Draft Environmental Impact Statement

Draft Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed 4(d) Determination under Limit 6 for Five Early Winter Steelhead Hatchery Programs in Puget Sound

Prepared by the
National Marine Fisheries Service, West Coast Region

NOAA FISHERIES

November 2015

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
PROGRAM PLANNING AND INTEGRATION
Silver Spring, Maryland 20910

Dear Reviewer:

In accordance with provisions of the National Environmental Policy Act (NEPA) the *Draft Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed 4(d) Determination under Limit 6 for Five Early Winter Steelhead Hatchery Programs in Puget Sound* is enclosed for your review.

This Draft Environmental Impact Statement (DEIS) assesses environmental impacts associated with the National Marine Fisheries Service's (NMFS) review and approval of five hatchery and genetic management plans (HGMPs) submitted jointly by the fishery co-managers for hatchery programs in Puget Sound. The HGMPs have been submitted for approval as resource management plans under Limit 6 of the Endangered Species Act 4(d) rules for listed salmon and steelhead.

Additional copies of the DEIS may be obtained from the Responsible Program Official identified below. The DEIS is also accessible electronically through the NMFS West Coast Region's website at http://www.westcoast.fisheries.noaa.gov/hatcheries/salmon_and_steelhead_hatcheries.html.

Please submit written comments via mail, facsimile (fax), or email to the Responsible Program Official identified below. Written comments submitted during the agency's 45-day public comment period must be received by **December 28, 2015**. When submitting fax or email comments, include the following document identifier in the comment subject line: **Early Winter Steelhead Hatcheries EIS**.

Responsible Program Official: William W. Stelle, Jr.
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National Oceanic and Atmospheric Administration
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Sincerely,

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for Kristen A. Tronvig
Acting NOAA NEPA Coordinator

Enclosure

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Cover Sheet

November 2015

Title of Environmental Review:	Draft Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed 4(d) Determination under Limit 6 for Five Early Winter Steelhead Hatchery Programs in Puget Sound
Responsible Agency and Official:	William Stelle, Jr., Regional Administrator National Marine Fisheries Service, West Coast Region 7600 Sand Point Way NE, Building 1 Seattle, WA 98115
Contact:	Steve Leider NMFS Sustainable Fisheries Division, West Coast Region 510 Desmond Drive SE, Suite 103 Lacey, WA 98503 Steve.Leider@noaa.gov (Note: not for commenting) (360) 753-4650
Location of Proposed Activities:	The Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins in Puget Sound, Washington State
Proposed Action:	NMFS would review and evaluate five hatchery programs submitted by the fishery co-managers for the augmentation of steelhead fisheries. The operator is the Washington Department of Fish and Wildlife. NMFS would evaluate and make Endangered Species Act (ESA) take determinations under the ESA Limit 6 of 4(d) rules for listed Puget Sound Chinook salmon and steelhead.
Abstract:	The Washington Department of Fish and Wildlife and the Puget Sound treaty tribes jointly submitted five hatchery and genetic management plans for steelhead hatchery programs in Puget Sound, as resource management plans. 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 listed fish. NMFS's determination of whether the plans achieve the conservation standards of the ESA, as set forth in Limit 6 of 4(d) rules for listed salmon and steelhead, is the Federal action requiring National Environmental Policy Act (NEPA) compliance. The analysis within the environmental impact statement (EIS) informs NMFS, hatchery operators, and the public about the current and anticipated direct, indirect, and cumulative environmental effects of operating the five Puget Sound steelhead hatchery programs under the full range of alternatives.

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Summary

Draft Environmental Impact Statement to Analyze Impacts of NOAA's National Marine Fisheries Service Proposed 4(d) Determination under Limit 6 for Five Early Winter Steelhead Hatchery Programs in Puget Sound

Introduction

Steelhead have been produced in Puget Sound hatcheries since the early 1900s. The benefit of hatcheries at the outset was to produce hatchery-origin fish for harvest purposes. Hatcheries have contributed 70 to 80 percent of the catch in coastal salmon and steelhead fisheries. As the fish's natural habitat was degraded by human development and activities like passage barriers, forest practices, and urbanization, the role of hatcheries shifted toward mitigation for lost natural production and reduced harvest opportunity. Hatchery production presents risks to natural-origin steelhead. These include genetic risks from hatchery-origin fish to natural-origin fish as a result of poor broodstock and rearing practices, risks of competition with and predation on naturally spawned populations, and incidental harvest of natural-origin fish in fisheries targeting hatchery-origin fish.

