objectives of the Executive Order include developing Federal agency implementation strategies, identifying minority and low-income populations where proposed Federal actions could have disproportionately high and adverse human health and environmental effects, and encouraging the participation of minority and low-income populations in the NEPA process. Hatchery production has the potential to affect the extent of harvest available for minority and low-income populations that are the focus of Executive Order 12898.

5 TITLE VI OF THE CIVIL RIGHTS ACT OF 1964

Under Title VI of the Civil Rights Act of 1964 (42 U.S.C. 2000d *et seq*.), discrimination on the basis of race, color, or national origin is prohibited in programs and activities receiving Federal financial assistance. These programs cannot directly or indirectly distinguish among individuals on the basis of race, color, or national origin. In addition to intentional discrimination, this prohibition applies to procedures, criteria, or administrative methods that appear neutral but have a discriminatory effect on individuals because of their race, color, or national origin. Federal agencies, including NMFS, can use their enforcement and compliance authority under Title VI to address environmental justice concerns.

6 RELATIONSHIP BETWEEN INDIAN TRIBES AND STATE AND FEDERAL GOVERNMENTS

Relations between the Stillaguamish Tribe of Indians and state and federal governments are influenced by several legal instruments discussed in more detail below. Foremost are the Treaties of Point Elliot, Medicine Creek, and Point No Point between the United States Government and Indian tribes located in northern Puget Sound. The federal court case *United States v. Washington* (1974) upheld the terms of the hunting, fishing, and gathering rights described in the Treaty of Point Elliot and similar treaties with other Puget Sound Indian tribes and described the relationship between Washington State and the affected tribes in the management of harvestable species. Executive Order 13175 describes the general relationship and process for consultation and coordination between the Federal government and Indian tribal governments, while Secretarial Order 3206 describes the Federal-tribal trust responsibilities related specifically to implementation of the ESA.

6.1 Treaties of Point Elliott, Medicine Creek, and Point No Point

Beginning in the mid-1850s, the United States entered into a series of treaties with tribes in Puget Sound. The treaties were completed to secure the rights of the tribes to land and the use of natural resources in their historically inhabited areas, in exchange for the ceding of land to the United States for settlement by its citizens. The first treaty was the Treaty of Medicine Creek (signed in 1854), followed by two treaties signed in 1855: the Point Elliott Treaty and the Point No Point Treaty. These treaties secured the rights of tribes for taking fish at usual and accustomed grounds and stations in common with all citizens of the United States. Marine and freshwater areas of Puget Sound were affirmed as the usual and accustomed fishing areas for treaty tribes under *United States v. Washington* (1974).

The salmon and steelhead fishing rights of the signatory tribes in their usual and accustomed fishing areas are reserved under the treaties. The treaties complement the implementation of federally approved recovery plans for listed salmon and steelhead in Puget Sound (see Subsection 7 below). The treaties also influence the environmental effects on minority and low income populations, including those tribes with usual and accustomed fishing areas where hatchery-origin fish are harvested and hatcheries that are operated, wholly or in part, by treaty tribes (see Subsection 4, Executive Order 12898, above).

6.2 United States v. Washington

Salmon and steelhead fisheries within the project area are jointly managed by the Washington Department of Fish and Wildlife (WDFW) and Puget Sound treaty tribes (co-managers) under the continuing jurisdiction of *United States v. Washington* (1974). *United States v. Washington* (1974) is the Federal court proceeding that enforces and implements reserved treaty fishing rights with regard to salmon and steelhead returning to Puget Sound. Hatcheries in Puget Sound provide salmon and steelhead for these fisheries. Hatcheries are considered an important component to providing fish for the tribes to harvest (Stay 2012; Northwest Indian Fisheries Commission [NWIFC] 2013). These fishing rights and attendant access were established by treaties the Federal government signed with the tribes in the 1850s (Subsection 6.1, Treaties of Point Elliott, Medicine Creek, and Point No Point). In 1974, Judge George Boldt decided in *United States v. Washington* that the tribes' fair and equitable share was 50 percent of all of the harvestable fish destined for the tribes' traditional fishing places. Hatchery-origin fish are considered fish to the same extent as natural-origin fish and, thus, are counted in the determination of the treaty share (*United States v. Washington*, 759 F.2d 1353, 1358-60 (9th Cir.), cert. denied, 474 U.S. 994 [1985]). In the recent ruling in the Culverts subproceeding of *United States v. Washington*, the Federal District Court held that the treaty right imposes a duty on the state to refrain from degrading salmon and steelhead habitat by maintaining fish-blocking culverts on state roads and highways (20 F. Supp. 3d 828, 889 [W.D. Wa. 2007], aff'd 2220 F.3d 836 [9th Cir. 2016]). The joint state-tribal resource management plans submitted to NMFS for review and approval under Limit 6 of the ESA 4(d) Rule, including the HGMPs described under the Proposed Action, are implemented within the parameters of *United States v. Washington*.

6.3 The Federal Trust Responsibility

The United States government has a trust, or special relationship, with Indian tribes. The unique and distinctive political relationship between the United States and Indian 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. Executive Order 13175, Consultation and Coordination with Indian Tribal Governments (https://www.federalregister.gov/documents/2000/11/09/00-29003/consultation-and-coordination-with-indian-tribal-governments), states that the United States has recognized Indian tribes as domestic dependent nations under its protection. The Federal government has enacted numerous statutes and promulgated numerous regulations that establish and define a trust relationship with Indian tribes.

The relationship has been compared to one existing under common law trust, with the United States as trustee, the Indian tribes or individuals as beneficiaries, and the property and natural resources managed by the United States as the trust corpus (*Dep't of the Interior v. Klamath Water Users Protective Ass'n*, 532 US 1, 11, 2001). The trust responsibility has been interpreted to require Federal agencies to carry out their activities in a manner that is protective of Indian treaty rights. This policy is also reflected in the March 30, 1995, document, *Department of Commerce – American Indian and Alaska Native Policy* (U.S. Department of Commerce 1995). The Ninth Circuit Court of Appeals has held, however, that "unless there is a specific duty that has been placed on the government with respect to Indians, [the government's general trust obligation] is discharged by [the government's] compliance with general regulations and statutes not specifically aimed at protecting Indian tribes" (*Gros Ventre Tribe v. United States*, 2006, citing *Morongo Band of Mission Indians v. FAA*, 1998; *United States v. Jicarilla Apache Nation,* U.S., 131 S.Ct. 2313, 180 L.Ed.2nd 187, 2011).

As an agency mandate, NMFS' implementation of its Federal trust responsibilities influences the analysis of resources evaluated in this EA.

6.4 Secretarial Order 3206

Secretarial Order 3206 (American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA) (https://www.westcoast.fisheries.noaa.gov/publications/reference_documents/esa_refs/so3206.pdf), issued by the secretaries of the Departments of Interior and Commerce on June 5, 1997, clarifies the responsibilities of the agencies, bureaus, and offices of the departments when actions taken under the ESA and its implementing regulations affect, or may affect, Indian lands, tribal trust resources, or the exercise of American Indian tribal rights as they are defined in the Order. The Order acknowledges the trust responsibility and treaty obligations of the United States toward tribes and tribal members, as well as its government-to-government relationship when corresponding with tribes. Under the Order, the USFWS and NMFS (collectively, the Services) "will carry out their responsibilities under the [ESA] in a manner that harmonizes the Federal trust responsibility to tribes, tribal sovereignty, and statutory missions of the

[Services], and that strives to ensure that Indian tribes do not bear a disproportionate burden for the conservation of listed species, so as to avoid or minimize the potential for conflict and confrontation."

In the event that the Services determine that conservation restrictions directed at a tribal activity are necessary to protect listed species, specifically where the activity could result in incidental take under the ESA, the Services shall provide the affected tribe(s) written notice, including an analysis and determination that (i) the restriction is reasonable and necessary for conservation of the species; (ii) the conservation purpose of the restriction cannot be achieved by reasonable regulation of non-Indian activities; (iii) the measure is the least restrictive alternative available to achieve the required conservation purpose; (iv) the restriction does not discriminate against Indian activities, either as stated or applied; and (v) voluntary tribal measures are not adequate to achieve the necessary conservation purpose.

More specifically, the Services shall, among other things, do the following:

- Work directly with Indian tribes on a government-to-government basis to promote healthy ecosystems (Section 5, Principle 1).
- Recognize that Indian lands are not subject to the same controls as Federal public lands (Section 5, Principle 2).
- Assist Indian tribes in developing and expanding tribal programs so that healthy ecosystems are promoted and conservation restrictions are unnecessary (Section 5, Principle 3).
- Be sensitive to Indian culture, religion, and spirituality (Section 5, Principle 4).

Additionally, the U.S. Department of Commerce issued a Departmental Administrative Order (DAO) addressing *Consultation and Coordination with Indian Tribal Governments* (DAO 218-8, April 26, 2012; http://www.osec.doc.gov/opog/dmp/daos/dao218_8.html), which implements relevant Executive Orders, Presidential Memoranda, and Office of Management and Budget Guidance. The DAO describes actions to be "followed by all Department of Commerce operating units … and outlines the principles governing Departmental interactions with Indian tribal governments." The DAO affirms that the "Department works with Tribes on a government-to-government basis to address issues concerning … tribal trust resources, tribal treaty, and other rights."

6.5 Tribal Policy for Salmon Hatcheries

The Puget Sound treaty tribes' (tribes) *Tribal Policy Statement for Salmon Hatcheries in the Face of Treaty Rights at Risk* (NWIFC 2013) was submitted to NMFS and WDFW by the tribes for the purpose of reaffirming "the role salmon and steelhead hatcheries play in implementing the treaty right to fish and in recovering salmon populations in the face of continuing loss of salmon habitat by degradation and climate change." The Policy acknowledges that state and Federal governments historically developed and used hatcheries as a means of mitigating for the loss of habitat and natural production they had permitted. The Policy states that "As long as watersheds, the Salish Sea estuary, and the ocean are unable to maintain self-sustaining salmon populations in sufficient abundance, hatcheries will remain an integral and indispensable component of salmon management. Hatcheries are necessary for tribes to be able to harvest salmon in their traditional areas to carry out the promises of the treaties fully and meet the requirements of *United States vs. Washington* and *Hoh vs. Baldrige*." The analyses in this EA take into account the need to protect tribal trust resources as described in preceding subsections, including the contributions of hatcheries under the Proposed Action and the alternatives, to meeting treaty reserved fishing rights.

7 RECOVERY PLANS FOR PUGET SOUND SALMON AND STEELHEAD

A Federal recovery plan is in place for the ESA-listed Puget Sound Chinook salmon (NMFS 2006; Shared Strategy for Puget Sound 2007; 72 Fed. Reg. 2493, January 19, 2007). Broad partnerships of Federal, state, local, and tribal governments and community organizations collaborated in the development of the recovery plan under Washington's Salmon Recovery Act. The comprehensive recovery plan includes conservation goals and proposed habitat, hatchery, and harvest actions needed to achieve the conservation goals for each watershed within the geographic boundaries of the listed evolutionarily significant units (ESUs). Subsequently, NMFS released for public review a draft framework (the Population Recovery Approach) that categorized the relative role of each Chinook salmon population and watershed that supports them for consultation and recovery planning purposes, into one of three "tiers[1]" (75 Fed. Reg. 82208, December 29, 2010). The Stillaguamish Chinook salmon populations are in Tier 2. Tier 2 populations are of secondary importance for recovery, compared to Tier 1 populations which must achieve low extinction risk status. The Puget Sound Steelhead Distinct Population Segment (DPS) was listed in 2007. A draft plan was released in December 2018 (NMFS 2018), with a final plan anticipated in 2019. The recovery plans, as well as the required 5-year status assessments produced by NMFS, provide

[1] Under the Population Recovery Approach, Tier 1 Chinook salmon populations are of primary importance for preservation, restoration, and ESU recovery and have to be viable for the ESU as a whole to meet viability criteria in Ruckelshaus et al. (2002). If not assigned to Tier 1, populations with cumulative scores relative to the ESU-wide mean that are greater than the ESU-wide mean are assigned to Tier 2, whereas scores below the ESU-wide mean are assigned to Tier 3. Impacts on Tier 1 populations would be more likely to affect the viability of the ESU as a whole than similar impacts on Tier 2 or Tier 3 populations, because of the primary importance of Tier 1 populations to overall ESU viability. Tier 2 populations would be less important for recovery to a low extinction risk status. Tier 3 populations would be allowed to absorb more effects but would still require ESA protection so that the populations maintain a trajectory toward recovery, albeit over a longer term than for Tier 1 and Tier 2 populations (NMFS 2010).

information that is fundamental to the analysis of existing conditions for listed salmon and steelhead resources.

8 THE PACIFIC SALMON TREATY

Implementation of the Pacific Salmon Treaty agreement between the United States and Canada affects the abundance and availability of salmon for harvest in Puget Sound fisheries, including those in the project area. Through the Treaty, salmon produced in United States and Canadian watersheds are allocated between the two countries for harvest in accordance with agreed sharing formulas. The current Treaty Annexes defining harvest sharing agreements for Chinook salmon, coho salmon, and chum salmon lapse in 2018; a similar Annex defining sharing agreements for sockeye salmon and pink salmon lapses in 2019. Hatchery salmon production as proposed under the Proposed Action helps meet Pacific Salmon Treaty harvest sharing agreements with Canada. Interception of adult salmon produced in the project area affects annual harvest levels, and socioeconomic and cultural resource benefits imparted by Snohomish River basin tribal and non-Indian fisheries.

9 WASHINGTON STATE ENDANGERED, THREATENED, AND SENSITIVE SPECIES ACT

This EA considers the effects of hatchery programs and harvest actions on state endangered, threatened, and sensitive species that have a relationship with salmon and steelhead. The State of Washington has species of concern listings (WAC 232-12-014 and 232-12-011) that include all state endangered, threatened, sensitive, and candidate species. These species are managed by WDFW, as needed, to help prevent the species from further population declines. The state-listed species are identified on WDFW's website (https://wdfw.wa.gov/sites/default/files/2019-06/threatened and endangered species list.pdf); the most recent update occurred in June 2019. The criteria for listing and de-listing, and the requirements for recovery and management plans for these species are provided in WAC 232-12-297. The state list is separate from the Federal ESA list; the state list includes species status relative to Washington State jurisdiction only. Critical wildlife habitats associated with state or federally listed species are identified in WAC 222-16-080. Species on the state endangered, threatened, candidate, and sensitive species list are reviewed in this EA if the Proposed Action and the alternatives could affect these species.

10 HATCHERY AND FISHERY REFORM POLICY

WDFW's Hatchery and Fishery Reform Policy (Policy C-3619) was adopted in 2009 (Washington Fish and Wildlife Commission 2009). It supersedes WDFW's Wild Salmonid Policy, which was adopted in 1997. Its purpose is to advance the conservation and recovery of wild salmon and steelhead by promoting and guiding the implementation of hatchery reform. The policy applies to WDFW hatchery actions included under the Proposed Action and the alternatives reviewed in this EIS. It is NMFS' understanding that the HGMPs WDFW submitted to NMFS for review and approval were prepared with the intent to improve hatchery effectiveness, ensure compatibility between hatchery production and salmon recovery plans and rebuilding programs, and support sustainable fisheries.

11 WASHINGTON STATE FOREST PRACTICES ACT AND HABITAT CONSERVATION PLAN

The 1974 Forest Practices Act (RCW Chapter 76.09) requires a balance between protecting public resources and maintaining the state's timber industry. The Act created the Forest Practices Board as an independent state agency to establish forest practices rules for implementing the Act and Stewardship of Non-industrial Forests and Woodlands (RCW 76.13). The Washington State Forest Practices Rules (Title 222 WAC) establish standards for timber harvest, pre-commercial thinning, road construction, fertilization, forest chemical application, and other forest practices to protect public resources, including water quality and fish habitat, while maintaining a viable timber industry. The Forest Practices Rules have been amended multiple times since they were established in 1975, including changes in response to federal listings of endangered salmon and impaired water quality on non-federal forested streams (Salmon Recovery Act of 1999 [RCW Chapter 77.85], also known as the Forest and Fish Law).

The Washington State Department of Natural Resources completed a Forest Practices Habitat Conservation Plan (FPHCP) in December 2005, which was approved by federal agencies in June 2006. Private land owners that follow the Forest Practices Rules during their forest management activities are provided ESA coverage by Incidental Take Permits issued to Washington State for ESA-listed species, including salmon and steelhead. The FPHCP includes protection measures designed to ensure riparian and stream functions such as large woody debris, shade, nutrients, sediment control, wetlands, and hydrologic regimes.

12 WASHINGTON SHORELINE MANAGEMENT ACT AND SNOHOMISH COUNTY SHORELINE MANAGEMENT PROGRAM

Washington's Shoreline Management Act was passed by the State Legislature in 1971 and adopted by voters in 1972. The overarching goal of the Act is "to prevent the inherent harm in an uncoordinated and piecemeal development of the state's shorelines." The Act applies to all 39 counties and more than 200 towns and cities that have "shorelines of the state" (RCW 90.58.030(2)) within their boundaries.