The Washington Department of Fish and Wildlife (WDFW) and the Puget Sound treaty tribes (hereafter referred to as the co-managers) have jointly submitted to the National Marine Fisheries Service (NMFS) hatchery and genetic management plans (HGMPs) for five hatchery programs that would produce earlyreturning ("early") winter steelhead in Puget Sound. The HGMPs describe the hatchery programs, including fish life stages produced and potential research, monitoring, and evaluation actions to minimize the risk of negatively affecting listed salmon and steelhead (Table S-1). The HGMPs have been submitted for review and approval as resource management plans (RMPs) under Limit 6 of the 4(d) Rule under the Endangered Species Act (ESA). The plans are consistent with the framework of *United States v. Washington* (1974) for coordination of treaty fishing rights, non-tribal harvest, artificial production objectives, and artificial production levels.

Table S-1. ESA status of listed Puget Sound salmon and steelhead.

Species	ESU/DPS	Current Endangered Species Act Listing Status
Chinook salmon (*Oncorhynchus tshawytscha*)	Puget Sound	Threatened (76 Fed. Reg. 50448, August 15, 2011)
Chum salmon *(O. keta)*	Hood Canal summer-run (includes Strait of Juan de Fuca summer-run)	Threatened (76 Fed. Reg. 50448, August 15, 2011)
Steelhead (*O. mykiss*)	Puget Sound	Threatened (76 Fed. Reg. 50448, August 15, 2011)
Coho salmon (*O. kisutch*)	Puget Sound/Strait of Georgia	Species of Concern (69 Fed. Reg. 19975, April 15, 2004)

Source: NMFS

NMFS's determination of whether the HGMPs submitted as RMPs achieve the conservation standards of the ESA, as set forth in Limit 6 under the salmon and steelhead 4(d) Rules, is the Federal action requiring National Environmental Policy Act (NEPA) compliance. Although this environmental impact statement (EIS) itself will not determine whether the HGMPs submitted as RMPs meet ESA requirements—those determinations are made under the specific criteria of the ESA and the section 4(d) Rule—the analyses within the EIS will inform NMFS, hatchery operators, and the public about the current and anticipated cumulative environmental effects of operating the five early winter steelhead hatchery programs under the full range of alternatives.

What are 4(d) rules?

Section 4(d) of the ESA directs NMFS to issue regulations to conserve species listed as threatened. This applies particularly to "take," which can include any act that kills or injures fish, and may include habitat modification. The ESA prohibits any take of species listed as endangered, but some take of threatened species that does not interfere with survival and recovery may be allowed.

The salmon and steelhead 4(d) rules apply take prohibitions to all actions except those within the 13 limits to the rules. The limits, or exemptions, describe specified categories of activities that contribute to conserving listed salmon. A separate, but closely related, tribal 4(d) Rule creates an additional limit for tribal RMPs.

Limit 5 of the 4(d) Rule, using specific criteria, provides limits on the prohibitions of "take" for a variety of hatchery purposes, based on NMFS' evaluation and approval of HGMPs submitted by hatchery operators. Limit 6 of the 4(d) Rule provides limits on the prohibitions of "take" for joint tribal and state plans developed under *United States v. Washington* processes, including artificial production actions.

Proposed Action

Under the Proposed Action, NMFS would make a determination that the HGMPs submitted as RMPs, meet the requirements of Limit 6 under the 4(d) Rule of the ESA. The HGMPs for Puget Sound hatcheries would be implemented by the co-managers.

Project Area

The project area covered in this EIS includes the places where the proposed steelhead hatchery programs would (1) collect broodstock; (2) spawn, incubate, and rear fish; (3) release fish; or (4) remove surplus hatchery-origin adult steelhead that return to hatchery facilities; and (5) conduct monitoring and evaluation activities. The project area includes the Dungeness, Nooksack, Stillaguamish, Snohomish/Skykomish, and Snoqualmie River basins. Portions of 5 counties in Washington State are included. These five hatchery programs operate using eight hatchery facilities, and would produce 620,000 juvenile steelhead per year.

Purpose and Need

NMFS's purpose for the Proposed Action is to ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound.

NMFS's need for the Proposed Action is to:

- Respond to the co-managers' request for an exemption from take prohibitions of section 9 of the ESA for their hatchery programs triggered by submission of HGMPs as RMPs under Limit 6 of the 4(d) Rule.