These shorelines are defined as:

- All marine waters
- Streams and rivers with greater than 20 cubic feet per second mean annual flow
- Lakes 20 acres or larger
- Upland areas (shorelands) that extend 200 feet landward from the edge of these waters
- The following areas associated with one of the above
    a. Biological wetlands and river deltas
    b. Some or all of the 100-year floodplain including all wetlands within the 100-year floodplain

The Act also states that "the interests of all the people shall be paramount in the management of shorelines of statewide significance." These special shorelines are defined as: Pacific Coast, Hood Canal and certain Puget Sound shorelines; all waters of Puget Sound and the Strait of Juan de Fuca; lakes or reservoirs with a surface acreage of 1,000 acres or more; larger rivers (1,000 cubic feet per second or greater for rivers in western Washington, 200 cubic feet per second or greater east of the Cascade crest); and wetlands associated with all the above. There are three basic policy areas to the Act: shoreline use, environmental protection and public access. The Act emphasizes accommodation of appropriate uses that require a shoreline location, protection of shoreline environmental resources and protection of the public's right to access and use the shorelines (RCW 90.58.020). Under the Act, each city and county with "shorelines of the state" must prepare and adopt a Shoreline Master Program that is based on state laws and rules but is tailored to the specific geographic, economic and environmental needs of the community. The local programs are essentially a shoreline-specific combined comprehensive plan, zoning ordinance, and development permit system.

Snohomish County's Shoreline Management Program assigns environmental designations for unincorporated county shoreline areas and establishes regulations and development standards for evaluating and permitting proposed shoreline uses and modifications. The Washington Shoreline Management Act designates certain marine areas and larger streams, rivers, and lakes as "shorelines of statewide significance." Shorelines of statewide significance under jurisdiction of the County's Program include the Stillaguamish River, Stillaguamish River Estuary, Possession Sound, Port Gardner, Port Susan, and Puget Sound. Because these shorelines are considered major resources from which all people in the state derive benefit, the County's Program must recognize and protect statewide interest over local interest for development of shorelines, preserve the natural character of the shorelines, achieve long-term over short-term benefit, protect the resources and ecology of the shorelines, increase public access to publicly owned areas of the shorelines, and increase recreational opportunities for the public on the shorelines.

The degree to which the requirements of the Washington Shoreline Management Act, through the Snohomish County Shoreline Management Program, are applied to protect shoreline habitat of critical importance to salmon and steelhead habitat in the action and analysis areas will determine the extent to which hatchery salmon released into the natural environment through the Proposed Action survive, and in turn how the hatchery salmon affect the resources evaluated in this EA. Implementation of Act requirements will also affect the viability status of natural salmon and steelhead populations, and resource elements affected by those natural fish.

13 WASHINGTON STATE WATER POLLUTION CONTROL ACT

Enacted in 1973, the Washington State Water Pollution Control Act (RCW Chapter 90.48) was "declared to be the public policy of the state of Washington to maintain the highest possible standards to insure the purity of all waters of the state consistent with public health and public enjoyment thereof, the propagation and protection of wild life, birds, game, fish and other aquatic life, and the industrial development of the state, and to that end require the use of all known available and reasonable methods by industries and others to prevent and control the pollution of the waters of the state of Washington. Consistent with this policy, the state of Washington will exercise its powers, as fully and as effectively as possible, to retain and secure high quality for all waters of the state. The state of Washington in recognition of the Federal government's interest in the quality of the navigable waters of the United States, of which certain portions thereof are within the jurisdictional limits of this state, proclaims a public policy of working cooperatively with the Federal government in a joint effort to extinguish the sources of water quality degradation, while at the same time preserving and vigorously exercising state powers to insure that present and future standards of water quality within the state shall be determined by the citizenry, through and by the efforts of state government, of the state of Washington."

Under the Act, Ecology has jurisdiction to control and prevent the pollution of streams, lakes, rivers, ponds, inland waters, salt waters, water courses, and other surface and underground waters of the state of Washington. Any person who conducts a commercial or industrial operation of any type which results in the disposal of solid or liquid waste material into the waters of the state, including commercial or industrial operators discharging solid or liquid waste material into sewerage systems operated by municipalities or public entities which discharge into public waters of the state, shall procure a permit from Ecology before disposing of such waste material. Ecology may by rule eliminate the permit requirements for disposing of wastes by upland finfish rearing facilities unless a permit is required under the Federal Clean Water Act's NPDES. Hatcheries proposed for operation under the Proposed Action must comply with Ecology water quality standards, or for the tribal programs, EPA standards. In addition, the degree to which the requirements of the Act are applied to protect water quality in the action and analysis areas will determine the extent to which hatchery salmon released into the natural environment through the Proposed Action survive, and in turn how the hatchery salmon affect the resources evaluated in this EA. Implementation of Act requirements will also affect the viability status of natural salmon and steelhead populations, and resource elements affected by those natural fish.

14 SURFACE AND GROUNDWATER REGULATIONS

14.1 Water Resources Act of 1971

Under the Water Resources Act of 1971 (RCW Chapter 90.54), Ecology is mandated to protect, and where possible, enhance the quality of the natural environment by retaining base flows in the state's waterways for the preservation of wildlife, fish, scenic, aesthetic, and other environmental values. The Act sets forth “fundamentals of water resource policy for the state to ensure that waters of the state are protected and fully utilized for the greatest benefit to the people of the state of Washington and, in relation thereto, to provide direction to Ecology, other state agencies and officials, and local government in carrying out water and related resources programs. It is the intent of the legislature to work closely with the executive branch, Indian tribes, local government, and interested parties to ensure that water resources of the state are wisely managed.” The effectiveness of Ecology's establishment and maintenance of base flows in freshwater reaches to protect fish habitat and habitat processes within the action and analysis areas actions will determine the extent to which hatchery salmon released into the natural environment through the Proposed Action survive, and in turn how the hatchery salmon affect the resources evaluated in this EA. Implementation of base flow requirements will also affect the viability status of natural salmon and steelhead populations, and resource elements affected by those natural fish.

14.2 Water Rights and Minimum Flows

The Washington State Water Code (RCW Chapter 90.03) establishes state water policy to promote use of the state’s public surface waters to obtain maximum net benefits from diversionary uses and protect instream and natural values and rights. The Washington State Groundwater Code (RCW Chapter 90.44) supplements the Washington State Water Code by extending the application of surface water statutes to the appropriation and beneficial use of groundwaters within the state. These regulations address water management, including the administration of water rights and protection of minimum flows and levels.

The Water Code centralized water right administration with Ecology and made the state permit system the exclusive way to establish new surface water rights (permits). The Groundwater Code extended the surface water permitting process to groundwater (certificates). The Groundwater Code also identified certain “small withdrawals” of groundwater as exempt from the permitting process (permit-exempt groundwater withdrawals) (RCW 90.44.050).

Under RCW 90.03.247, Minimum flows and levels—Departmental authority exclusive—Other recommendations considered, whenever an application for a permit to make beneficial use of public waters is approved relating to a stream or other water body for which minimum flows or levels have been adopted and are in effect at the time of approval, any permit issued by the state shall be conditioned to protect the water levels or flows. No agency may establish minimum flows and levels or similar water flow or level restrictions for any stream or lake of the state other than Ecology, whose authority to establish is exclusive, as provided in RCW Chapter 90.03, RCW 90.22.010, and RCW 90.54.040. In establishing such minimum flows, levels, or similar restrictions, Ecology shall, during all stages of development of minimum flow proposals, consult with and carefully consider the recommendations of the WDFW, the Department of Commerce, the Department of Agriculture, and representatives of the affected Indian tribes. Ecology's effectiveness in administering the tenets of this water code to protect flows and levels in freshwater habitat critical for fish survival and productivity in the action and analysis areas will determine the extent to which hatchery salmon released into the natural environment through the Proposed Action survive, and in turn how the hatchery salmon affect the resources evaluated in this EA. Implementation of the requirements under this water code will also affect the viability status of natural salmon and steelhead populations, and resource elements affected by those natural fish.

The Minimum Water Flows and Levels Act of 1967 (RCW Chapter 90.22) authorizes Ecology to establish minimum flows for protecting fish, game, birds, other wildlife, recreational and aesthetic values and/or water quality. Under RCW 90.22.010, Establishment of minimum water flows or levels—Authorized—Purposes, Ecology may establish minimum water flows or levels for streams, lakes or other public waters for the purposes of protecting fish, game, birds or other wildlife resources, or recreational or aesthetic values of said public waters whenever it appears to be in the public interest to establish the same. In addition, Ecology shall, when requested by WDFW to protect fish, game or other wildlife resources under the jurisdiction of the agency, or if the Ecology finds it necessary to preserve water quality, establish such minimum flows or levels as are required to protect the resource or preserve the water quality described in the request or determination. Any request submitted by WDFW shall include a statement setting forth the need for establishing a minimum flow or level. When Ecology acts to preserve water quality, it shall include a similar statement with the proposed rule filed with the code reviser. This section shall not apply to waters artificially stored in reservoirs, provided that in the granting of storage permits by Ecology in the future, full recognition shall be given to downstream minimum flows, if any there may be, which have theretofore been established hereunder. The efficacy of Ecology's establishment of minimum allowable flow levels designed to protect fish habitat and habitat processes in the action and analysis areas will determine the extent to which hatchery salmon released into the natural environment through the Proposed Action survive, and in turn how the hatchery salmon affect the resources evaluated in this EA. Implementation of Act requirements will also affect the viability status of natural salmon and steelhead populations, and resource elements affected by those natural fish.

14.3 Instream Resources Protection and Water Resources Program for the Stillaguamish River Basin

The Instream Resources Protection and Water Resources Program for the Stillaguamish River Basin (WAC Chapter 173-505) is a set of rules adopted by Ecology on September 26, 2005, that sets forth Ecology's policies to guide the protection, use, and management of Stillaguamish River Basin surface water and interrelated groundwater resources. The purpose of the program is to "retain perennial rivers, streams, and lakes in the Stillaguamish River basin with instream flows and levels necessary to protect and preserve wildlife, fish, scenic, aesthetic, recreation, water quality and other environmental values, navigational values, and stock water requirements." In addition to establishing instream flows, the rules appropriated all unappropriated water from streams and rivers in the basin, as well as hydraulically connected groundwater, and set forth a program to administer future water allocation and use. Some new uses of water within the basin are allowed in limited instances:

1. Single or small group domestic uses relying on permit-exempt wells, limited basin-wide to 5 cubic feet per second or 3,231,575 gallons of water per day of groundwater
2. Single indoor domestic uses supplied from lakes and ponds, not to exceed 150 gallons per day, per residence
3. Stock water uses, limited basin-wide to 1 cubic foot per second of surface water and 20 acre-feet per year of groundwater

Under the rules, Ecology can only approve changes or transfers to existing surface or groundwater rights in the basin if there is a finding that existing rights, including established instream flows, will not be impaired.

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Appendix B

Puget Sound Salmon and Steelhead Hatchery Programs and Facilities

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Table B-1. Chinook hatchery programs and facilities.

Salmon Species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chinook salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chinook	Georgia Strait	Nooksack	**Skookum Creek Hatchery South Fork Early Chinook (August 2015)**	SF Nooksack	Spring	Integrated recovery	Conservation	Lummi Indian Nation	Subyearling/ May	1,000,000[a]	Skookum Creek Hatchery	SF Nooksack RM 14.3, tributary to the mainstem Nooksack River at RM 36.6
Chinook	Georgia Strait	Nooksack	**Kendall Creek Hatchery NF Nooksack Native Chinook Restoration (May 2018)**	NF Nooksack	Spring	Integrated recovery	Conservation	WDFW	Subyearling/ April-May	800,000	Kendall Creek Hatchery	Kendall Cr Hatchery, NF Nooksack RM 46; NF Nooksack in the vicinity of Boyd Cr RM 63; McKinnon Pond on the MF Nooksack RM 5.
Chinook	Georgia Strait	Nooksack	Lower Nooksack Fall Chinook (August 2015)	Green R. lineage (out-of-ESU)	Summer/ Fall	Isolated harvest	Harvest augmentation	Lummi Indian Nation	Subyearling/ April - May	1000000[a]	Lummi Bay Hatchery	Lummi Bay (500K) and Bertrand Creek, tributary to the Nooksack River at RM 1.5 (500K)
Chinook	Georgia Strait	Nooksack	Samish Hatchery fall Chinook (November 2014)	Green R. lineage (out-of-ESU)	Summer/ Fall	Isolated harvest	Harvest augmentation	WDFW	Subyearling/ May	6,000,000[a]	Samish Hatchery	Samish River RM 10.5
Chinook	Georgia Strait	San Juan Islands (Orcas)	Glenwood Springs Hatchery (July 2016)	Green R. lineage (out-of-ESU)	Summer/ Fall	Isolated harvest	Harvest augmentation	Long Live the Kings	Subyearling/ June	725,000	Glenwood Springs Hatchery	Eastsound, Orcas Island (One HGMP)
Chinook	Whidbey Basin	Skagit	**Marblemount spring Chinook (May 2018)**	Suiattle, Upper Skagit, Cascade composite	Spring	Isolated harvest	Indicator stock/ Harvest augmentation	WDFW	Subyearling/ June	587,500	Marblemount Hatchery	Cascade River, tributary to the Skagit River at RM 78.5
Chinook	Whidbey Basin	Skagit	Marblemount summer Chinook (May 2018)	Upper Skagit	Summer	Integrated research	Indicator stock	WDFW	Subyearling/ May	200,000	Marblemount Hatchery	Countyline Ponds, Skagit River mainstem RM 91
Chinook	Whidbey Basin	Stillaguamish	**Stillaguamish Summer Chinook Natural Stock Restoration (October 2018)**	NF Stillaguamish	Summer	Integrated recovery	Conservation	WDFW	Subyearling/ April-May	220,000	Whitehorse Pond	Whitehorse Spring Ck (RM 1.5); trib to NF Stillaguamish at RM 28
Chinook	Whidbey Basin	Stillaguamish	**Stillaguamish Fall Chinook Natural Stock Restoration (October 2018)**	SF Stillaguamish	Fall	Integrated recovery	Conservation	Stillaguamish Tribe	Subyearling/ May	200,000	Harvey Creek Hatchery	Brenner Hatchery, SF Stillaguamish River RM 31.0

Table B-1. Chinook hatchery programs and facilities (continued).

Salmon Species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chinook salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chinook	Whidbey Basin	Snohomish	**Bernie Kai-Kai Gobin Salmon Hatchery "Tulalip Hatchery" Subyearling Program (December 2012)**	Skykomish	Summer/ Fall	Integrated harvest	Harvest augmentation	Tulalip Tribes	Subyearling/ May	2,400,000	Bernie Kai-Kai Gobin Salmon Hatchery	Tulalip Bay, Port Susan
Chinook	Whidbey Basin	Snohomish	**Wallace River summer Chinook (February 2013)**	Skykomish	Summer	Integrated harvest	Harvest augmentation	WDFW	Subyearling/ June	1,000,000	Wallace River Hatchery	Wallace River RM 4.0, tributary to Skykomish River at RM 36
									Yearling/ April	500,000	Wallace River Hatchery	Wallace River RM 4.0, tributary to Skykomish River at RM 36
Chinook	Central/ South Sound	Lake Washington	**Issaquah Hatchery fall Chinook (2015-pending)**	Sammamish	Fall	Integrated harvest	Harvest augmentation	WDFW	Subyearling/ May-June	2,000,000	Issaquah Hatchery	Issaquah Creek RM 3.0, tributary to Lake Sammamish
Chinook	Central/ South Sound	Kitsap Peninsula	Grovers Creek Hatchery and Satellite Rearing Ponds (March 2013)	Green R. lineage (out-of-ESU)	Fall	Isolated harvest	Harvest augmentation	Suquamish Tribe	Subyearling/ May-June	420,000	Grovers Creek	Grovers Creek
									Subyearling/ May-June	100,000	Grovers Creek Hatchery/ Gorst Creek Rearing Ponds	Dogfish Creek (Webster's) Rearing Ponds
									Subyearling/ May	1,600,000	Grovers Creek Hatchery/ Gorst Creek Rearing Ponds	Gorst Creek Rearing Pond
Chinook	Central/ South Sound	Duwamish/ Green	**Soos Creek fall Chinook (April 2013)**	Green	Fall	Integrated harvest	Harvest augmentation	WDFW	Subyearling/ June	3,200,000	Soos Creek Hatchery	Soos Creek RM 0.8, tributary to the Green River at RM 33
									Subyearling/ June	1,000,000	Palmer Ponds	Green River RM 56.1
									Yearling/ April	300,000	Soos Creek /Icy Creek Pond	Icy Creek, tributary to the Green River at RM 48.3
Chinook	Central/ South Sound	Duwamish/ Green	**Fish Restoration Facility (FRF) Green River Fall Chinook (July 2014) - replaces Keta Creek fall Chinook (July 2014)**	Green	Fall	Integrated harvest	Harvest augmentation/ research	Muckleshoot Tribe	Subyearling/ June	600,000 or below	FRF	Green River mainstem at RM 60
									Fry/ March-May		FRF	Green River watershed tributaries upstream of Howard Hanson Dam, located at RM 64
									Subyearling/ June			
Chinook	Central/ South Sound	Puyallup	**Voights Creek fall Chinook program (April 2013)**	Puyallup	Fall	Integrated harvest	Harvest augmentation	WDFW	Subyearling/ June	1,600,000	Voights Creek Hatchery	Voights Creek (RM .5), trib to Carbon River at RM 4.0, trib to Puyallup River at RM 17.8

Table B-1. Chinook hatchery programs and facilities (continued).

Salmon Species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chinook salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chinook	Central/ South Sound	Puyallup	**Clarks Creek Fall Chinook (November 2012)**	Puyallup	Fall	Integrated harvest	Harvest augmentation	Puyallup Tribe	Subyearling/ April-May	1,000,000	Clarks Creek	Clarks Creek RM 0.8, tributary to Puyallup River at RM 5.8; Acclimation Ponds in Upper Puyallup River watershed (Puyallup RM 31-49 - includes Rushingwater Ck, Mowich R., and Cowskull Ck.); W.F. Hylebos Creek RM 1.0
										200,000	Upper Puyallup Acclimation Ponds	
										20,000	Hylebos Creek	
Chinook	Central/ South Sound	White	**White River Hatchery (spring Chinook) (December 2014)**	White	Spring	Integrated recovery	Conservation	Muckleshoot Tribe	Subyearling/ Late April - June	340,000	White River Hatchery	White River RM 23.4
									Yearling/ April	55,000	White River Hatchery	White River RM 23.4
									Subyearling/ June	1,300,000	White River Acclimation Ponds	Acclimation Ponds on the Greenwater R (trib to White River at RM 35.3), Huckleberry Creek (trib at RM 53.1), Cripple Creek (trib to W Fork White at RM 2), Jensen Creek, and Twenty-eight Mile Creek.
Chinook	Central/ South Sound	Carr Inlet/South Sound	**Minter Creek/ Hupp Springs Hatchery White River spring Chinook (July 2016-pending 2017 update)**	White	Spring	Isolated recovery	Conservation/ Harvest	WDFW	Subyearling/ May	400,000	Hupp Springs Hatchery	Hupp Springs Hatchery on Minter Creek RM 3.0, tributary to Carr Inlet, South Puget Sound
Chinook	Central/ South Sound	Carr Inlet/South Sound	Minter Creek Hatchery fall Chinook (March 2017)	Green R. lineage (out-of-ESU)	Fall	Isolated harvest	Harvest augmentation	WDFW	Subyearling/ May	1,400,000	Minter Creek Hatchery	Minter Creek RM 0.5, tributary to Carr Inlet, South Puget Sound
Chinook	Central/ South Sound	Chambers Creek, South Puget Sound	Chambers Creek fall Chinook (March 2018)	Green R. lineage (out-of-ESU)	Fall	Isolated harvest	Harvest augmentation	WDFW	Subyearling/ March - April	100,000	Chambers Creek Hatchery	Chambers Creek Fishway Trap RM 0.5
									Subyearling/ May - June	750,000	Chambers Creek Hatchery	Chambers Creek Fishway Trap RM 0.5
									Subyearling/ Sept	100,000	Garrison Springs Hatchery	Chambers Creek Fishway Trap RM 0.5

Table B-1. Chinook hatchery programs and facilities (continued).

Salmon Species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chinook salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chinook	Central/ South Sound	Nisqually	**Nisqually Fish Hatchery at Clear Creek/Kalama Creek Salmon Hatchery (Nov 2016 draft - update pending)**	Nisqually	Fall	Segregated Harvest /Integrated harvest	Harvest augmentation (two stage integrated harvest)	Nisqually Tribe	Subyearling/ May-June (segregated component)	3,400,000	Clear Creek Hatchery	Clear Creek, tributary to Nisqually River at RM 6.3, RM 0.2 of Clear Creek.; McAllister Creek, tributary to the Nisqually River estuary at RM 5.5 on McAllister Creek
									Subyearling/ May-June (integrated component)	600,000	Kalama Creek Hatchery	Kalama Creek, tributary to Nisqually River at RM 9.2, RM 0.2 of Kalama Creek
Chinook	Central/ South Sound	Deschutes	Tumwater Falls fall Chinook (May 2013)	Green R. lineage (out-of-ESU)	Fall	Isolated harvest	Harvest augmentation	WDFW	Subyearling/ March-June	3,800,000	Tumwater Falls Hatchery	Deschutes River RM 0.2
Chinook	Hood Canal	Skokomish	**George Adams fall Chinook (November 2014)**	Skokomish	Fall	Integrated harvest	Harvest augmentation	WDFW	Subyearling/ May-June	3,800,000	George Adams Hatchery	Purdy Creek RM 1.8, tributary to the Skokomish River ay RM 4.0
Chinook	Hood Canal	Skokomish	North Fork Skokomish River spring Chinook (March 2015)	Cascade	Spring	Integrated harvest	Harvest augmentation	Tacoma Power in cooperation with WDFW and the Skokomish Tribe	Subyearling/ summer-fall	300,000	North Fork Skokomish Hatchery	North Fork Skokomish River at RM 8.3, tributary to the Skokomish River at RM 9
									Yearling/ spring	75,000		
Chinook	Hood Canal	Finch Creek, west Hood Canal	Hoodsport fall Chinook (July 2014)	Green R. lineage (out-of-ESU)	Fall	Isolated harvest	Harvest augmentation	WDFW	Subyearling/ June	3,000,000	Hoodsport Hatchery	Finch Creek RM 0.0, tributary to west Hood Canal
									Yearling/ May	120,000	Hoodsport Hatchery	Finch Creek RM 0.0, tributary to west Hood Canal
Chinook	Strait of Juan de Fuca	Dungeness	**Dungeness River spring Chinook (January 2013)**	Dungeness	Spring	Integrated recovery	Conservation	WDFW	Subyearling/ May-June	150,000	Dungeness and Hurd Creek	Upper Dungeness River RM 15.8; Gray Wolf Acclimation Ponds RM 1.0; Dungeness River RM 10.5
									Yearling/ April	50,000	Hurd Creek Hatchery	Dungeness River RM 3.0
Chinook	Strait of Juan de Fuca	Elwha	**Elwha River summer/fall Chinook (November 2012)**	Elwha	Summer/ Fall	Integrated recovery	Conservation	WDFW	Subyearling/ June	2,500,000	Elwha Channel	Elwha River RM 3.5
									Yearling/ March-April	200,000	Elwha Channel	Elwha River RM 3.5

[a] Numbers are maximum release levels using current facilities and do not reflect production that would require new facilities.

Table B-2. Steelhead hatchery programs and facilities.

Salmon Species	Steelhead major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Steelhead population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Steelhead	Northern Cascades	Nooksack	Kendall Creek Hatchery Winter Steelhead (July 2014)	Chambers Ck lineage (out-of-DPS)	Winter	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April-May	150,000	Kendall Creek Hatchery	NF Nooksack RM 46
Steelhead	Northern Cascades	Stillaguamish	Whitehorse Pond Summer Steelhead Program (draft 2014)	Skamania Hatchery-lineage (out-of-DPS)	Summer	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April-May	70,000	Whitehorse Pond	Whitehorse Spring Ck RM 1.5, tributary to NF Stillaguamish at RM 28
Steelhead	Northern Cascades	Stillaguamish	Whitehorse Pond Winter Steelhead Program (July 2014)	Chambers Ck lineage (out-of-DPS)	Winter	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April-May	130,000	Whitehorse Pond	Whitehorse Spring Ck RM 1.5, tributary to NF Stillaguamish at RM 28
Steelhead	North Cascades	Snohomish/ Skykomish	Reiter Pond Summer Steelhead Program (draft 2013)	Skamania Hatchery-lineage (out-of-DPS)	Summer	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April-May	190,000	Reiter Ponds	Reiter Pond 140K (RM 45); NF Skykomish @ Index 10K; Sultan R. 20K; Raging R. 50K
Steelhead	Northern Cascades	Snohomish/ Skykomish	Skykomish River Winter Steelhead Hatchery Program (February 2016)	Chambers Ck lineage (out-of-DPS)	Winter	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April-May	140,000	Reiter Ponds	Reiter Pond at Skykomish River RM 46
									Yearling/ April-May	27,600	Wallace Hatchery	Wallace River RM 4.0, tributary to Skykomish at RM 36
Steelhead	Northern Cascades	Snohomish/ Snoqualmie	Tokul Creek Winter Steelhead Program (July 2014)	Chambers Ck lineage (out-of-DPS)	Winter	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April-May	74,000	Tokul Creek Hatchery	Tokul Creek (RM 0.5), tributary of the Snoqualmie River at RM 39, tributary to the Snohomish River at RM 20.5
Steelhead	Northern Cascades	Green	Soos Creek (Green River) Hatchery Summer Steelhead (Oct 2015)	Skamania Hatchery-lineage (out-of-DPS)	Summer	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April	50,000	Soos Creek Hatchery	Soos Creek RM 0.8, tributary to the Green River at RM 33.5
									Yearling/ April	50,000	Icy Creek Pond	Icy Creek, tributary to the Green River at RM 48.3
Steelhead	Northern Cascades	Green	**Green River Native Winter (late) Steelhead (Oct 2014)**	Green River	Winter	Integrated recovery	Conservation	WDFW	Yearling/ May	23,000	Soos & Icy Creek Pond	Icy Creek, tributary to the Green River RM 48.3
									Yearling/ May	15,000	Soos & Flaming Geyser (Pond)	Flaming Geyser Park, Cristy Creek, tributary to the Green River at RM 44.3
									Yearling/ May	17,000	Palmer Ponds	Palmer Ponds, Green River RM 56.1

Table B-2. Steelhead hatchery programs and facilities (continued).

Salmon Species	Steelhead major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Steelhead population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Steelhead	Central and South Puget Sound	Green	**Fish Restoration Facility (FRF) Green River Winter Steelhead (July 2014)**	Green River	Winter	Integrated Recovery	Harvest Augmentation	Muckleshoot Indian Tribe	Yearling/ July	350,000 or below	FRF	Green River mainstem at RM 60
									Fed Fry/ July	?	FRF	Green River watershed tributaries upstream of Howard Hanson Dam, located at RM 64
									Yearling/ July	?		
Steelhead	Central and South Puget Sound	White	**White River Winter Steelhead Supplementation Program (November 2015)**	White River	Winter	Integrated recovery	Conservation	Puyallup Indian Tribe and Muckleshoot Indian Tribe w/ WDFW	Yearling/ May	60,000	Diru Creek Hatchery and White River Hatchery	White River RM 24.3. White River (from acclimation pond(s) on Clearwater, Greenwater, or Huckleberry Cr tributaries upstream of Mud Mt Dam RM 29.6).
Steelhead	Hood Canal and Strait of Juan de Fuca	Skokomish	**Hood Canal Steelhead Supplementation Project (April 2014)**	Skokomish River	Winter	Integrated recovery	Conservation	Long Live the Kings	Yearlings/ April-May	21,600	McKernan Hatchery	SF Skokomish River
										6,000	LLTK Lilliwaup Hatchery	SF Skokomish River
		Dewatto		Eastside Hood Canal Tributaries					Yearlings/ April-May	7,400	LLTK Lilliwaup Hatchery	Dewatto River
									Adults/ March-April	253		Dewatto River
		Duckabush		Westside Hood Canal Tributaries					Yearlings/ April-May	6,667	LLTK Lilliwaup Hatchery	Duckabush River
									Adults/ March-May	230		Duckabush River
Steelhead	Hood Canal and Strait of Juan de Fuca	North Fork Skokomish River	North Fork Skokomish River Winter Steelhead Program (April 2016 - draft)	Skokomish River	Winter	Integrated recovery	Conservation	Tacoma Power	Yearling/ May	15,000 (225 adults)	North Fork Skokomish Salmon Hatchery	North Fork Skokomish River, Base of Dam #2, RM 8.3
Steelhead	Hood Canal and Strait of Juan de Fuca	Dungeness	Dungeness Winter Steelhead Program (July 2014)	Chambers Ck lineage (out-of-DPS)	Winter	Isolated harvest	Harvest augmentation	WDFW	Yearling/ May	10,000	Dungeness Hatchery	Dungeness River RM 10.5
Steelhead	Hood Canal and Strait of Juan de Fuca	Elwha	**Lower Elwha Fish Hatchery (August 2012)**	Elwha River	Winter	Integrated recovery	Conservation	Lower Elwha Klallam Tribe	Yearling/ May	175,000	Lower Elwha Hatchery	Elwha River RM 1.25

Table B-3. Coho salmon hatchery programs and facilities.

Salmon species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Coho salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Coho	Strait of Georgia	Nooksack	Skookum Hatchery Coho (Nov 2015)	Nooksack	Normal-timed	Isolated harvest	Harvest augmentation	Lummi Indian Nation	Yearling/ May-June	1,500,000[a]	Skookum Creek Hatchery	SF Nooksack RM 14.3, tributary to the mainstem Nooksack River at RM 36.6
Coho	Strait of Georgia	Nooksack	Lummi Bay Hatchery Coho (Nov 2015)	Nooksack	Normal-timed	Isolated harvest	Harvest augmentation	Lummi Indian Nation	Yearling/ April-May	1,500,000[a]	Lummi Bay Hatchery	Lummi Bay, north Puget Sound
Coho	Whidbey Basin	Skagit	Skagit Coho Program (May 2018)	Skagit (Cascade) River	Normal-timed	Isolated harvest	indicator stock/ Harvest augmentation	WDFW	Yearling/ June	500,000	Marblemount Hatchery	Cascade River Rm 1.0, tributary to the Skagit River at RM 78.5
Coho	Whidbey Basin	Skagit	Baker River Coho (May 2018)	Skagit (Baker)	Normal-timed	Integrated Harvest	Harvest augmentation	PSE/WDFW	Fry/ May-June	160,000	Baker Lake Hatchery	Baker Lake, behind Upper Baker Dam, Baker River RM 9.1
									Yearling/ June	5,000	Baker Lake Hatchery	Baker Lake, behind Upper Baker Dam, Baker River RM 9.1
									Yearling/ June	55,000	Baker Lake Hatchery	Stress Relief Ponds on Baker River RM 0.7 (Baker River Fish Trap), tributary to Skagit River at RM 56.5
									Yearling/ June	5,000	Baker Lake Hatchery	Lake Shannon, behind Lower Baker Dam, Baker River RM 8.9
Coho	Whidbey Basin	Stillaguamish	Stillaguamish Coho Program (October 2018)	Stillaguamish	Normal-timed	Integrated harvest/ recovery	Harvest augmentation/c onservation	Stillaguamish Tribe	Yearling/ May-June	60,000	Harvey Creek Hatchery/North Fork/Johnson Creek Hatchery	Harvey Creek Hatchery RM 2.0 on Harvey/Armstrong Creek, trib to the Stillaguamish River at RM 15.3
Coho	Whidbey Basin	Snohomish	Tulalip Coho Program (March 2013)	Skykomish	Normal-timed	Integrated Harvest	Harvest augmentation	Tulalip Tribes	Yearling/ May-June	2,000,000	Bernie Kai-Kai Gobin Salmon Hatchery, Wallace River Hatchery	Tulalip Creek and Tulalip Bay, Port Susan
Coho	Whidbey Basin	Snohomish	Wallace River Coho Program (October 2013)	Skykomish	Normal-timed	Integrated Harvest	Harvest augmentation	WDFW	Yearling/ May	150,000	Wallace River Hatchery	Wallace River RM 4.0, tributary to Skykomish River at RM 36
Coho	Whidbey Basin	Snohomish	Everett Net Pen Coho Program (June 2013)	Skykomish	Normal-timed	Isolated harvest	Harvest augmentation	Everett Steelhead and Salmon Club	Yearling/ June	20,000	Wallace River Hatchery	Port of Everett Visitor's Dock, mouth of the Snohomish River on Port Gardner Bay.

Table B-3. Coho salmon hatchery programs and facilities (continued).

Salmon species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Coho salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Coho	Central/ South Sound	Lake Washington	Issaquah Coho Program (December 2014)	Issaquah Creek (x Green River)	Normal-timed	Isolated harvest	Harvest augmentation	NWSSC-Laebugten	Yearling/ June	25,000	Issaquah Creek Hatchery	Port of Edmonds, Public Fishing Pier
						Integrated Harvest		WDFW	Yearling/ May	450,000	Issaquah Creek Hatchery	Issaquah Creek RM 3.0, tributary to Lake Sammamish
Coho	Central/ South Sound	Green	Soos Creek Coho Program (July 2014)	Green	Normal-timed	Integrated Harvest	Harvest augmentation	WDFW	Yearling/ May	600,000	Soos Creek Hatchery	Soos Creek RM 0.8, tributary to the Green River at RM 33.5
						Isolated harvest		Trout Unlimited	Yearling/ June	30,000	Soos Creek Hatchery	Des Moines Marina, central Puget Sound
									Fry/ January	54,000	Miller Creek Hatchery	Des Moines Creek, various
									Fry/ January	33,000	Miller Creek Hatchery	Miller Creek, various
									Fry/ January	33,000	Miller Creek Hatchery	Walker Creek, various
Coho	Central/ South Sound	Green	Keta Creek Complex (June 2017)	Green	Normal-timed	Integrated Harvest	Harvest augmentation	Muckleshoot Indian Tribe	Yearling/ May	1,000,000	Crisp Creek Ponds	Crisp Creek RM 1.1 Green R. tributary at RM 40.1
										1,000,000	Elliot Bay Netpens	Elliot Bay, Puget Sound
										50,000	Supplementation site	TBD in Green River watershed
Coho	Central/ South Sound	Green	Fish Restoration Facility (FRF) Green River Coho (July 2014)	Green	Normal-timed	Integrated Harvest	Harvest augmentation	Muckleshoot Indian Tribe/ Suquamish Tribe	Yearling/ TBD	600,000 or below	FRF	Green River mainstem at RM 60
									Fed Fry/ TBD	?	FRF	Green River watershed tributaries upstream of Howard Hanson Dam, located at RM 64
									Yearling/ TBD	?		
Coho	Central/ South Sound	Green	Marine Technology Center Coho Program (November 2014)	Green	Normal-timed	Isolated harvest	Education	WDFW	Yearling/ May	10,000	Soos Creek Hatchery	Seahurst Park (on Puget Sound) in Burien, Washington
Coho	Central/ South Sound	Puyallup	Voights Creek Coho Program (August 2016)	Puyallup (Voights Creek Hatchery)	Normal-timed	Integrated harvest	Harvest augmentation	WDFW	Yearling/ April,May	1,080,000	Voights Creek Hatchery	Voights Creek RM 0.5, tributary to Carbon River at RM 4.0, trib to Puyallup River at RM 17.8

Table B-3. Coho salmon hatchery programs and facilities (continued).