- Provide, as appropriate, tribal and non-tribal fishing opportunities as described under the state and tribal co-managers' Puget Sound Salmon Management Plan implemented under *United States v. Washington.*

The co-managers' purpose in developing and submitting HGMPs and submitting them as RMPs under Limit 6 is 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 ESA's 4(d) Rule.

What is an ESU? What is a DPS?

NMFS lists salmon as threatened or endangered according to the status of their evolutionarily significant units (ESUs). An ESU is a salmon population that is 1) substantially reproductively isolated from conspecific populations and 2) represents an important component of the evolutionary legacy of the species.

In contrast to salmon, NMFS lists steelhead under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) policy for recognizing distinct population segments (DPSs) under the ESA. This policy adopts criteria similar to, but somewhat different than, those in the ESU policy for determining when a group of vertebrates constitutes a DPS. A group of organisms is discrete if it is "markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, and behavioral factors." NMFS lists steelhead according to the status of the steelhead DPS.

The co-managers' need for the Proposed Action is to continue to maintain and operate salmon and steelhead hatchery programs using existing facilities for conservation, mitigation, and tribal and non-tribal fishing opportunity pursuant to the Puget Sound Salmon Management Plan implemented under *United States v. Washington*, and treaty rights preservation purposes while meeting ESA requirements. WDFW and the Puget Sound treaty tribes strive to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound salmon and steelhead 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.

Relationship between the ESA and NEPA

The relationship between the ESA and NEPA is complex, in part because both laws address environmental values related to the impacts of a Proposed Action. However, each law has a distinct purpose, and the scope of review and standards of review under each statute are different.

The purpose of an EIS under NEPA is to promote disclosure, analysis, and consideration of the broad range of environmental issues surrounding a proposed major Federal action by considering a full range of reasonable alternatives, including a No-action Alternative. Public involvement promotes this purpose.

The purpose of the ESA is to conserve listed species and the ecosystems upon which they depend. Determinations about whether hatchery programs in Puget Sound meet ESA requirements are made under section 4(d) or section 7 of the ESA. Each of these ESA sections has its own substantive requirements, and the documents that reflect the analyses and decisions are different than those related to a NEPA analysis.

It is not the purpose of this EIS to suggest to the reader any conclusions relative to the ESA analysis for this action. While the NEPA Record of Decision (ROD) identifies the selected NEPA alternative, the ROD does not conclude whether that alternative complies with the ESA.

Alternatives Analyzed in Detail

Alternative 1 (No Action)

Under this alternative, NMFS would not make a determination under the 4(d) Rules for any of the five HGMPs, and WDFW would discontinue its early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins (Table S-2). This No-action Alternative represents NMFS's best estimate of what would happen in the absence of the Proposed Action – a determination that the co-managers' submitted HGMPs meet requirements of the 4(d) Rule.

Table S-2. Annual hatchery releases of juvenile steelhead under the alternatives by river basin.

River Basin	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Reduced Production)	Alternative 4 (Native Broodstock)
Dungeness	0	10,000	5,000	10,000
Nooksack	0	150,000	75,000	150,000
Stillaguamish	0	130,000	65,000	130,000
Skykomish	0	256,000	128,000	256,000
Snoqualmie	0	74,000	37,000	74,000
Total	0	**620,000**	**310,000**	**620,000**

Source: HGMPs.

Alternative 2 (Proposed Action)

This alternative consists of hatchery operations as proposed under the co-managers' HGMPs. NMFS would make a determination that the HGMPs submitted by the co-managers meet requirements of the 4(d) Rule. The early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be implemented as described in the five submitted HGMPs (Table S-2), and up to 620,000 steelhead yearlings would be released. The hatchery programs would utilize existing hatchery capacity for operations, and would be adaptively managed over time to incorporate best management practices as new information is available.

Alternative 3 (Reduced Production)

Under this alternative, WDFW would reduce the number of fish released from each of the five proposed hatchery programs by 50 percent (to 310,000 steelhead yearlings) because it represents a mid-point between the Proposed Action (Alternative 2) and the No-action Alternative (Alternative 1) (Table S-2).

Revised HGMPs would be submitted reflecting these reduced production levels, and NMFS would make a determination that the revised HGMPs submitted as RMPs meet the requirements of the 4(d) Rule.