Salmon species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Coho salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Coho	Central/ South Sound	Puyallup	Puyallup Acclimation Sites - Diru Creek Fall coho (May 2013)	Puyallup (Voights Creek Hatchery)	Normal-timed	Integrated recovery	Restoration	Puyallup Tribe	Yearling/ April-May	100,000	Diru Creek Hatchery	Mowich River Acclimation Pond, RM 0.2 on Mowich River; Cowskull Creek Acclimation Pond, RM 0.1 on Cowskull Creek, trib to Puyallup River at RM 44.8; Rushingwater Acclimation Pond, RM 0.5 on Rushingwater Creek, trib to Mowich River at RM 1.1
									Yearling/ May	200,000	Voights Creek Hatchery/ Puyallup Tribal Hatchery	Lake Kapowisin Net Pens
Coho	Central/ South Sound	Carr Inlet	Minter Creek Coho (October 2018)	Minter Creek	Normal-timed	Integrated Harvest	Harvest augmentation	WDFW	Yearling/ May-July	500,000	Minter Creek Hatchery	Minter Creek RM 0.5, tributary to northern Carr Inlet in south Puget Sound
										150,000		Hupp Springs Hatchery at RM 3.0
Coho	Central/ South Sound	Nisqually	Kalama Creek Hatchery Fall Coho (April 2003)	Central/South Sound mix	Normal-timed	Isolated harvest	Harvest augmentation	Nisqually Tribe	Yearling/ April	400,000	Kalama Creek Hatchery	Kalama Creek, tributary to Nisqually River at RM 9.2
Coho	Central/ South Sound	South Puget Sound	Squaxin Island/ South Sound Net Pens (July 2014)	Central/South Sound mix	Normal-timed	Isolated harvest	Harvest augmentation	Squaxin Island Tribe and WDFW	Yearling/ May-June	1,800,000	South Sound net-pens	Peale Passage, deep South Puget Sound
Coho	Central/ South Sound	Deschutes River	Deschutes Basin Coho Supplementation (June 2018)	Central/South Sound mix (Minter Creek Hatchery)	Normal-timed	Integrated harvest	Harvest augmentation/education	WDFW and Squaxin Island Tribe	Subyearling/ January-March or April-May	100,000	Minter Creek Hatchery	Deschutes River, various locations and timing adaptively managed based upon Deschutes River flows and abundance of adult coho salmon returns.
Coho	Hood Canal	Skokomish	George Adams Coho Yearling Program (January 2013)	Mixed Puget Sound, localized to Skokomish River	Normal-timed	Isolated harvest	Harvest augmentation	WDFW	Yearling/ post April-15	300,000	George Adams Hatchery	Purdy Creek RM 1.0, tributary to Skokomish River at RM 4.1

Table B-3. Coho salmon hatchery programs and facilities (continued).

Salmon species	Chinook salmon major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Coho salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Coho	Hood Canal	Port Gamble Bay/ Little Boston Creek	Port Gamble Coho Net Pens (March 2003)	Big Quilcene River	Early-timed	Isolated harvest	Harvest augmentation	Port Gamble S'Klallam Tribe/USFWS	Yearling/ June	400,000	George Adams Hatchery, Port Gamble Net pens	Port Gamble Bay, northern Hood Canal
Coho	Hood Canal	Quilcene	Quilcene Coho Net Pen (March 2003)	Big Quilcene River	Early-timed	Isolated harvest	Harvest augmentation	Skokomish Tribe and USFWS	Yearling/ May	150,000	Quilcene NFH, Quilcene Bay Net pens	Quilcene Bay, northwestern Hood Canal
Coho	Hood Canal	Big Quilcene River	Quilcene National Fish Hatchery Coho Salmon Production Program (June 2010)	Big Quilcene River	Early-timed	Isolated harvest	Harvest augmentation	USFWS	Yearling/ April-May	406,000	Quilcene NFH	Big Quilcene River RM 2.8
Coho	Strait of Juan de Fuca	Dungeness	Dungeness River Coho (January 2013)	Dungeness-mixed origin	Early-timed	Isolated harvest	Harvest augmentation	WDFW	Yearling/ June	500,000	Dungeness Hatchery and Hurd Creek Hatchery	Dungeness River RM 10.5
Coho	Strait of Juan de Fuca	Elwha	Lower Elwha Fish Hatchery (August 2012)	Elwha	Normal-timed	Integrated harvest	Harvest augmentation	Lower Elwha Klallam Tribe	Yearling/ May	425,000	Lower Elwha Hatchery	Elwha River RM 0.3

Note: MPGs for coho salmon have not been designated. Unless otherwise noted, MPG names are for the Chinook salmon MPGs associated with the watershed, or coho salmon populations.

[a] Numbers are maximum release levels using current facilities and do not reflect production that would require new facilities.

Table B-4. Pink salmon hatchery programs and facilities.

Salmon Species	Major population group	Watershed	Hatchery program name, HGMP date (in parentheses)	Pink salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Pink	Pink salmon MPGs have not been designated. Chinook salmon MPG is Hood Canal	Finch Creek (western Hood Canal)	Hoodsport Pink Salmon Program (January 2013)	Dungeness/ Dosewallips (localized to the release site)	Normal	Isolated harvest	Harvest augmentation	WDFW	Fed fry/ April	500,000	Hoodsport Hatchery	Finch Creek, western Hood Canal
Pink	Pink salmon MPGs have not been designated. Chinook salmon MPG is Strait of Juan de Fuca	Dungeness	Dungeness River Pink Salmon Program (January 2013)	Dungeness	Normal	Integrated Recovery	Conservation	WDFW	Fed fry/ April	100,000	Hurd Creek Hatchery	Dungeness River RM 3.0
Pink	Pink salmon MPGs have not been designated. Chinook salmon MPG is Strait of Juan de Fuca	Elwha	Elwha River Pink Salmon Preservation and Restoration Program (August 2012)	Elwha	Normal	Integrated Recovery	Conservation	Lower Elwha Klallam Tribe (and WDFW)	Fed fry/ March	3,000,000	Lower Elwha Hatchery	Elwha River, RM 1.3

Note: MPGs for pink salmon have not been designated. MPG names are for the Chinook salmon MPGs associated with the watershed.

Table B-5. Sockeye salmon hatchery programs and facilities.

Salmon Species	Major population group	Watershed	Hatchery program name, HGMP date (in parentheses	Sockeye salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Sockeye	Baker River sockeye form a single ESU. No MPG.	Skagit/Baker	Baker River Sockeye Program (August 2015)	Baker River (ESU)	Early Summer	Integrated harvest	Conservation	WDFW	Unfed fry/ February-May	2,000,000	Baker Lake Spawning Beach #4	Baker Lake Spawning Beach #4, located at the mouth of Sulphur Creek
									Fed fry/ March-May	3,500,000	Baker Lake Sulphur Cr Facility	Baker Lake, behind Upper Baker Dam, Baker River RM 9.1
									Fed fry/ March-May	2,500,000	Baker Lake Sulphur Cr Facility	Lake Shannon, tailrace below hatchery
									Subyearling/ November	330,000	Baker Lake Sulphur Cr Facility	Baker Lake, behind Upper Baker Dam, Baker River RM 9.1
									Yearling/ April	5,000	Baker Lake Sockeye Spawning Beach facilities	Baker Lake, behind Upper Baker Dam, Baker River RM 9.1
									Yearling/ April	5,000	Baker Lake Sulphur Cr Facility	Lake Shannon, tailrace below hatchery
Sockeye	NA	Lake Washington	Cedar River Sockeye Program (December 2014)	Lake Washington (localized Baker River stock)	Early Summer	Integrated harvest	Conservation/ Harvest	WDFW	Fed fry/ January-May	34,000,000	Cedar River Hatchery	Cedar River RM 21.7, 13.5, and 2.1

Table B-6. Fall and summer chum salmon hatchery programs and facilities.

Salmon Species	Major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chum salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Strait of Georgia	Nooksack	Whatcom Creek Chum Program (October 2014)	Nooksack	Fall	Isolated harvest	Education/ Harvest augmentation	Bellingham Technical College/ WDFW	Fed fry/ May	2,000,000	Whatcom Creek Hatchery, Kendall Creek Hatchery	Whatcom Creek RM 0.5, tributary to Bellingham Bay
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Strait of Georgia	Nooksack	NF Noosack River Fall Chum Program (Jan 2016)	Nooksack	Fall	Integrated harvest	Harvest augmentation	Lummi Indian Nation/ WDFW	Fed fry/ April-May	1,000,000[a]	Kendall Creek Hatchery	Kendall Creek, tributary to NF Nooksack River RM 46
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Strait of Georgia	Nooksack	Lummi Bay Fall Chum (Nov 2015)	Nooksack	Fall	Isolated harvest	Harvest augmentation	Lummi Indian Nation/ WDFW	Fed fry/ April-May	2,300,000[a]	Lummi Bay Complex,	Lummi Bay, north Puget Sound
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Whidbey Basin	Skagit	Upper Skagit Hatchery (August 2015)	Skagit	Fall	Integrated harvest/ Education	Education/ Harvest augmentation	Upper Skagit Indian Tribe	Fed fry/ May	450,000	Upper Skagit Hatchery	Red Creek tributary to Skagit River at RM 22.9
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Whidbey Basin	Skagit	Chum Remote Site Incubator (August 2015)	Skagit	Fall	Integrated Recovery	Conservation	Sauk-Suiattle Indian Tribe	Fed fry/ April	125,000	Three Sauk River RSI sites.	Hatchery Creek, trib. To the Sauk River at RM 0.2; Lyle Creek at RM 0.5; and Unnamed Side Channel at RM 15

Table B-6. Fall and summer chum salmon hatchery programs and facilities (continued).

Salmon Species	Major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chum salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Whidbey Basin	Skagit	Chum Remote Site Incubator (June 2015)	Skagit	Fall	Integrated Recovery	Conservation	Sauk-Suiattle Indian Tribe	Fed fry/ April	125,000	Sauk-Suiattle Hatchery	Hatchery Creek, trib. To the Sauk River at RM 0.2; Lyle Creek at RM 0.5; and Unnamed Side Channel at RM 15
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Whidbey Basin	Stillaguamish	Stillaguamish (Harvey Creek) Chum Program (October 2018)	Stillaguamish	Fall	Integrated education	Education/ Harvest augmentation	Stillaguamish Tribe	Unfed and fed fry/ April-May	225,000	Harvey Creek Hatchery	Harvey Creek Hatchery RM 2.0 on Harvey/ Armstrong Creek, trib to the Stillaguamish River at RM 15.3
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Whidbey Basin	Snohomish	Tulalip Bay Hatchery Chum (April 2013)	Walcott Slough (localized to release site)	Fall	Isolated harvest	Harvest augmentation	Tulalip Tribes	Fed fry/ May	8,000,000	Bernie Kai-Kai Gobin Salmon Hatchery	Battle Creek RM 0.3, Tulalip Bay, Port Susan
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Central/South Sound	Green	Keta Creek Hatchery (December 2014)	East Kitsap (localized)	Fall	Integrated harvest	Harvest augmentation	Muckleshoot Indian Tribe	Fed fry/ April-May	5,000,000	Keta Creek Hatchery	Crisp Creek RM 1.1, tributary to the Green River at RM 40.1
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Central/South Sound	East Kitsap	Cowling Creek Hatchery and Satellite Incubation and Rearing Facilities (March 2003)	Chico Creek (East Kitsap)	Fall	Integrated harvest	Harvest augmentation	Suquamish Tribe	Unfed fry/ April	600,000	Cowling Creek Hatchery	Dogfish Creek (Liberty Bay), Clear and Barker Creeks (Dyes Inlet), and Steele Creek (Burke Bay); all are East Kitsap tribs
									Fed fry/ May	1,200,000	Cowling Creek Hatchery	Cowling Creek, tributary to Miller bay, East Kitsap

Table B-6. Fall and summer chum salmon hatchery programs and facilities (continued).

Salmon Species	Major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chum salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Central/South Sound	Puyallup	Diru Creek Winter Chum (May 2013)	Chambers Creek (localized)	Late Fall	Integrated harvest	Harvest augmentation	Puyallup Indian Tribe	Fed fry/ April-May	1,950,000	Diru Creek Hatchery (Puyallup Tribal Hatchery)	Diru Creek RM 0.25, tributary to Clarks Creek, trib to Puyallup River at RM 5.8
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Central/South Sound	Carr Inlet	Minter Creek Chum Program (January 2013)	Elson Creek (Skookum Inlet), localized	Fall	Integrated harvest	Harvest augmentation	WDFW	Fed fry/ April	2,000,000	Minter Creek Hatchery	Minter Creek RM 0.5, tributary to northern Carr Inlet in south Puget Sound
Chum	Fall-run chum salmon MPGs have not been designated. Listed summer-run chum salmon population is Hood Canal. Chinook salmon MPG is Hood Canal.	Skokomish	McKernan Fall Chum Program (September 2013)	Finch Creek	Fall	Isolated harvest	Harvest augmentation	WDFW	Fed fry/ April	11,500,000	McKernan Hatchery, George Adams Hatchery	Weaver Creek RM 1.0, tributary to the Skokomish River at RM 16
									Fry/ May-June	1,500,000	Rick's Ponds (LLtK), George Adams	Skokomish River
Chum	Fall chum MPGs have not been designated. Listed summer chum population is Hood Canal. Chinook salmon MPG is Hood Canal.	Enetai Creek (south Hood Canal)	Enetai Hatchery Fall Chum (September 2013)	Walcott Slough/ Quilcene (localized to release site)	Fall	Isolated harvest	Harvest augmentation	Skokomish Tribe	Fed fry/ April	3,200,000	Enetai Hatchery	Enetai Creek, tributary to south Hood Canal north of the Skokomish River

Table B-6. Fall and summer chum salmon hatchery programs and facilities (continued).

Salmon Species	Major population group	Watershed	Hatchery program name, HGMP date (in parentheses), and listing status [listed or proposed for listing stocks shown in bold]	Chum salmon population	Species run or race	Hatchery program type	Hatchery program purpose	Hatchery operator	Life stage and time of release	HGMP release number	Primary facility	Release location(s)
Chum	Fall chum MPGs have not been designated. Area includes listed Hood Canal summer chum population, and the Hood Canal Chinook MPG.	Finch Creek (west Hood Canal)	Hoodsport Fall Chum (September 2013)	Finch Creek	Fall	Isolated harvest	Harvest augmentation	WDFW	Fed fry/ April	12,000,000	Hoodsport Hatchery, George Adams Hatchery	Finch Creek, westside tributary to Hood Canal
Chum	Hood Canal. No MPGs for summer-run chum salmon	Lilliwaup Creek	**Lilliwaup Creek Summer Chum (October 1999)**	Hood Canal	Summer	Integrated recovery	Conservation	WDFW and LLTK	Fry	150,000	Lilliwaup Hatchery	Lilliwaup Creek RM 0.5
Chum	Fall-run chum salmon MPGs have not been designated. Area includes the listed Hood Canal summer-run chum salmon population, and the Hood Canal Chinook salmon MPG.	Port Gamble Bay (north Hood Canal)	Port Gamble Hatchery Fall Chum (March 2013)	Walcott Slough (localized to release site)	Fall	Isolated harvest	Harvest augmentation	Port Gamble S'Klallam Tribe	Fed fry/ April-May	475,000	Little Boston Hatchery	Little Boston Creek, Port Gamble Bay, north Hood Canal.
Chum	Fall-run chum salmon MPGs have not been designated. Chinook MPG is Strait of Juan de Fuca	Elwha	Lower Elwha Fish Hatchery (August 2012)	Elwha	Fall	Integrated recovery	Conservation	Lower Elwha Klallam Tribe	Fed fry/ March-April	450,000	Lower Elwha Hatchery	Elwha River RM 0.3

Note: MPGs for fall chum salmon have not been designated. Unless otherwise noted (for summer chum), MPG names are for the Chinook salmon associated with the watershed, or summer chum populations.
[a] Numbers are maximum release levels using current facilities and do not reflect production that would require new facilities.

Appendix C

Competition and Predation Literature Summary and Qualitative Evaluation Methods

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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 in steelhead in freshwater, estuarine, and marine habitats. In addition, a qualitative evaluation method is described assessing the risk of competition and predation to natural-origin fish from hatchery-origin fish in freshwater. The method is rules-based in that specific factors and criteria are considered when making an evaluation. The method is a simplified evaluation of competition because not all potential factors are explicitly considered. The results of an evaluation using this methodology could be expanded based on other factors not 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. Consequently, a qualitative evaluation method for estuarine and marine waters analogous to freshwaters was not possible.

The following subsections provide (1) a brief review of salmon and steelhead competition in freshwater, estuarine, and marine habitats; (2) a detailed description of the methodology, factors considered, and criteria; and (3) the results of the evaluation for salmon hatchery programs in the Stillaguamish River Basin.

1 REVIEW OF COMPETITION BY 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 mechanism that is part of how fauna adapt to their biological and physical environments and does not inherently result in negative effects in nature. However, negative effects of competition on natural-origin fish from hatchery-origin fish may result from direct interactions (i.e., hatchery-origin fish interfere with access to limited resources by natural-origin fish) or indirect interactions (i.e., exploitation of a limited resource by hatchery-origin fish reduces the amount of that resource available for natural-origin fish) (SIWG 1984). Hatchery-origin fish of different life stages may compete with natural-origin fish for food and spawning and rearing space. Juvenile and adult hatchery-origin fish may compete with natural-origin salmon and steelhead for food resources and rearing space in freshwater, estuary, and marine habitats (Flagg et al. 2000; Naish et al. 2007). When adult hatchery-origin fish and natural-origin fish occur at the same time and place, hatchery-origin spawners may also compete with natural-origin spawners for mates and spawning habitat. An important objective of hatchery management is to minimize the negative effects of competition from hatchery-origin fish on natural-origin-fish (HSRG 2004).