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

Alternative 4 (Native Broodstock)

Under this alternative, WDFW would change its program management to transition the programs from the current non-native Chambers Creek stock to broodstock derived from fish native to the respective watershed in the project area (Table S-2). While this could be done in multiple ways, involving different periods of time and various objectives, for the purpose of this analysis NMFS assumes that use of Chambers Creek stock in the broodstock would be terminated immediately. Fish taken for broodstock would then only be those determined to be native to the given watershed.

Broodstock collection would be contingent upon availability of natural-origin fish, ensuring first that an appropriate number of fish would be able to spawn naturally; after that critical threshold is ensured, then a proportion of additional returns would be taken into the hatchery facilities.

NMFS's 4(d) regulations do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs submitted as RMPs. NMFS's 4(d) regulations require NMFS to make a determination that the HGMPs submitted as RMPs *as proposed* either meet or do not meet the standards prescribed in the rule. Nonetheless, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios.
A summary of distinguishing features of the alternatives is shown in Table S-3.

Summary of Resource Effects

Table S-4 provides a summary of the predicted resource effects under each of the four alternatives. The summary reflects the detailed resource discussions in Chapter 4, Environmental Consequences.
The relative magnitude and direction of impacts is described in Table S-4 using the following terms:

Undetectable:	The impact would not be detectable.
Negligible:	The impact would be at the lower levels of detection, and could be either positive or negative.
Low:	The impact would be slight, but detectable, and could be either positive or negative.
Moderate:	The impact would be readily apparent, and could be either positive or negative.
High:	The impact would be greatly positive or severely negative.

Table S-3. Summary of distinguishing features of the alternatives.

Alternative	NMFS Review, Evaluation, and Approval of Plans under 4(d) Rules	Number of Hatchery-origin Fish Released	Changes in Hatchery Programs	Conservation Benefit to Salmon and Steelhead
Alternative 1 (No Action)	No evaluation and determination under the 4(d) rules	0	Early winter steelhead programs would be terminated.	Teminating releases would eliminate any risk to listed salmon and steelhead from early winter steelhead hatchery programs.
Alternative 2 (Proposed Action)	Evaluation and determination under the 4(d) rules	620,000	Existing production levels would continue, and conservation measures would be applied to early winter steelhead hatchery programs to reduce risks and to meet conservation requirements.	Conservation requirements for listed salmon and steelhead would be met.
Alternative 3 (Reduced Production)	Same as Alternative 2	310,000	Releases of early winter steelhead hatchery programs would be reduced 50 percent.	Conservation requirements for listed salmon and steelhead would be met, and risks from early winter steelhead production would be reduced.
Alternative 4 (Native Broodstock)	Same as Alternative 2	620,000	Use of early winter steelhead broodstock would be terminated immediately; the hatchery programs would transition to broodstock derived from fish native to the watershed.	Conservation requirements for listed salmon and steelhead would be met.

Table S-4. Summary of environmental consequences for EIS alternatives for each resource.

Resource	Alternative 1 (No Action – termination)	Alternative 2[1] (Proposed Action)	Alternative 3[1] (Reduced Production)	Alternative 4[1] (Native Broodstock)
Water Quantity	Compared to existing conditions, the early winter steelhead hatchery programs would be terminated, but all of the hatchery facilities that support the programs would continue to operate to produce fish for programs that are not part of the Proposed Action. Short- and long-term water use may be less than under existing conditions because no early winter steelhead would be produced.	The hatchery programs would continue to operate at existing levels, and would have negligible to moderate negative effects on water quantity, depending on the hatchery program, compared to Alternative 1.	Same as Alternative 2, although water use would be reduced to support lower production levels of early winter steelhead.	Same as Alternative 2.
Salmon and Steelhead	Because early winter steelhead hatchery production would be terminated, negative and positive effects to salmon or steelhead from the programs would be eliminated, compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would generally have negligible to moderate negative effects on gene flow, competition and predation, hatchery facilities, masking, incidental fishing, and disease transfer effects; and negligible positive effects from nutrient cycling, depending on the hatchery program and affected species. As under existing conditions, there would be no benefit to the viability of the listed steelhead DPS.	Same as Alternative 2, except that effects from gene flow, competition and predation, hatchery facilities, masking, incidental fishing, and disease transfer from early winter steelhead would be reduced. There would be no change in viability benefit to the listed steelhead DPS compared to existing conditions.	Same as Alternative 2 except that collection of local native broodstock could have a low negative effect on the abundance and spatial structure of the natural-origin populations (i.e., mining), and a potential positive benefit to viability of the listed steelhead DPS.