Of the many factors affecting natural-origin salmon and steelhead populations, competition for resources is believed to exert the greatest influence on juvenile salmon and steelhead survival (Hillman and Mullan 1989; Hillman et al. 1989; Cannamela 1993; Healey and Reinhardt 1995). Competition occurs naturally within and between species, and the severity of effects on salmon and steelhead survival and productivity is dependent on fish density and the quality and availability of habitat. Regardless of the presence of hatchery-origin fish, competition contributes to the mortality typically experienced by juvenile salmon and steelhead during their early life history in fresh water, and during their first few months in marine waters.

Hatchery-origin fish of different life stages may compete with natural-origin fish for food and spawning and rearing space. Juvenile, subadult, and adult hatchery-origin fish may compete with natural-origin salmon and steelhead for food resources and rearing space in freshwater, estuary, and marine habitats (Flagg et al. 2000; Naish et al. 2007). When adult hatchery-origin fish and natural-origin fish occur at the same time and place, hatchery-origin spawners may also compete with natural-origin spawners for mates and spawning habitat. In comparison to natural-origin fish species competing among other natural-origin fish species but without the presence of hatchery-origin fish; in most instances, natural-origin salmon and steelhead have different juvenile and adult life history strategies. These strategies effectively partition use of limited resources, thereby reducing the extent of competitive interactions among salmon and steelhead in nature (Nilsson 1967; SIWG 1984; Groot and Margolis 1991; Taylor 1991).

Juvenile hatchery-origin salmon and steelhead released into the natural environment primarily compete with natural-origin salmon and steelhead for resources when the hatchery-origin fish migrate downstream or sometimes residualize (described below). Species that rear in fresh water for 1 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 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 ocean. However, this is difficult to fully achieve in practice. All natural-origin smolts do not out-migrate at the same time; timing of smoltification can vary by 45 or more days within a single population (Quinn 2005; Achord et al. 2007). In contrast, most hatchery-origin fish are released over a shorter time period (e.g., 2 weeks).

To help reduce risks to natural-origin fish, hatchery programs in Puget Sound are generally operated to release hatchery-origin juvenile fish as smolts after the peak of natural-origin salmon and steelhead outmigration periods. Hatchery-origin fish therefore out-migrate from high risk freshwater areas quickly and have a reduced opportunity to interact with the typically smaller natural-origin fish (Puget Sound

Treaty Tribes and WDFW 2004). This strategy to release fish that rapidly migrate downstream to the estuary and marine environment reduces the risk of interaction and limits prospects for substantial competition with natural-origin fish reared in streams, rivers, and lakes (Flagg et al. 2000).

However, hatchery releases typically include some fish that have not yet reached the smolt stage, as well as some fish that are past the smolt stage. After release, these types of hatchery-origin fish are likely to out-migrate slowly, if at all. Hatchery-origin fish that fail to out-migrate and, instead, live in fresh water are called residuals. 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). Releases of large numbers of fry or pre-smolts also have greater potential for competitive effects because interactions would occur for the periods needed for the fish to become smolts and out-migrate (up to 3 years in the case of steelhead).

SIWG (1984) reviewed the freshwater resource competition risks posed by hatchery-origin fish to natural-origin salmon and steelhead. They 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 1). SIWG (1984) concluded that natural-origin Chinook salmon, coho salmon, and steelhead have a high risk of competition effects (both interspecific and intraspecific) from hatchery-origin fish representing any of these three species.

In particular, 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). Young natural-origin juveniles may be competitively displaced by hatchery-origin fish, especially when hatchery-origin fish are more numerous, are of equal or greater size, and (if hatchery-origin fish are released as pre-smolts) the hatchery-origin fish become residuals before natural-origin fry emerge from redds (Pearsons et al. 1994; Tatara and Berejikian 2012). Tatara and Berejikian (2012) also found that the density of natural-origin and hatchery-origin fish relative to habitat-carrying capacity likely has a considerable influence on competitive interactions. However, 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.

Although freshwater release locations for most Puget Sound hatchery programs are in streams or rivers, some hatchery programs release fish into lake systems. Lake-rearing Chinook salmon life history strategies are ecologically unique compared to most Puget Sound Chinook salmon life history strategies, because the more common ocean-type Chinook salmon rarely occur in lakes throughout their natural distribution. Where Chinook salmon use lake systems, the potential for and the effects of intraspecific and interspecific competitive interactions may differ from hatchery effects on natural-origin fish in riverine habitats. This requires additional consideration of potential spatial and temporal effects associated with the release location within the lake system, including the timing of hatchery-origin fish releases relative to natural-origin salmon rearing and outmigration periods in lake basins.

In general, the potential effect of hatchery-origin salmon and steelhead competition on the behavior, and hence 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 overlap in area and the time in which competitive interactions may occur.

1.2 Estuarine and Marine Areas

Hatchery-origin juveniles, smolts, and subadults can compete with natural-origin fish in estuarine and marine areas, leading to negative impacts on natural-origin fish in instances where preferred food may be limiting (SIWG 1984; Dawley et al. 1986). SIWG (1984) assessed potential intraspecific and interspecific risks to natural-origin salmon associated with hatchery-origin fish regarding resource competition in marine waters and determined most interspecific risks were unknown due to lack of data (Table 2). In the early marine life stage, when natural-origin fish enter marine waters and fish are concentrated in relatively small areas, food may be in short supply and competition is most likely to occur. This period is of especially high concern for intraspecific and interspecific resource competition from hatchery-origin chum salmon and pink salmon to natural-origin chum salmon and pink salmon (Simenstad et al. 1980; Bax 1983; SIWG 1984) (Table 2).

Declines in average body size and weight-at-age of Pacific salmon observed during the 1980s and 1990s across the North Pacific Ocean were hypothesized by Holt et al. (2008) because of the abundance of hatchery-origin fish. However, research has not always concluded that competition by hatchery-origin fish exerts a density-dependent effect of reducing the growth and survival of natural-origin fish. McNeil (1991) found no clear density-dependent relationship between hatchery-origin and natural-origin fish that indicated competition was occurring in the marine environment. In most areas, descriptive studies of spatial and temporal overlap between hatchery-origin and natural-origin fish remain the basis for inferring the potential risks from hatchery-origin fish.

In the Campbell River estuary in British Columbia, Levings et al. (1986) did not find evidence of competition between natural-origin and hatchery-origin Chinook salmon, because the release of hatchery-origin fish did not appear to reduce the residence time of natural-origin fish, and there was no evidence of a density-dependent relationship between the two rearing types. The hatchery-origin fish also had a negligible effect on the growth of natural-origin Chinook salmon due to the tendency of hatchery-origin fish to inhabit deeper water, resulting in little dietary overlap between the two groups, as well as shorter residence time for hatchery-origin fish in the estuary (Levings et al. 1986; also see Fresh et al. 1979; Healey 1982; Myers and Horton 1982; Rowse and Fresh 2003). Duffy (2003) found similar growth rates between hatchery-origin and natural-origin fish in south Puget Sound in contrast to variable but higher growth rates for natural-origin fish in north Puget Sound. In this same study, Duffy (2003) noted obvious differences in juvenile salmon and steelhead diets between north and south Puget Sound. Other descriptive studies have also documented differences, similarities, and trends in salmon and steelhead diets that bear on assessments of competition from hatchery-origin fish (Healey 1980; McCabe et al. 1986; Macdonald et al. 1987; Brodeur 1990).

Except for small-scale chum salmon programs in the Skagit, Green, and Stillaguamish Rivers, pink salmon and chum salmon hatcheries in Puget Sound are located close to marine waters and fish are released as fry; therefore, there is minimal potential for competition or predation effects in fresh water on natural-origin populations. Few studies have examined the interactions of hatchery-origin and natural-origin pink salmon and chum salmon, but large hatchery-origin fish releases, such as those that occur in southern Hood Canal from the Hoodsport Hatchery and George Adams Hatchery, have demonstrated the potential to affect the survival of natural-origin fish in the nearshore marine environment through food resource competition (Johnson et al. 1997). Ruggerone and Goetz (2004) found that after the 1982-1983 El Niño, large pink salmon fry emigrations in Puget Sound during even years correlated to lower survival of hatchery-origin Chinook salmon that also emigrated as subyearlings during even years and suggested that competition in nearshore waters explained the phenomenon. Although the study examined competitive effects of natural-origin salmon on hatchery-origin fish rather than effects of hatchery-origin fish on natural-origin fish, Ruggerone and Goetz (2004) provides support that interspecific competitive interactions may affect survival in nearshore waters.

An important consideration when evaluating competition in marine waters is that the actual number of juvenile hatchery-origin fish that reach Puget Sound marine waters is likely less than the total number released into fresh water from hatchery facilities. Volkhardt et al. (2006a) reported survival of hatchery-origin fry and subyearling Skagit River Chinook salmon released from Marblemount Hatchery and an offsite pond was typically around 50 percent to traps located near Mt. Vernon. Mortality from piscivorous bird and fish predation, adverse flow conditions (floods, drought leading to stranding), and anthropogenic impacts (e.g., potential dewatering from hydroelectric dam operations, adverse water quality conditions from pollution, diversions into water bypass projects, and water intake screen entrainment) can substantially reduce post- release hatchery-origin fish survival to the estuary.

The actual mortality levels resulting from these factors are affected by the timing, fish release numbers, and locations of the hatchery-origin fish release site. For example, Fresh et al. (1980) found that chum salmon juveniles released into a Hood Canal stream had a survival rate of 94 percent from the release point to the lower portion of the stream near the estuary when released at night, whereas the survival rate decreased to 72 percent when they were released at midday. Migration mortality increases with the distance hatchery-origin fish travel to reach an estuary. Freshwater survival for chum salmon juveniles was estimated to be 74 percent for fry released at RM 1.4 of a Puget Sound stream, and 48 percent for fry released at about RM 6.2 (Fresh et al. 1980). The authors concluded from these data that increased exposure to predators decreases chum salmon survival.

Given the above studies, the proportion of the total estimated number of juvenile hatchery-origin salmon and steelhead reaching the Puget Sound estuary after release from hatchery facilities may range from nearly 100 percent for fish liberated directly into or very near the estuary to 50 percent or less for juvenile fish released in relatively low numbers and many river miles removed from marine waters. The actual number of juvenile hatchery-origin salmon and steelhead that may, therefore, be of concern regarding estuarine competition and carrying-capacity effects on natural-origin Chinook salmon is likely much less than the stated freshwater release levels.

Hatchery-origin juveniles, smolts, and subadults can compete with natural-origin fish in estuarine and marine areas and negatively impact natural-origin fish in areas where preferred food may be limiting. In the early marine life stages, when natural-origin fish enter marine waters and fish are concentrated in relatively small areas, food may be in short supply and competition is most likely to occur. This period is of especially high concern when hatchery-origin chum salmon and pink salmon compete with natural-origin chum salmon and pink salmon for food resources.

2 REVIEW OF PREDATION BY HATCHERY-ORIGIN SALMON AND STEELHEAD JUVENILES

Hatchery-origin salmon and steelhead may prey on co-occurring natural-origin salmon and steelhead juveniles. Studies have documented predation by coho salmon smolts on juvenile Chinook salmon, sockeye salmon, pink salmon, and chum salmon (Hargreaves and LeBrasseur 1986; Ruggerone and Rogers 1992; Hawkins and Tipping 1999). Juvenile hatchery-origin steelhead have also been shown to prey on natural-origin Chinook salmon and sockeye salmon juveniles (Cannamela 1993; Sharpe et al. 2008).

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, number, and distribution of predators and prey; responses of predators; and the amount of time predators and prey share habitat areas (SIWG 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 fresh water suggest that hatchery-origin fish may prey on fish that are up to 50 percent of their length (Pearsons and Fritts 1999; HSRG 2004), 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.

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. Because of their location, size, and time of emergence, newly emerged natural-origin salmon and steelhead fry are likely to be the most vulnerable to predation by releases of hatchery-origin fish. 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). Newly released hatchery-origin smolts have the potential to prey on smaller natural-origin fry and parr that are encountered in fresh water as the smolts migrate to the ocean. In general, natural-origin salmon and steelhead are most vulnerable to predation when abundance of natural-origin fish is depressed and predator abundance is high, in small streams where migration distances are long, and when environmental conditions favor high visibility (SIWG 1984).

SIWG (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 fresh water. Predation risks in fresh water were found to be greatest to natural-origin pink salmon, chum salmon, and sockeye salmon from releases of larger sized hatchery-origin coho salmon, Chinook salmon, and steelhead (Table 3).

Predation is influenced by the relative abundances of predators and prey. Low prey abundance may affect the ability of predators to catch prey, while high prey abundance may swamp predators and limit their impact. A number of complex and inter-related factors may affect predation potential, including behavior (e.g., schooling, movements during the day and night), habitat preference, physiological status (e.g., readiness to transition from fresh water to marine water), and physical condition of the environment (e.g., visibility due to light and turbidity, and temperature).

2.2 Estuarine and Marine Areas

SIWG (1984) categorized the risk of direct predation by hatchery-origin fish on natural-origin salmon and steelhead in marine waters. Predation risks in marine waters were found to be greatest to natural-origin pink salmon, chum salmon, and sockeye salmon from releases of yearling hatchery-origin coho salmon, Chinook salmon, and steelhead (Table 4).

Duffy et al. (2005, 2010) found that juvenile Chinook salmon preyed on fish, consuming mostly sand lance and, in some instances, juvenile pink salmon. Yearling Chinook salmon were more reliant on fish prey, including pink salmon, chum salmon, and subyearling Chinook salmon. Juvenile pink salmon and chum salmon were the main prey of yearling coho salmon in north and south Puget Sound (Duffy 2009). The diets of hatchery-origin Chinook salmon and coho salmon in marine environments are generally similar to those of natural-origin fish. Similar to freshwater conditions, Chinook salmon and coho salmon may prey on fish up to 50 percent of their length in marine areas (Brodeur 1991; Duffy et al. 2010).

In summary, of all the hatchery-origin fish released, the larger Chinook salmon, coho salmon, and steelhead that are released at the yearling life stage have the greatest potential to be predators, and the smaller natural-origin pink salmon, chum salmon, and sockeye salmon have the greatest potential to be prey.

3 EVALUATION METHODS

3.1 Freshwater Competition

This evaluation method 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 difficulty in assigning absolute negative consequences of competition can be found in the use of the PCD Risk 1 model for the Puget Sound Hatcheries DEIS (NMFS 2014). The PCD Risk 1 model estimates indirect mortality from competition by accumulating associated weight loss from multiple competitive interactions (Pearsons and Busack 2012). However, NMFS (2014) Appendix D found that the PCD Risk 1-modeled competition mortality of natural-origin fish resulting from interactions with hatchery fish did not occur; all model runs had zero direct competition mortality. Consequently, NMFS (2014) Appendix D used an alternative output from the model, competition equivalents, as a metric for the risk of negative effects from competition, which is based on the sum total of all hatchery-origin and natural-origin fish interactions that resulted in a body weight loss of 10 percent to natural-origin fish. The results of the PCD Risk 1 modeling for the Puget Sound Hatcheries DEIS suggests that professional judgement is required in concluding the presence of significant effects on natural-origin fish even in light of a quantitative modeling procedure.

The qualitative evaluation method is based on the factors discussed above and are a subset of the quantitative factors considered in the PCD Risk 1 model by Pearsons and Busack (2012) and results in one of four categories of risk levels to natural-origin salmon or steelhead juveniles: negligible, low, moderate, or high.

- 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 of hatchery-origin species

Other factors that could reduce competitive interactions such as hatchery-origin survival rate during the outmigration, habitat capacity, habitat complexity (Pearsons and Busack 2012), turbidity (SIWG 1984; Bash et al. 2001), or volitional hatchery release techniques are not considered explicitly in the evaluation, but may be used by the analyst to further qualify the risk of negative effects from competitive interactions, if appropriate.

The basic premise of the evaluation is that the initial/default level of potential competitive interactions between a hatchery- and natural-origin species of interest is determined by Table 1, which is the risk level assigned by SIWG (1984), but specific factors can reduce this level of risk. Consequently, for evaluations involving interactions from hatchery releases of Chinook salmon, coho salmon, and steelhead, the risk from competition is high while it is low for all other interactions. The evaluation is a sequential list of nine criteria (Table 5) with two potential answers (true, false/unknown). Each of the nine 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. A response of unknown occurs when the available information is insufficient for determining if a factor would reduce the risk of competition.

The nine criteria have been implemented in a spreadsheet so that an analyst can input the available information for each of the factors, and formulas calculate the appropriate reductions in risk category, if any. Criteria for the categorical reductions in risk for each of the factors are described below.

3.1.1 Fish Size

Relative size 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 evaluation method provide rationale for reducing the risk of negative effects from competitive interactions based on the relative size of hatchery-origin and natural-origin fish.

Under Criterion 2, we reduced the risk of competitive interactions by two levels (e.g., high to low) 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 competition (Pearsons and Busack 2012).

Under Criteria 3 and 4, we 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 qualitative competition evaluation we modified Dominance Mode 2 from Pearsons and Busack (2012), which provides a hypothetical percentage of hatchery-origin fish that would dominate a natural-origin fish based on the difference in size (Table 6). 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 mm 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 mm 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.

If basin-specific size information for hatchery-origin and natural-origin fish is available, it can be used for the evaluation. However, in some circumstances size information may not be available and generic sizes by species and life stage from the Puget Sound region can be used (Table 7).

3.1.2 Hatchery- and Natural-Origin Population Sizes

The risk of adverse effects from competition 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 as the threshold for lowering risk by one category level (e.g., moderate to low).

3.1.3 Temporal Overlap

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 overlap in the outmigration periodicity of hatchery and natural-origin fish. Generic outmigration and release timing of salmon and steelhead from the Puget Sound Region is provided in Table 7.

For the qualitative evaluation, we considered competition risk to be substantially reduced, by two risk level categories, if hatchery-origin and natural-origin outmigration periodicities overlapped by 14 days or fewer. For periodicities that overlapped for 14 to 28 days, risk would be reduced by one category, and if the overlap was for more than 28 days, there would be no reduction in risk. Rationale for these thresholds is that overlaps between hatchery-origin fish and natural-origin fish ranged from 0 days to 84 days (Table 8) based on the timing information in Table 4. The median overlap was 28 days; consequently, this value was used as the threshold where longer overlaps would have no reduction in risk.

3.1.4 Spatial Overlap

Most hatchery releases are directly from the hatchery or smolts are trucked to acclimation ponds upstream or downstream from the hatchery location. Occasionally fish, usually fry, are trucked and released directly into a stream. The farther a released fish must swim to reach the estuary, the more likely that natural-origin smolts and rearing fish will be encountered. A survey of 32 hatchery release locations within 12 Puget Sound watersheds indicated distances from release location to the estuary ranged from 0.0 to 91.0 miles (NMFS 2014, Appendix D). A third of the sites were 9.5 miles or less from the estuary, and half were 25.3 miles or less from the estuary. For the qualitative evaluation we used 15 miles or less from the estuary to indicate a substantial reduction in risk (two risk categories) and 15 to 30 miles from the estuary to indicate a slight reduction in risk (one risk category). For releases greater than 30 miles there would be no reduction in the risk of competitive interactions. For the release locations surveyed these thresholds would result in a two-risk-category reduction for about 39 percent of the surveyed sites, a one-risk-category reduction for about 14 percent of the release sites, and no reduction for about 47 percent of the sites.

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 Subsection 2.1 and are a subset of the quantitative factors considered in the PCD Risk 1 model by Pearsons and Busack (2012).

- 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 determined by Table 3, and specific factors reduce this level of risk. Consequently, for the evaluation of hatchery-origin releases of Chinook salmon, coho salmon, and steelhead, the initial potential for negative effects is high for interactions with natural-origin pink salmon, chum salmon, and sockeye salmon and unknown for Chinook salmon, steelhead, and coho salmon. The potential for negative effects from hatchery-origin pink salmon, chum salmon, or sockeye salmon on all natural-origin salmon species is considered low. The evaluation is a sequential list of six criteria (Table 9). Each of the six 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. 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 or turbidity (SIWG 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, but may be used by the analyst to further qualify the risk of negative effects from predation, if appropriate.

3.2.1 Fish Size

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, we reduced the risk of predation by two levels (e.g., high to low) if the average hatchery-origin fish is less than twice the size (length) of an average natural-origin fish. As described in Subsection 2.1, most studies of predation in fresh water suggest that hatchery-origin fish may prey on fish that are up to 50 percent of their length (Pearsons and Fritts 1999; HSRG 2004), 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).

3.2.2 Temporal Overlap

For the qualitative predation evaluation, temporal overlap was considered the same as for the competition evaluation. We considered risk to be substantially reduced, by two risk level categories, if hatchery- and natural-origin outmigration periodicities overlapped by 14 days or fewer. For periodicities that overlapped for 14 to 28 days, risk would be reduced by one category, and if the overlap was for more than 28 days, there would be no reduction in risk. Rationale for these thresholds was the same as for the competition evaluation.

3.2.3 Spatial Overlap

Spatial overlap for the predation evaluation was considered that same as for the competition evaluation and used the same rationale. We used 15 miles or less from the estuary to indicate a substantial reduction in risk (two risk categories) and 15 to 30 miles from the estuary to indicate a slight reduction in risk (one risk category). For releases greater than 30 miles from the estuary there would be no reduction in the risk of predation.

4 STILLAGUAMISH RIVER FRESHWATER COMPETITION AND PREDATION RISK EVALUATION

The Stillaguamish hatchery bundle was evaluated for the risk of competitive and predatory encounters between natural-origin salmon and steelhead by the release of hatchery-origin Chinook salmon subyearlings, coho salmon yearlings, and chum fry. The following subsections describe the results of the evaluations.

4.1 Freshwater Competition

Information on natural-origin juvenile population size was only available for summer- and fall-run Chinook salmon based on estimates from the Puget Sound Hatchery DEIS (NMFS 2014) Appendix D. For all other comparisons, Criteria 5 of the competition evaluation was considered unknown and did not affect the risk ratings. Average fish size and periodicity of natural-origin fish for all comparisons were drawn from generic values provided in Table 7. Periodicities for hatchery-origin fish were derived from the Stillaguamish River Basin HGMPs.

The risk of competitive interactions occurring between hatchery-origin summer- and fall-run Chinook salmon, coho salmon, and chum salmon with natural-origin Chinook salmon, steelhead, coho salmon, chum salmon, and pink salmon in the Stillaguamish River Basin ranged from negligible to moderate, depending on the species (Table 10). Potential interactions that included Chinook salmon, steelhead, and coho salmon were all initially high, but were generally reduced because temporal overlaps were less than 28 days, there were large differences in size between the hatchery-origin and natural-origin fish, or hatchery-origin fish were released less than 30 miles from the estuary. The risk from competition between hatchery-origin fall Chinook salmon subyearlings and natural-origin fall Chinook salmon parr was not reduced from high based on any of the criteria considered in Table 5. However, the combined hatchery-origin maximum release level (200,000 subyearlings) and maximum fall-run smolt abundance in the South Fork Stillaguamish River (54,014 fish) would be much less than the habitat capacity (749,338 fish) (NMFS 2014, Appendix D), which would reduce the risk of competition between hatchery-origin and natural-origin Chinook salmon. Interactions between hatchery-origin coho salmon and chum salmon and natural-origin fish were all reduced because releases occur from the Harvey Creek Hatchery, which is about 15.3 miles from the Stillaguamish River estuary.

4.2 Freshwater Predation

Initial predation risk ratings from hatchery releases of Chinook salmon and coho salmon on pink salmon and chum salmon were high, and unknown for other species, while the risk from hatchery releases of chum salmon on all species was considered low (Table 3). After consideration of mitigating factors, the risk of predation from summer- and fall-run Chinook salmon hatchery releases was considered moderate on chum salmon fry and high for pink salmon fry. The mitigating factor for the risk of predation on chum salmon fry was that most Chinook salmon subyearlings are released after chum salmon fry have already emigrated by the end of Aril, so the temporal overlap is less than 28 days and during some years could be less than 14 days. Consequently, the risk of predation was reduced from high to moderate. Pink salmon fry generally emigrate slightly later (April and May) than chum salmon, so the risk level is considered to remain at high. For coho salmon hatchery releases, mitigating factors included the release location, which is low in the watershed, and a short temporal overlap of less than 2 weeks for chum salmon. These mitigation factors reduced the risk of predation to negligible for chum salmon and low for pink salmon.

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Table 1. Risk of hatchery-origin salmon and steelhead competition on natural-origin salmon and steelhead in freshwater areas.

Hatchery-origin Species	Natural-origin Species					
	Steelhead	**Pink Salmon**	**Chum Salmon**	**Sockeye Salmon**	**Coho Salmon**	**Chinook Salmon**
Steelhead	H	L	L	L	H	H
Pink Salmon	L	L	L	L	L	L
Chum Salmon	L	L	L	L	L	L
Sockeye Salmon	L	L	L	L	L	L
Coho Salmon	H	L	L	L	H	H
Chinook Salmon	H	L	L	L	H	H

Source: SIWG (1984)
Note: H = high risk, L = low risk, and U = unknown risk of an impact occurring.

Table 2. Risk of hatchery-origin salmon and steelhead competition on natural-origin salmon and steelhead in nearshore marine areas.

Hatchery-origin Species	Natural-origin Species					
	Steelhead	**Pink Salmon**	**Chum Salmon**	**Sockeye Salmon**	**Coho Salmon**	**Chinook Salmon**
Steelhead	H	U	U	L	U	U
Pink Salmon	U	H	H	U	U	U
Chum Salmon	U	H	H	U	U	U
Sockeye Salmon	L	U	U	H	U	U
Coho Salmon	U	U	U	U	H	U
Chinook Salmon	U	U	U	U	U	H

Source: SIWG (1984)
Note: H = high risk, L = low risk, and U = unknown risk of an impact occurring.

Table 3. Risk of hatchery-origin salmon and steelhead predation on natural-origin salmon and steelhead in freshwater areas.

Hatchery-origin Species	Natural-origin Species					
	Steelhead	**Pink Salmon**	**Chum Salmon**	**Sockeye Salmon**	**Coho Salmon**	**Chinook Salmon**
Steelhead	U	H	H	H	U	U
Pink Salmon	L	L	L	L	L	L
Chum Salmon	L	L	L	L	L	L
Sockeye Salmon	L	L	L	L	L	L
Coho Salmon	U	H	H	H	U	U
Chinook Salmon	U	H	H	H	U	U

Source: SIWG (1984)
Note: H = high risk, L = low risk, and U = unknown risk of an impact occurring.

Table 4. Risk of hatchery-origin salmon and steelhead predation on natural-origin salmon and steelhead in nearshore marine areas.

Hatchery-origin Species	Natural-origin Species					
	Steelhead	**Pink Salmon**	**Chum salmon**	**Sockeye Salmon**	**Coho Salmon**	**Chinook Salmon**
Steelhead	U	H	H	H	U	U
Pink Salmon	L	L	L	L	L	L
Chum Salmon	L	L	L	L	L	L
Sockeye Salmon	L	L	L	L	L	L
Coho Salmon	U	H	H	H	U	U
Chinook Salmon	U	H	H	H	U	U

Source: SIWG (1984)
Note: H = high risk, L = low risk, and U = unknown risk of an impact occurring.

Table 5. Sequential criteria for the qualitative competition evaluation resulting in risk reduction, if any.

#	Criterion	True	False or Unknown
1	The hatchery-origin species steelhead, Chinook salmon, or coho salmon.	The default potential risk to natural-origin steelhead, coho salmon, or Chinook salmon is High. Go to Criterion 2.	The default potential risk to natural-origin pink salmon, chum salmon, and sockeye salmon is Low. Go to Criterion 2.
2	The hatchery-origin species 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., Moderate to Negligible). Go to Criterion 3.	Potential risk is unchanged. Go to Criterion 3.
3	The average (or median) length of hatchery-origin fish at the time of release is at least 25 mm smaller than the length of natural-origin species.	Reduce the potential risk by two categories (e.g., Moderate to Negligible). Go to Criterion 4.	Potential risk is unchanged. Go to Criterion 4.
4	The average (or median) length of hatchery-origin fish at the time of release is 5 to 25 mm smaller than the average length of natural-origin species.	Reduce the potential risk by one category (e.g., Moderate to Low). Go to Criterion 5.	Potential risk is unchanged. Go to Criterion 5.
5	The number of hatchery-origin fish is substantially fewer (<= 50%) than the number of natural-origin juveniles produced in the basin.	Reduce the potential risk by one category (e.g., Moderate to Low). Go to Criterion 6.	Potential risk is unchanged. Go to Criterion 6.
6	The number of days of potential overlap between hatchery-origin and natural-origin fish is less than or equal to 14 days.	Reduce the potential risk by two categories (e.g., Moderate to Negligible). Go to Criterion 8.	Potential risk is unchanged. Go to Criterion 8.
7	The number of days of potential overlap between hatchery-origin and natural-origin fish is greater than 14 days and less than or equal to 28 days.	Reduce the potential risk by one category (e.g., Moderate to Low). Go to Criterion 8.	Potential risk is unchanged. Go to Criterion 8.

Table 5. Sequential criteria for the qualitative competition evaluation resulting in risk reduction, if any. (continued)

#	Criterion	True	False or Unknown
NA	The number of days of potential overlap between hatchery-origin and natural-origin fish is greater than 28 days.	Potential risk is unchanged. Go to Criterion 8.	Potential risk is unchanged. Go to Criterion 8.
8	Hatchery-origin fish are released less than or equal to 15 miles from the estuary.	Reduce the potential risk by two categories (e.g., Moderate to Negligible). Final Result.	Potential risk is unchanged. Go to Criterion 9.
9	Hatchery-origin fish 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., Moderate to Low). Final Result.	Potential risk is unchanged. Final Result.
NA	Hatchery-origin fish are released more than 30 miles from the estuary.	Potential risk is unchanged.	Potential risk is unchanged.

Table 6. From Pearsons and Busack (2012), hypothetical percentages of hatchery-origin fish dominance over natural-origin (wild) fish assuming Dominance Mode = 2. Difference in fish size is expressed as a relative difference, and dominance is expressed as the percentage of interactions that hatchery-origin fish dominate natural-origin fish. Scenarios assume that natural-origin fish have prior residence.

PCD RISK 1

Dominance Mode = 2

Scenario: more aggressive hatchery fish	**Difference in size (hatchery fish size relative to wild fish size)**						
	< -25	-25 to -15	-15 to -5	- 5 to 5	5 to 15	15 to 25	>25
percentage of hatchery fish dominance over wild fish	10	20	30	70	90	95	100

Table 7. Relative size and predominant freshwater occurrence or release timing for natural-origin and hatchery-origin salmon and steelhead juveniles by life stage. Table adapted from the Puget Sound Hatcheries DEIS (NMFS 2014).

Species (Origin)	Life Stage[1]	Size (Fork length in Inches [mm])		Predominant Occurrence or Release Timing
		Mean	Range	
Chinook Salmon (natural-origin)	Fry	1.6 (40)	1.3-2.3 (34-59)	December – April
Chinook Salmon (natural-origin)	Parr	3.0 (75)	2.2-3.6 (57-92)	late May – July
Chinook Salmon (natural-origin)	Yearling	4.7 (120)	3.6-6.1 (92-154)	late March – May
Chinook Salmon (hatchery-origin)	Subyearling	3.1 (80)	2.2-3.4 (57-86)	May–June
Chinook Salmon (hatchery-origin)	Yearling	6.1 (155)	5.9-7.7 (150-196)	April
Steelhead (natural-origin)	Fry	2.4 (60)	0.9-3.9 (23-100)	June – October
Steelhead (natural-origin)	Parr	3.8 (96)	2.6-5.2 (65-131)	October – mid-May
Steelhead (natural-origin)	Smolt	6.5 (165)	4.3-8.5 (109-215)	late April – June
Steelhead (isolated) (hatchery-origin)	Yearling	8.1 (206)	7.1-9.1 (180-230)	May
Steelhead (integrated) (hatchery-origin)[2]	Yearling+	7.4 (190)	7.0-8.3 (180-210)	May – June
Coho Salmon (natural-origin)	Fry	1.2 (30)	1.1-1.4 (29-36)	March

Table 7. Relative size and predominant freshwater occurrence or release timing for natural-origin and hatchery-origin salmon and steelhead juveniles by life stage. Table adapted from the Puget Sound Hatcheries DEIS (NMFS 2014). (continued)

Species (Origin)	Life Stage[1]	Size (Fork length in Inches [mm])		Predominant Occurrence or Release Timing
		Mean	Range	
Coho Salmon (natural-origin)	Parr	2.1 (54)	1.5-2.9 (37-74)	April
Coho Salmon (natural-origin)	Yearling	4.2 (107)	2.9-7.5 (74-190)	late April – May
Coho Salmon (hatchery-origin)	Fry	1.7 (43)	1.5-2.5 (38-64)	March – April
Coho Salmon (hatchery-origin)	Subyearling	4.1 (104)	3.9-4.2 (99-107)	November
Coho Salmon (hatchery-origin)[3]	Yearling	5.5 (140)	5.2-6.1 (131-156)	April – June
Summer-run Chum Salmon (natural-origin)	Fry	1.5 (38)	1.3-2.0 (33-50)	March
Fall-run Chum Salmon (natural-origin)	Fry	1.5 (38)	1.3-2.0 (33-50)	April
Fall-run Chum Salmon (hatchery-origin)	Fry	2.0 (50)	1.7-2.0 (42-52)	May
Pink Salmon (natural-origin)	Fry	1.3 (34)	1.3-1.7 (32-43)	April – May
Pink Salmon (hatchery-origin)[4]	Fry	2.0 (50)	1.6-2.0 (40-52)	April
Sockeye Salmon (natural-origin)[5]	Fry	1.1 (28)	1.0-1.2 (25-31)	April – May

Table 7. Relative size and predominant freshwater occurrence or release timing for natural-origin and hatchery-origin salmon and steelhead juveniles by life stage. Table adapted from the Puget Sound Hatcheries DEIS (NMFS 2014). (continued)

Species (Origin)	Life Stage[1]	Size (Fork length in Inches [mm])		Predominant Occurrence or Release Timing
		Mean	Range	
Sockeye Salmon (natural-origin)[5]	Lake phase fry[6]	2.0 (51)	1.3-4.7 (32-119)	June – March
Sockeye Salmon (natural-origin)[5]	Smolt	4.9 (125)	4.7-5.1 (120-129)	March – April
Sockeye Salmon (hatchery-origin)[5]	Fry	1.2 (30)	0.9-1.2 (24-30)	February – April

Notes and sources:

Natural-origin parr and yearling Chinook salmon data from Beamer et al. (2005) and WDFW juvenile out-migrant trapping reports (Seiler et al. 2000, 2003, 2004; Volkhardt et al. 2006a,b; Kinsel et al. 2007, 2008; Topping and Zimmerman 2011).

Natural-origin steelhead size data and occurrence estimates from Shapovalov and Taft (1954) and WDFW juvenile out-migrant trapping reports (Volkhardt et al. 2006a,b; Kinsel et al. 2007; Topping and Zimmerman 2011).

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,b) (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).