Table S-4. Summary of environmental consequences for EIS alternatives for each resource. (continued)

Resource	Alternative 1 (No Action – termination)	Alternative 2[1] (Proposed Action)	Alternative 3[1] (Reduced Production)	Alternative 4[1] (Native Broodstock)
Other Fish Species	Because early winter steelhead hatchery production would be terminated, other fish species would be affected if they compete with, are prey of (positive effect), or prey on (negative effect) early winter hatchery-origin steelhead, compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would have low negative to negligible positive effects on other fish species if they compete with or are prey of (negative effect), or prey on fish from early winter steelhead hatchery programs (positive effect), compared to Alternative 1.	Same as Alternative 2, except that the food supply for fish species that benefit from steelhead as prey would be reduced, and risk to other fish species that compete with, are prey of, or prey on steelhead would be reduced, compared to Alternative 2.	Same as Alternative 2.
Wildlife – Southern Resident killer whale	Because early winter steelhead hatchery production would be terminated, early winter steelhead prey that would have been available to Southern Resident killer whales under existing conditions would be eliminated. This reduction from existing conditions would likely result in a negligible negative effect. Southern Resident killer whales would continue to occupy their existing habitats with a similar abundance, and would continue to prey on available salmon and other steelhead, especially Chinook salmon, as under existing conditions.	The hatchery programs would continue to operate at existing levels, and would have a negligible positive effect on Southern Resident killer whales, which would continue to occupy their existing habitats with a similar abundance, and would continue to prey on salmon and steelhead, especially Chinook salmon, compared to Alternative 1.	Similar to Alternative 2, except that early winter steelhead hatchery production and adult returns would decrease, reducing the supply of steelhead available to Southern Resident killer whales as prey. Alternative 3 would have a negligible positive effect, similar to Alternative 2, but less pronounced.	Same as Alternative 2.

Table S-4. Summary of environmental consequences for EIS alternatives for each resource. (continued)

Resource	Alternative 1 (No Action – termination)	Alternative 2[1] (Proposed Action)	Alternative 3[1] (Reduced Production)	Alternative 4[1] (Native Broodstock)
Socioeconomics	Because early winter steelhead hatchery production would be terminated, non-tribal and tribal fishing opportunities would be reduced and there would be a loss of person income and jobs, compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would have low to moderate positive socioeconomic effects from hatchery operations and fishing activities (non-tribal and tribal), compared to Alternative 1.	Same as Alternative 2, except that the socioeconomic effects from hatchery operations and fishing (non-tribal and tribal) would decrease.	Same as Alternative 2.
Environmental Justice	Because early winter steelhead hatchery production would be terminated, reduced fishing opportunities would negatively impact all communities of concern, and affected Native American tribes, compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would provide low positive effects from fishing opportunities for all communities of concern, and moderate positive effects for Native American tribes, compared to Alternative 1.	Same as Alternative 2, except that fishing opportunities for all communities of concern, and for Native American tribes, would decrease.	Same as Alternative 2.

[1] Potential differences between the no action and the action alternatives would be due to differences in hatchery production levels and program type under the action alternatives.

Preferred Alternative

This draft EIS does not contain a preferred alternative. NMFS will identify the preferred alternative in the final EIS after considering the comments received on this document. The preferred alternative may be one of the alternatives or a combination of components of more than one alternative, possibly varying for each hatchery program. NMFS will also identify an environmentally preferred alternative in the ROD. This alternative may or may not be the same as the preferred alternative.

How should reviewers approach this EIS?

NMFS encourages reviewers to:

1. Review the draft EIS to gain an understanding of how it is organized and how the alternatives are framed and analyzed.
2. Carefully consider the information provided in Chapter 4, Environmental Consequences, and Chapter 5, Cumulative Effects.

After considering the effects, comment on how NMFS should formulate a preferred alternative for publication in the final EIS and ROD.

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Acronyms and Abbreviations

CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	Cubic feet per second
DAO	Departmental Administrative Order
DPS	Distinct population segment
EA	Environmental assessment
Ecology	Washington Department of Ecology
EIS	Environmental impact statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
ESU	Evolutionarily significant unit
FONSI	Finding of No Significant Impact
FTE	Full-time equivalent
HGMP	Hatchery and genetic management plan
HSRG	Hatchery Scientific Review Group
MMPA	Marine Mammal Protection Act
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service (also called NOAA Fisheries Service)
NPDES	National Pollutant Discharge Elimination System
pHOS	Proportion of hatchery-origin spawners
PNI	Proportionate natural influence
RM	River mile
RMP	Resource management plan
ROD	Record of Decision
Services	USFWS and NMFS
TRT	Technical Recovery Team
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WAC	Washington Administrative Code
WDFW	Washington Department of Fish and Wildlife

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Glossary of Key Terms

Abundance: Generally, the number of fish in a defined area or unit. It is also one of four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

Adaptive management: A deliberate process of using research, monitoring, and scientific evaluation in making decisions in the face of uncertainty.