Natural-origin sockeye salmon data from Burgner (1991) for Lake Washington sockeye (predominantly 3-1 fish); parr size range extrapolated from smolt and fry data considering year-round residence.

Hatchery-origin fish release size and timing data are average individual fish size and standard release timing targets applied for hatchery salmon and steelhead production in Puget Sound (from WDFW salmon and steelhead HGMPs as referenced in NMFS [2014] and WDFW and Point No Point Treaty Tribes [2000]).

1 For this evaluation, the key stages in the life histories of natural-origin and hatchery-origin juvenile salmon and steelhead are as follows: fry are very small, have absorbed their egg sac, are less than 1 year old (applies to hatchery-origin and natural-origin fish); subyearlings are small, less than 1 year old (typically applies to hatchery-origin releases); parr are juveniles from 1 to 3 years old depending on the species (typically refers to natural-origin fish); smolts are larger hatchery-origin and natural-origin juveniles that are undergoing their transformation from living in fresh water to living in the marine environment and are headed downstream to the ocean; yearlings are typically smolts that are reared in the hatchery environment for a year prior to being released.

2 Information is from the Green River late winter-run steelhead HGMP (WDFW 2014).

3 The vast majority of hatchery-origin coho salmon are released as yearlings.

4 There are no hatchery programs that release pink salmon in south or central Puget Sound.

5 The vast majority of hatchery-origin sockeye salmon are released as fry into Puget Sound lakes. No hatchery-origin sockeye salmon are released in the Stillaguamish River Basin.

6 Lake phase refers to juvenile fish rearing in a lake environment rather than a stream environment.

Table 8. Number of days (weeks x 7 days) of overlap in hatchery release and natural-origin periodicity based on Table 7. Rose-colored cells identify matching species and life stages.

Hatchery Releases			**Natural-origin Species and Life Stage**										
Species	**Life stage**	**Periodicity**	**Chinook**			**Steelhead**			**Coho**			**Chum**	**Pink**
			Yearling	**Parr**	**Fry**	**Smolt**	**Parr**	**Fry**	**Yearlings**	**Parr**	**Fry**	**Fry**	**Fry**
			Late Mar – May	**Late May – Jul**	**Dec – Apr**	**Late Apr – June**	**Oct – Mid-May**	**Jun – Oct**	**Late Apr – May**	**Apr**	**Mar**	**Apr**	**Apr – May**
Chinook	Subyearling	May – Jun	28	35	0	56	14	28	28	0	0	0	28
Chinook	Yearling	April	0	0	28	7	28	0	7	28	0	28	28
Steelhead	Yearling	May	28	7	0	28	14	0	28	0	0	0	28
Steelhead	Yearling+	May – June	28	35	0	56	14	28	28	0	0	0	28
Coho	Yearling	late Apr – Jun	35	30	7	63	21	28	35	7	0	7	35
Chum	Fry	Mar – May	63	7	56	35	70	0	35	28	28	28	56
Pink	Fry	April	28	28	28	7	28	0	7	28	0	28	28
Sockeye	Fry	Feb – Apr	35	0	84	7	84	0	7	28	28	28	28

Table 9. Sequential criteria for the qualitative predation evaluation resulting in risk reduction, if any.

#	Criterion	True	False or Unknown
1	The hatchery-origin species steelhead, Chinook salmon, or coho salmon and the natural-origin species are pink, chum or sockeye salmon.	The default potential risk to natural-origin steelhead, coho salmon, or Chinook salmon is High. Go to Criterion 2.	The default potential risk to natural-origin pink salmon, chum salmon, and sockeye salmon is Low. Go to Criterion 2.
2	The hatchery-origin species 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 size differences. Reduce the potential risk by two categories (e.g., Moderate to Negligible). Go to Criterion 3.
3	The number of days of potential overlap between hatchery-origin and natural-origin fish is less than or equal to 14 days.	Reduce the potential risk by two categories (e.g., Moderate to Negligible). Go to Criterion 5.	Potential risk is unchanged. Go to Criterion 4.
4	The number of days of potential overlap between hatchery-origin and natural-origin fish is greater than 14 days and less than or equal to 28 days.	Reduce the potential risk by one category (e.g., Moderate to Low). Go to Criterion 5.	Potential risk is unchanged. Go to Criterion 5.
NA	The number of days of potential overlap between hatchery-origin and natural-origin fish is greater than 28 days.	Potential risk is unchanged. Go to Criterion 5.	Potential risk is unchanged. Go to Criterion 5.
5	Hatchery-origin fish are released less than or equal to 15 miles from the estuary.	Reduce the potential risk by two categories (e.g., Moderate to Negligible). Go to Final Result.	Potential risk is unchanged. Go to Criterion 6.
6	Hatchery-origin fish 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., Moderate to Low). Final Result.	Potential risk is unchanged. Final Result.
NA	Hatchery-origin fish are released more than 30 miles from the estuary.	Potential risk is unchanged.	Potential risk is unchanged.

Table 10. Risk of competitive interactions between hatchery-origin summer- and fall-run Chinook salmon, coho salmon, and chum salmon with natural-origin Chinook salmon, steelhead, coho salmon, chum salmon, and pink salmon in the Stillaguamish River Basin. Qualitative risk rating (H: High, M: Moderate, L: Low, N: Negligible, U: Unknown) is followed by the number(s) of the criterion[1] affecting the rating in parentheses.

Hatchery Releases						**Natural-origin Species and Life Stage**				
						Summer-run and Fall-run Chinook		**Steelhead**		
						Parr	**Fry**	**Smolt**	**Parr**	**Fry**
						Late May – Jul	Dec – Apr	Late Apr – June	Oct – Mid-May	Jun – Oct
Species	**Life Stage**	**Number Released**	**Location (Distance from Estuary)**	**Periodicity[2]**	**Avg Size (Range)**	75 (57 - 92)	40 (34 -59)	165 (109 - 215)	96 (65 - 131)	40[3]
Summer Chinook	Subyearling	220,000	Whitehorse Hatchery (46 miles)	Late Mar – mid-Jun	80 (57 - 86)	M (7)	L (2)	L (3)	M (4)	N (2, 6)
Fall Chinook	Subyearling	200,000	Brenner Cr. Hatchery (49 miles)	Apr – late Jun	80 (57 - 86)	M (7)	N (2, 7)	L (3)	M (4)	N (2, 7)
Coho	Yearling	60,000	Harvey Cr. Hatchery (15.3 miles)	Late Apr – Jun	140 (131 - 156)	M (9)	N (2, 6, 9)	N (4, 9)	N (7, 9)	N (2, 7, 9)
Chum	Fry	250,000	Harvey Cr. Hatchery (15.3 miles)	Mar – May	50 (42 - 52)	N (1, 4, 6, 9)	N (1, 9)	N (1, 3, 9)	N (1, 3, 9)	N (1, 4, 6, 9)

Table 10. Risk of competitive interactions between hatchery-origin summer- and fall-run Chinook salmon, coho salmon, and chum salmon with natural-origin Chinook salmon, steelhead, coho salmon, chum salmon, and pink salmon in the Stillaguamish River Basin. Qualitative risk rating (H: High, M: Moderate, L: Low, N: Negligible, U: Unknown) is followed by the number(s) of the criterion[1] affecting the rating in parentheses. (continued)

Hatchery Releases						**Natural-origin Species and Life Stage**				
						Coho			**Chum**	**Pink**
						Yearlings	**Parr**	**Fry**	**Fry**	**Fry**
						Late Apr – May	Apr	Mar	Apr	Apr – May
Species	**Life Stage**	**Number Released**	**Location (Distance from Estuary)**	**Periodicity**	**Avg Size (Range)**	107 (74 - 190)	54 (37 - 74)	30 (29 - 36)	38 (33 - 50)	34 (32 - 43)
Summer Chinook	Subyearling	220,000	Whitehorse Hatchery (46 miles)	Late Mar – mid-Jun	80 (57 - 86)	L (3)	M (7)	N (2, 6)	N (1, 2,7)	N (1, 2)
Fall Chinook	Subyearling	200,000	Brenner Cr. Hatchery (49 miles)	Apr – Jun	80 (57 - 86)	L (3)	M (7)	N (2, 6)	N (1, 2,7)	N (1, 2)
Coho	Yearling	60,000	Harvey Cr. Hatchery (15.3 miles)	Late Apr – Jun	140 (131 - 156)	L (9)	N (2, 6, 9)	N (2, 6, 9)	N (1, 2, 6, 9)	N (1, 2, 9)
Chum	Fry	250,000	Harvey Cr. Hatchery (15.3 miles)	Mar – May	50 (42 - 52)	N (1, 3, 9)	N (1, 7, 9)	N (1, 7, 9)	N (1, 7, 9)	N (1, 9)

[1] Criterion number and description (HO: Hatchery-origin, NO: Natural-origin)

(1) Risk is initially L because of species type.
(2) Risk is reduced because HO fish >=2x larger.
(3) Risk is reduced because HO fish size is at least 25 mm smaller than NO fish.
(4) Risk is reduced because HO fish size is 5 to 25 mm smaller than NO fish.
(5) Risk is reduced because the number of HO fish is <= 50% of NO fish.
(6) Risk is reduced because temporal overlap is <= 14 days.
(7) Risk is reduced because temporal overlap is >14 days and <= 28 days.
(8) Risk is reduced because release point is less than 15 miles from estuary.
(9) Risk is reduced because release point is 15 to 30 miles from estuary.

[2] Sources: Table 4 and Stillaguamish HGMPs (Stillaguamish Tribe of Indians 2018a,b,c,d).

[3] Average size and range for steelhead fry is 60 mm (23-100 mm) (Puget Sound Hatcheries DEIS [NMFS 2014]). However, 40 mm was used in the evaluation because the temporal overlap is early in the period when steelhead fry might be present.

Table 11. Risk of predation from hatchery-origin summer- and fall-run Chinook salmon, coho salmon, and chum salmon on natural-origin Chinook salmon, steelhead, coho salmon, chum salmon, and pink salmon in the Stillaguamish River Basin. Qualitative risk rating (H: High, M: Moderate, L: Low, N: Negligible, U: Unknown) is followed by the number(s) of the criterion[1] affecting the rating in parentheses.

Hatchery Releases						**Natural-origin Species and Life Stage**				
						Summer and Fall Chinook		**Steelhead**		
						Parr	**Fry**	**Smolt**	**Parr**	**Fry**
						Late May – Jul	Dec – Apr	Lte Apr – June	Oct – Mid-May	Jun – Oct
Species	**Life Stage**	**Number Released**	**Location (Distance from Estuary)**	**Periodicity[2]**	**Avg Size (Range)**	75 (57 - 92)	40 (34 - 59)	165 (109 - 215)	96 (65 - 131)	40[3]
Summer Chinook	Subyearling	220,000	Whitehorse Hatchery (46 miles)	Late Mar – mid-Jun	80 (57 - 86)	U	U	U	U	U
Fall Chinook	Subyearling	200,000	Brenner Cr. Hatchery (31 miles)	Apr – Jun	80 (57 - 86)	U	U	U	U	U
Coho	Yearling	60,000	Harvey Cr. Hatchery (15.3 miles)	Late Apr – Jun	140 (131 - 156)	U	U	U	U	U
Chum	Fry	250,000	Harvey Cr. Hatchery (15.3 miles)	Mar – May	50 (42 - 52)	N (1, 2, 3, 6)	N (1, 2, 6)	N (1, 2, 6)	N (1, 2, 6)	N (1, 2, 3, 6)

Table 11. Risk of predation from hatchery-origin summer- and fall-run Chinook salmon, coho salmon, and chum salmon on natural-origin Chinook salmon, steelhead, coho salmon, chum salmon, and pink salmon in the Stillaguamish River Basin. Qualitative risk rating (H: High, M: Moderate, L: Low, N: Negligible, U: Unknown) is followed by the number(s) of the criterion[1] affecting the rating in parentheses. (continued)

Hatchery Releases						**Natural-origin Species and Life Stage**				
						Coho			**Chum**	**Pink**
						Yearlings	**Parr**	**Fry**	**Fry**	**Fry**
						Late Apr – May	Apr	Mar	Apr	Apr – May
Species	**Life Stage**	**Number Released**	**Location (Distance from Estuary)**	**Periodicity**	**Avg Size (Range)**	107 (74 - 190)	54 (37 - 74)	30 (29 - 36)	38 (33 - 50)	34 (32 - 43)
Summer Chinook	Subyearling	220,000	Whitehorse Hatchery (46 miles)	Late Mar – mid-Jun	80 (57 - 86)	U	U	U	M (4)	H
Fall Chinook	Subyearling	200,000	Brenner Cr Hatchery (31 miles)	Apr – Jun	80 (57 - 86)	U	U	U	M (4)	H
Coho	Yearling	60,000	Harvey Cr Hatchery (15.3 miles)	Late Apr – Jun	140 (131 - 156)	U	U	U	N (3, 6)	M (6)
Chum	Fry	250,000	Harvey Cr Hatchery (15.3 miles)	Mar – May	50 (42 - 52)	N (1, 2, 6)	N (1, 2, 4, 6)	N (1, 2, 4, 6)	N (1, 2, 4, 6)	N (1, 2, 6)

[1] Criterion number and description (HO: Hatchery-origin, NO: Natural-origin)
- (1) Risk is initially L because of species type.
- (2) Risk is reduced because HO fish <2x larger.
- (3) Risk is reduced because temporal overlap is <= 14 days.
- (4) Risk is reduced because temporal overlap is >14 days and <= 28 days.
- (5) Risk is reduced because release point is less than 15 miles from estuary.
- (6) Risk is reduced because release point is 15 to 30 miles from estuary.

[2] Sources: Table 4 and Stillaguamish HGMPs (Stillaguamish Tribe of Indians 2018a,b,c,d).

[3] Average size and range for steelhead fry is 60 mm (23-100 mm) (Puget Sound Hatcheries DEIS [NMFS 2014]). However, 40 mm was used in the evaluation because the temporal overlap is early in the period when steelhead fry might be present.

Appendix D

Public Comments Received and NMFS' Responses to Comments

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Alan Olson - NOAA Affiliate <alan.olson@noaa.gov>

Stillaguamish Hatcheries comment
1 message

mr. g. West <kimly.west@gmail.com> Fri, Jun 28, 2019 at 10:12 AM
To: Hatcheries.Public.Comment@noaa.gov

no one wants to purchase farm fish.
please stop this insanity.
do not approve this fishery.

no want want to eat farm fish.

National Marine Fisheries Service (NMFS) Responses to Comments Submitted by Mr. G. West Email dated June 28, 2019

Comment noted.

Alan Olson - NOAA Affiliate <alan.olson@noaa.gov>

Comments on Stillaguamish River hatchery programs
1 message

OnBoard Tours <onboardtours@yahoo.com> Mon, Jul 29, 2019 at 4:36 PM
Reply-To: "onboardtours@yahoo.com" <onboardtours@yahoo.com>
To: "hatcheries.public.comment@noaa.gov" <hatcheries.public.comment@noaa.gov>

I support 2.2.4 Alternative 4 (Reduced Production).

Why is this alternative even included? It confuses the public when NMFS states no authority:
"NMFS' regulations under the 4(d) Rule do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs. NMFS' regulations under the 4(d) Rule require NMFS to make a determination that the HGMPs as proposed either meet or do not meet the standards
prescribed in the rule."

Hatcheries were developed to produce fish for human consumption and economic gain, not to help threatened and endangered fish stocks. The failures of hatcheries impact wild fish, wild salmon, other endangered species, and entire ecosystems.

NOAA Fisheries needs to prioritize recovery of threatened and endangered species above human economics, as the ESA was created to do. Taxpayers have already invested decades and millions of dollars into unsuccessful recovery plans, in part due to increased hatchery production authorizations.

Sincerely,
Caroline Armon
Marine Ecology Educator

Sent from Yahoo Mail on Android

National Marine Fisheries Service (NMFS) Responses to Comments Submitted by Caroline Armon, Marine Ecology Educator

Email dated July 29, 2019

Your support of Alternative 4 is noted. As described in Chapter 2, Alternatives, Alternative 4 is included in the analysis to assist the reader with a full understanding of the range of potential effects on the human environment under various management scenarios even though NMFS does not have authority to order applicants to change the magnitude of hatchery program releases. NEPA requires that a range of appropriate alternatives to the proposal be examined regardless of whether doing so might entail reviewing alternatives that are outside the capability of the applicant or outside the jurisdiction of the permitting agency.

We agree that hatcheries were originally developed for harvest purposes; however, as described by the Hatchery Science Reform Group (HSRG 2014) hatchery programs have evolved and currently have broader objectives, including to help conserve and recover ESA-listed populations and support depressed non-listed salmon populations. The purpose of the hatchery program review by NMFS is to ensure that requirements of the ESA under Limit 6 of the 4(d) Rule are met and that risks to natural-origin listed salmon and steelhead populations are minimized or avoided.

Regarding National Oceanic and Atmospheric Administration (NOAA) Fisheries' priorities, our mission statement includes "NOAA Fisheries is responsible for the stewardship of the nation's ocean resources and their habitat. We provide vital services for the nation: productive and sustainable fisheries, safe sources of seafood, the recovery and conservation of protected resources, and healthy ecosystems—all backed by sound science and an ecosystem-based approach to management." Sustainable commercial fisheries and recovery of ESA-listed fish species are both important priorities to NOAA Fisheries. Evaluation of hatchery programs under ESA Limit 6 of the 4(d) Rule is one of the ways that NOAA Fisheries balances both of these important parts of our mission.

References

HSRG. 2014. On the Science of Hatcheries: an updated perspective on the role of hatcheries in salmon and steelhead management in the Pacific Northwest. A. Appleby, H. L. Blankenship, D. Campton, K. Currens, T. Evelyn, D. Fast, T. Flagg, J. Gislason, P. Kline, C. Mahnken, B. Missildine, L. Mobrand, G. Nandor, P. Paquet, S. Patterson, L. Seeb, S. Smith, and K. Warheit. June 2014; revised October 2014.