Acclimation pond: A concrete or earthen pond or a temporary structure used for rearing and imprinting juvenile fish in the water of a particular stream before their release into that stream.

Adipose fin: A small fleshy fin with no rays, located between the dorsal and caudal fins of salmon and steelhead. The adipose fin is often “clipped” on hatchery-origin fish so they can be differentiated from natural-origin fish.

Anadromous: A term used to describe fish that hatch and rear in fresh water, migrate to the ocean to grow and mature, and return to freshwater to spawn.

Analysis area: Within this Environmental Impact Statement (EIS), the analysis area is the geographic extent that is being evaluated for each resource. For some resources (e.g., socioeconomics and environmental justice), the analysis area is larger than the project area. See also **Project area**.

Best management practice (BMP): A policy, practice, procedure, or structure implemented to mitigate adverse environmental effects.

Broodstock: A group of sexually mature individuals of a species that is used for breeding purposes as the source for a subsequent generation.

Co-managers: Washington Department of Fish and Wildlife and Puget Sound treaty tribes, which are jointly responsible for managing fisheries and hatchery programs in the state of Washington.

Commercial harvest: The activity of catching fish for commercial profit.

Conservation: Used generally in the EIS as the act or instance of conserving or keeping fish resources from change, loss, or injury, and leading to their protection and preservation. This contrasts with the definition under the United States Endangered Species Act (ESA), which refers to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to the ESA are no longer necessary.

Critical habitat: A specific term and designation within the ESA, referring to habitat area essential to the conservation of a listed species, though the area need not actually be occupied by the species at the time it is designated.

Dewatering: Typically, the immediate downstream habitat effects associated with a water withdrawal action that diverts the entire flow of a stream or river to another location.

Distinct Population Segment (DPS): Under the ESA, the term "species" includes any subspecies of fish or wildlife or plants, and any "Distinct Population Segment" of any species or vertebrate fish or wildlife that interbreeds when mature. The ESA thus considers a DPS of vertebrates to be a "species." The ESA does not however establish how distinctness should be determined. Under NMFS policy for Pacific salmon, a population or group of populations will be considered a DPS if it represents an Evolutionarily Significant Unit (ESU) of the biological species. In contrast to salmon, NMFS lists steelhead runs under the joint NMFS-U.S. Fish and Wildlife Service (USFWS) Policy for recognizing DPSs (DPS Policy: 61 Fed. Reg. 4722, February 7, 1996). This policy adopts criteria similar to those in the ESU policy, but applies to a broader range of animals to include all vertebrates.

Diversion screen: A screen used at a hatchery facility, dam, or weir to direct fish, usually to keep fish from entering a water intake. See also **Water intake screen**.

Diversity: Variation at the level of individual genes (polymorphism); provides a mechanism for populations to adapt to their ever-changing environment. It is also one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

Domestication: See **Hatchery-influenced selection**.

Endangered species: As defined in the ESA, any species that is in danger of extinction throughout all or a significant portion of its range.

Endangered Species Act (ESA): A United States law that provides for the conservation of endangered and threatened species of fish, wildlife, and plants.

Environmental justice: The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

Escapement: Adult salmon and steelhead that survive fisheries and natural mortality, and return to spawn.

Estuary: The area where fresh water of a river meets and mixes with the salt water of the ocean.

Evolutionarily Significant Unit (ESU): A concept NMFS uses to identify Distinct Population Segments of Pacific salmon (but not steelhead) under the ESA. An ESU is a population or group of populations of Pacific salmon that 1) is substantially reproductively isolated from other populations, and 2) contributes substantially to the evolutionary legacy of the biological species. See also **Distinct Population Segment** (pertaining to steelhead).

Federal Register: The United States government's daily publication of Federal agency regulations and documents, including executive orders and documents that must be published per acts of Congress.

Fingerling: A juvenile fish.

First Nation: A term referring to the aboriginal people located in what is now Canada.

Fishery: Harvest by a specific gear type in a specific geographical area during a specific period of time.

Fishway: Any structure or modification to a natural or artificial structure for the purpose of providing or enhancing fish passage.

Fitness: As used in this EIS, the propensity of a group of fish (e.g., populations) to survive and reproduce.

Forage fish: Small fish that breed prolifically and serve as food for predatory fish.

Fry: Juvenile salmon and steelhead that are usually less than one year old and have absorbed their egg sac.

Gene flow: See Introgression

Habitat: The physical, biological, and chemical characteristics of a specific unit of the environment occupied by a specific plant or animal; the place where an organism naturally lives.

Hatchery and genetic management plan (HGMP): Technical documents that describe the composition and operation of individual hatchery programs. Under Limit 5 of the 4(d) rule, NMFS uses information in HGMPs to evaluate impacts on salmon and steelhead listed under the ESA.

Hatchery facility: A facility (e.g., hatchery, rearing pond, net pen) that supports one or more hatchery programs.

Hatchery-influenced selection: The process whereby genetic characteristics of hatchery populations become different from their source populations as a result of selection in hatchery environments (also referred to as domestication).

Hatchery operator: A Federal agency, state agency, or Native American tribe that operates a hatchery program.

Hatchery-origin fish: A fish that originated from a hatchery facility.

Hatchery-origin spawner: A hatchery-origin fish that spawns naturally.

Hatchery program: A program that artificially propagates fish. Most hatchery programs for salmon and steelhead spawn adults in captivity, raise the resulting progeny for a few months or longer, and then release the fish into the natural environment where they will mature.

Hatchery scientific review group (HSRG): The independent scientific panel established and funded by Congress to provide an evaluation of hatchery reform in Puget Sound from 2000 to 2005.

Hydropower: Electrical power generation through use of gravitational force of falling water at dams.

Incidental: Unintentional, but not unexpected.

Incidental fishing effects: Fish, marine birds, or mammals unintentionally captured during fisheries using any of a variety of gear types.

Integrated hatchery program: A hatchery program that intends for 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 included in an ESU or DPS.

Isolated hatchery program: A hatchery program that intends for the hatchery-origin population to be reproductively segregated from the natural-origin population. These programs produce fish that are different from local populations. They do not contribute to conservation or recovery of populations included in an ESU or DPS.

Limit 6: Under section 4(d) of the ESA (see **Section 4(d) Rule**), a limit on "take" prohibitions that applies to joint state/tribal resource management plans developed under the *United States v. Washington* (1974) or *United States v. Oregon* (1969) proceedings.

Limiting factor: A physical, chemical, or biological feature that impedes species and their independent populations from reaching a viable status.

National Environmental Policy Act (NEPA): A United States environmental law that established national policy promoting the enhancement of the environment and established the President's Council on Environmental Quality (CEQ).

National Marine Fisheries Service (NMFS): A United States agency within the National Oceanic and Atmospheric Administration and under the Department of Commerce charged with the stewardship of living marine resources through science-based conservation and management, and the promotion of healthy ecosystems.

National Pollutant Discharge Elimination System (NPDES): A provision of the Clean Water Act that prohibits discharge of pollutants into waters of the United States unless a special permit is issued by the Environmental Protection Agency, a state, or, where delegated, a tribal government on an Indian reservation.

Native fish: Fish that are endemic to or limited to a specific region.

Natural-origin: A term used to describe fish that are offspring of parents that spawned in the natural environment rather than the hatchery environment, unless specifically explained otherwise in the text. "Naturally spawning" and similar terms refer to fish spawning in the natural environment.

Net pen: A fish rearing enclosure used in marine areas.

Northwest Indian Fisheries Commission (NWIFC): A support service organization to 20 treaty Indian tribes in western Washington, created following the *U.S. vs Washington* ruling, that assists member tribes in their role as natural resources co-managers.

Out-migration: The downstream migration of salmon and steelhead toward the ocean.

Pathogen: An infectious microorganism that can cause disease (e.g., virus, bacteria, fungus) in its host.

Population: A group of fish of the same species that spawns in a particular locality at a particular season and does not interbreed substantially with fish from any other group.

Preferred alternative: The alternative selected or developed from an evaluation of alternatives. Under NEPA, the preferred alternative is the alternative an agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors.

Productivity: The rate at which a population is able to produce reproductive offspring. It is one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

Project area: Geographic area where the Proposed Action will take place. See also **Proposed Action**.