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Appendix E

Finding of No Significant Impact

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BACKGROUND

Proposed Action:

The National Marine Fisheries Service (NMFS) makes a determination that the four hatchery and genetic management plans (HGMPs), submitted as resource management plans (RMPs) by the Stillaguamish Tribe of Indians and Washington Department of Fish and Wildlife (WDFW), meet the requirements under Limit 6 of the 4(d) Rule under the Endangered Species Act (ESA) for listed Puget Sound Chinook salmon and steelhead. The hatchery programs considered are the (1) Stillaguamish summer-run Chinook salmon program, (2) Stillaguamish fall-run Chinook salmon program, (3) Stillaguamish fall-run coho salmon program, and (4) Stillaguamish chum salmon program. See the Stillaguamish Environmental Assessment (Stillaguamish EA) for more details about these hatchery programs.

Alternatives evaluated in the Stillaguamish EA are the following:

- **Alternative 1 (No Action):** NMFS would not make a determination under the 4(d) Rule
- **Alternative 2 (Proposed Action and Preferred Alternative):** NMFS would make a determination that the submitted HGMPs meet the requirements of the 4(d) Rule
- **Alternative 3 (Termination):** NMFS would make a determination that the submitted HGMPs would not meet the requirements of the 4(d) Rule
- **Alternative 4 (Reduced Production):** NMFS would make a determination that revised HGMPs with production levels 50 percent less than the currently submitted HGMPs meet the requirements of the 4(d) Rule

Selected Alternative:

Alternative 2: Under the Proposed Action and Preferred Alternative, NMFS would make a determination that the HGMPs submitted by the co-managers meet ESA requirements. The four salmon hatchery programs in the Stillaguamish River Basin would be implemented as described in the submitted HGMPs.

Related Consultations:

ESA and Essential Fish Habitat (EFH) consultations related to salmon and steelhead are documented in NMFS (2019). The biological opinion concluded that the Proposed Action is not likely to jeopardize the continued existence of the Puget Sound Chinook Salmon ESU or the Puget Sound Steelhead DPS, or destroy or adversely modify their designated critical habitat. Furthermore, the EFH consultation concluded that, because of the consequence of potential genetic effects during spawning and the predation and competition effects during the juvenile outmigration stage, the Proposed

Action would adversely affect EFH for Pacific salmon, but the Proposed Action includes the best approaches to avoid or minimize those adverse effects.

The consultation with the U.S. Fish and Wildlife Service (USFWS) for bull trout and marbled murrelet is documented in USFWS (2019). The USFWS determined that the level of anticipated take is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

SIGNIFICANCE REVIEW

The Council on Environmental Quality (CEQ) regulations state that the determination of significance using an analysis of effects requires examination of both context and intensity, and the regulations list 10 criteria for intensity (40 CFR 1508.27). In addition, the Companion Manual for National Oceanic and Atmospheric Administration Administrative Order 216-6A provides 16 criteria (the same 10 criteria as the CEQ regulations and 6 additional criteria) for determining whether the impacts of a Proposed Action are significant. Each criterion is discussed below with respect to the Proposed Action and considered individually, as well as in combination with the others.

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?

Response: The NMFS' 4(d) determination for continuation of the four hatchery programs analyzed in the attached Stillaguamish EA is expected to have both beneficial and adverse impacts, with high beneficial effects on the viability of the North Fork Stillaguamish River Chinook salmon population and South Fork Stillaguamish River Chinook salmon population and a high beneficial effect on Native American cultural resources. The Stillaguamish EA identified eight resources the Proposed Action may impact and categorized the magnitude of the potential impact from negligible to high and the direction of impact as either positive (i.e., beneficial) or negative (i.e., adverse). With the exception of the above three effects, all impacts were determined to range from negligible to low negative and were not biased by the positive effects of implementing the Proposed Action.

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

Response: The Proposed Action is expected to have a negligible negative impact on public health and safety, directly or indirectly. Hatchery facility operations associated with the Proposed Action are implemented in compliance with state and Federal safety regulations and environmental laws, thus reducing potential risks to public health. The public will have limited exposure to hatchery facility operations. The contribution of toxic contaminants from hatchery operations under the Proposed Action to the body burden of hatchery-origin salmon at a harvestable size is not substantial and would have no significant effect.

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?

Response: The Proposed Action is not expected to significantly impact any unique geographic areas, such as proximity to historic or cultural resources, park land, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas, because no new infrastructure is proposed through the action (hatchery operations and release of hatchery-origin fish) and the Proposed Action is not within a unique geographic area that would be impacted by these operations.

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

Response: NMFS recognizes that the use of hatcheries, in general, can be controversial to some members of the public, with views ranging from adamantly opposed to hatcheries regardless of the hatchery program objectives to adamantly in favor of achieving a program's intended benefits. The wide range of potential effects evaluated in the Stillaguamish EA are, in part, a reflection of NMFS' understanding of the potentially controversial aspects of the Proposed Action. The evaluation in the Stillaguamish EA suggests that the Proposed Action's effects on the quality of the human environment are not likely to be highly controversial because all four programs are relatively small (less than 0.5 percent of total Puget Sound hatchery production of about 167.8 million fish) integrated recovery programs (Appendix B, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities), their negative effects are at most low and consistent with implementation of the hatchery programs over prior years, and the programs are beneficial to the affected human communities. Moreover, NMFS has provided an opportunity for public comment in analyzing the likely impacts of the Proposed Action by soliciting input from more than 6,000 specific individuals or entities, as well as the public at large by notification through the Federal Register. The public input response (Appendix D, Public Comments Received and NMFS' Responses to Comments) was limited to four comments from two commenters raising general concerns about the production of hatchery-origin salmon. Consequently, the limited number and nature of these comments support NMFS' conclusion that the effects of the Proposed Action are not highly controversial.

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

Response: The Proposed Action's effects on the human environment are not likely to be highly uncertain or involve unique or unknown risks. No unique or unknown risks have been identified, and numerous scientific studies on hatchery risks have identified what NMFS believes is an accurate list of potential concerns. Although there are some uncertainties involved in the ongoing operation of hatchery programs, the risks are understood, and the proposed hatchery programs include explicit steps to monitor and evaluate these uncertainties in a manner that allows timely adjustments to minimize or avoid adverse impacts. NMFS retains the ability, through its regulations, to require changes if the programs are determined to be ineffective, particularly with respect to the control of genetic effects on salmon. The proposed operation of the programs is similar to other recent hatchery operations in many areas of the Pacific Northwest, and the procedures and effects are well known.

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?

Response: 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 Puget Sound have been analyzed through similar ESA analyses and NEPA reviews, so this action and the analysis thereof is not unique. Moreover, future applications for ESA section 4(d) determination in the analysis area (i.e., Puget Sound) would be analyzed on their own merits and impacts. Each such activity presents unique actions and effects, limiting the extent to which prior analyses can act as any sort of precedent.

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

Response: NMFS is well aware of the possibility that hatchery practices in one river basin may not likely raise significant impacts on their own, but that the totality of hatchery operations in Puget Sound could give rise to cumulatively significant impacts. As described in the ESA consultations cited above, the take of ESA-listed species in the Stillaguamish River Basin is small enough to result in a no-jeopardy ESA determination when considering all existing conditions, all other permits, and other actions in the area affecting these conditions and permits. These hatchery programs are coordinated with monitoring so that hatchery managers can respond to changes in the status of affected listed species. If the cumulative impacts of salmon management efforts fail to provide for recovery of listed species, adjustments to the hatchery production levels would likely be proposed through consultations between the relevant applicants and NMFS.

The Proposed Action is related to other hatchery production programs in Puget Sound in that they are guided by the same legal agreements and mitigation responsibilities, and they are managed by the same agencies. While direct and indirect impacts of the Proposed Action are not expected to be measurable outside the analysis area, it is also important to consider how impacts of certain activities outside the project area (the Stillaguamish River Basin) may or may not interact with the Proposed Action in such a way that impacts on resources are exacerbated.

Chapter 5 of the Stillaguamish EA (Cumulative Effects) evaluated the incremental impact of the Proposed Action when added to other past, present, and reasonably foreseeable future actions and conditions related to climate change, development, habitat restoration, hatchery production, and fisheries. The evaluation concluded that the Proposed Action would be unlikely to change the trends in cumulative effects on the eight resources analyzed because the effects attributable to the Proposed Action would be very small relative to other actions and conditions.

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?

Response: 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. Accordingly, it is equally unlikely that the Proposed Action may cause loss or destruction of significant scientific, cultural, or historic resources because of the limited geographic scope of the analysis area, which includes none of the aforementioned structures or resources.

Implementation of the Proposed Action is expected to provide high positive cultural resource benefits by increasing the potential for ceremonial and subsistence harvest of salmon by the Stillaguamish Tribe of Indians, which has been limited under current conditions. However, a variety of other factors besides the Stillaguamish River Basin salmon hatcheries also contribute to the amount of harvestable salmon, including freshwater and estuarine habitat quality and quantity, marine productivity, climate change, and recreational and commercial fishing that occurs in Puget Sound, Canada, and Alaska. Consequently, among all factors considered, the positive benefits from the hatchery programs under the Proposed Alternative are not significant impacts for cultural resources.

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?

Response: The degree to which the Proposed Action adversely impacts endangered or threatened species, or their critical habitat, as described in the Stillaguamish EA, will be negligible to low. All four hatchery programs are integrated conservation programs (sometimes referred to as integrated recovery programs) designed to support salmon populations experiencing low productivity and abundance in the Stillaguamish River Basin. In the Stillaguamish EA, NMFS considered the analyses performed in two biological opinions completed and cited above, on the proposed hatchery programs that determined the programs will not appreciably reduce the likelihood of survival and recovery of the four ESA-listed species within the analysis area and potentially affected by the Proposed Action, and therefore concluded the Puget Sound Chinook Salmon ESU, the Puget Sound Steelhead Distinct Population Segment (DPS), Coastal-Puget Sound Bull Trout DPS, and Southern Resident Killer Whale DPS will not be jeopardized.

The Stillaguamish EA summarizes the impacts of the Proposed Action on critical habitat for Chinook salmon, steelhead, Southern Resident killer whale, and bull trout, which were also analyzed in detail in the aforementioned ESA consultations. The biological opinions concluded that the expected impacts on critical habitat for endangered and threatened species from the activities associated with the hatchery programs (such as maintenance of facilities and instream structures) are unlikely to adversely modify or destroy critical habitat elements.

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

Response: The Proposed Action is not expected to threaten any violations of Federal, state, or local laws or requirements imposed for environmental protection. The context of the determined effects of the Proposed Action was developed in the broader context of consultations involving Federal and state agencies charged with recovery planning and implementation of the ESA. No regulatory violations or other significant environmental impacts are expected to result from the Proposed Action.

Hatchery operations are required to comply with the Clean Water Act, which is administered by the Environmental Protection Agency and the State of Washington’s Department of Ecology (Ecology), including obtaining and operating within the limits of National Pollutant Discharge Elimination System (NPDES) permits for discharge from hatchery facilities. Two of the three primary hatchery facilities used under the Proposed Action (Harvey Creek Hatchery and Brenner Creek Hatchery) are small and NMFS is informed that an NPDES permit is not required. All three primary hatchery facilities also have water rights permitted by Ecology that constrain the amount of water the facilities can withdraw from surface or groundwater sources.

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

Response: The Proposed Action is not expected to adversely affect stocks of marine mammals as defined in the Marine Mammal Protection Act. The analysis area is used by a variety of marine mammals that may eat salmon, as described in the Puget Sound Hatcheries draft environmental impact statement (DEIS) (NMFS 2014). Increases or decreases in the abundance of juvenile and adult salmon associated with hatchery operations in the Stillaguamish River Basin may affect marine mammal species that prey on them. However, as described in NMFS (2014), the effects of salmon hatchery programs on wildlife species, including most marine mammals, have generally been negligible. The exception to this general conclusion was the potential effects on Southern Resident killer whales, which were analyzed in the Stillaguamish EA. The Stillaguamish EA concluded that the salmon hatchery programs in the Stillaguamish River Basin would have a negligible positive effect on the diet, survival, and distribution of Southern Resident killer whales because the returning hatchery-origin adult salmon (especially Chinook salmon) would represent a small but meaningful part of their prey base relative to the total number of hatchery-origin and natural-origin salmon available from throughout the greater Puget Sound, Strait of Georgia, and Pacific Coast areas.

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

Response: The Proposed Action is not expected to adversely affect managed fish species beyond what the Stillaguamish EA identifies as negligible to low negative effects. The impacts of the Proposed Action on managed fish species (specifically salmon, steelhead, and bull trout) within Puget Sound are limited to the ecological impacts of intra- and inter-species competition and predation related to the release of juveniles; genetic diversity from hatchery-origin spawners, and the direct effects on target and non-target species due to broodstock collection activities. In addition, any effects on managed ESA-listed fish within the analysis area related to the Proposed Action were analyzed in the biological opinions cited above and considered in the Stillaguamish EA. See the biological opinions and Stillaguamish EA for further details on the impacts of the Proposed Action on these managed species.

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

Response: The Proposed Action is not reasonably expected to adversely affect EFH, as defined under the Magnuson-Stevens Fishery Conservation and Management Act, to a degree beyond negligible negative, and as described in the NMFS (2019) biological opinion and Subsection 4.4.3, Facility Operations, in the Stillaguamish EA. Specifically, the activities described in the HGMPs, such as surface water withdrawals and maintenance of intake structures, are unlikely to remove or destroy habitat elements, and these activities do not include any construction or habitat modification and therefore do not affect EFH necessary for these species to carry out spawning, breeding, feeding, or growth to maturity.

The return of Stillaguamish summer-run and fall-run Chinook salmon, coho salmon, and chum salmon produced by these hatchery programs is likely to have a positive effect on water quality, aquatic insect production, and riparian function because the additional returns from hatchery production will result in an increase of marine-derived nutrients in the analysis area.

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?

Response: The Proposed Action is not expected to have an adverse effect on vulnerable marine or coastal ecosystems, including but not limited to, deep coral ecosystems, for several reasons that are described in the Stillaguamish EA. First, the number of hatchery-origin fish released by the hatchery programs is relatively small, which reduces the likelihood that they could cause a significantly adverse effect. Second, while hatchery-origin fish from the Stillaguamish River Basin may use vulnerable marine or coastal ecosystems such as estuaries or eel grass beds as habitat and foraging areas for a portion of their life cycle, this use is temporary. Finally, Pacific salmon, including the species produced at Stillaguamish River Basin hatcheries, primarily use surface waters in the ocean less than 300 feet deep and consequently are not found in many vulnerable marine ecosystems such as deep coral ecosystems.

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

Response: The Proposed Action is expected to have no more than a low negative effect on biodiversity or ecosystem functions within the affected environment. As described in the Stillaguamish EA, the hatchery programs minimize the effects on ecosystems within the analysis area through the use of endemic broodstock native to the Stillaguamish River Basin and improved hatchery management protocols that limit the effects of hatchery-origin fish spawning in the wild. The hatchery programs may result in small improvements to benthic productivity through increased deposits of marine-derived nutrients resulting from returning hatchery-origin adult carcasses to the river basin post-spawning.

Although salmon produced in these hatchery programs are expected to prey on other fish species in the analysis area, predation is not expected in large quantities since juvenile hatchery-origin salmon generally migrate through fresh and estuarine waters quickly after being released. Hatchery-origin salmon produced by these hatchery programs may also provide a prey base for other predatory species such as bull trout, but these programs represent only a small portion of the total amount of food available to predator species. Consequently, the Proposed Action is not expected to have significant impacts on biodiversity and ecosystem function.

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

Response: The Proposed Action is not reasonably expected to result in the introduction or spread of nonindigenous species because the Proposed Action has no potential to cause the transport, release, propagation, or spread of nonindigenous species. The Proposed Action involves the operation of hatchery facilities for the purpose of artificial propagation of salmonids in the Stillaguamish River Basin for integrated conservation programs and fisheries. These artificial propagation programs use local endemic Chinook salmon, coho salmon, and chum salmon adults as broodstock, and therefore will not introduce nonindigenous species to the analysis area.

DETERMINATION

In view of the information presented in this document and the analysis contained in the supporting Stillaguamish EA prepared for NMFS' determination under ESA section 4(d) for the continuation of the four proposed hatchery programs (i.e., Stillaguamish Summer Chinook Natural Stock Restoration Program, Stillaguamish Fall Chinook Natural Stock Restoration Program, Stillaguamish Fall Coho Program, and Stillaguamish Chum Program), the Proposed Action will not significantly impact the quality of the human environment as described above and in the supporting Stillaguamish EA. In addition, all beneficial and adverse impacts of the Proposed Action have been addressed to reach the conclusion of no significant impact. Accordingly, preparation of an EIS for this action is not necessary.

October 24, 2019
Date

Regional Administrator
West Coast Region
National Marine Fisheries Service

References

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

NMFS. 2019. National Marine Fisheries Service (NMFS) Evaluation of Four Hatchery and Genetic Management Plans for Salmon in the Stillaguamish River Basin under Limit 6 of the Endangered Species Act Section 4(d) Rule. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation. NMFS Consultation Number: WCR-2018-8876. Lacey, WA.

USFWS. 2019. Biological Opinion: NMFS 4(d) Rule Determination for WDFW and Stillaguamish Tribe's Salmon Hatchery Operations in the Stillaguamish River Watershed, Snohomish County, Washington. USFWS Reference: 01EWFW00-2018 F-1603. Lacey, WA. May 31, 2019. 190 pages.