Proportion of hatchery-origin spawners (pHOS): The proportion of naturally spawning salmon or steelhead that are hatchery-origin fish.

Proportionate natural influence (PNI): A measure of hatchery influence on natural populations that is a function of both the proportion of hatchery-origin spawners spawning in the natural environment (pHOS) and the percent of natural-origin broodstock incorporated into the hatchery program (pNOB). PNI can also be thought of as the percentage of time all the genes of population collectively have spent in the natural environment.

Proposed Action: NMFS's review and approval under Limit 6 of the 4(d) rules for five early winter steelhead hatchery and genetic management plans (and hatchery releases) submitted as resource management plans by the co-managers.

Puget Sound treaty tribes: Indian tribes in the project area with treaty fishing rights pursuant to *United States v. Washington*. The tribes are the Jamestown S'Klallam, Lower Elwha Klallam, Lummi, Makah, Muckleshoot, Nisqually, Nooksack, Port Gamble S'Klallam, Skokomish, Suquamish, Puyallup, Sauk-Suiattle, Squaxin Island, Stillaguamish, Swinomish, Tulalip, and Upper Skagit Tribes.

Record of Decision (ROD): The formal NEPA decision document that is recorded for the public. It is announced in a Notice of Availability in the Federal Register.

Recovery: Defined in the ESA as the process by which the decline of an endangered or threatened species is stopped or reversed, or threats to its survival neutralized so that its long-term survival in the wild can be ensured, and it can be removed from the list of threatened and endangered species.

Recovery plan: Under the ESA, a formal plan from NMFS (for listed salmon and steelhead) outlining the goals and objectives, management actions, likely costs, and estimated timeline to recover the listed species.

Recreational harvest: The activity of catching fish for non-commercial reasons (e.g., sport or recreation).

Redd: The spawning site or "nest" in stream and river gravels in which salmon and steelhead lay their eggs.

Residuals: Hatchery-origin fish that out-migrate slowly, if at all, after they are released. Residualism occurs when such fish residualize rather than out-migrate as most of their counterparts do.

Resource management plan (RMP): A plan that includes a process, management objectives, specific details, and other information required to manage a natural resource. For this EIS, the resources are early winter steelhead hatchery programs in Puget Sound.

Run: The migration of salmon or steelhead from the ocean to fresh water to spawn. Defined by the season they return as adults to the mouths of their home rivers.

Run size: The number of adult salmon or steelhead (i.e., harvest plus escapement) returning to their natal areas. See also **Total Return**.

Salish Sea: The network of coastal waterways located between the southwestern tip of British Columbia and the northwestern tip of the state of Washington.

Salmonid: A fish of the taxonomic family Salmonidae, which includes salmon, steelhead, and trout.

Scoping: In NEPA, an early and open process for determining the extent and variety of issues to be addressed and for identifying the significant issues related to a proposed action (40 CFR 1501.7).

Section 4(d) Rule: A special regulation developed by NMFS under authority of section 4(d) of the ESA, modifying the normal protective regulations for a particular threatened species when it is determined that such a rule is necessary and advisable to provide for the conservation of that species.

Section 7 consultation: Federal agency consultation with NMFS or USFWS (dependent on agency jurisdiction) on any actions that may affect listed species, as required under section 7 of the ESA.

Section 10 permit: A permit for direct take of listed species for scientific purposes or to enhance the propagation or survival of listed species. Issued by NMFS or USFWS (dependent on agency jurisdiction) as authorized under section 10(a)(1)(A) of the ESA.

Smolts: Juvenile salmon and steelhead that have left their natal streams, are out-migrating downstream, and are physiologically adapting to live in salt water.

Smoltification: The process of physiological change that juvenile salmon and steelhead undergo in fresh water while out-migrating to salt water that allow them to live in the ocean.

Spatial structure: The spatial structure of a population refers both to the spatial distributions of individuals in the population and the processes that generate that distribution. It is one of the four parameters used to describe the viability of natural-origin fish populations (McElhany et al. 2000).

Stock: A group of fish of the same species that spawns in a particular lake or stream (or portion thereof) at a particular season and which, to a substantial degree, does not interbreed with fish from any other group spawning in a different place or in the same place in a different season.

Straying (of hatchery-origin fish): A term used to describe when hatchery-origin fish return to and/or spawn in areas where they are not intended to return/spawn.

Subsistence fisheries: Harvest by Puget Sound treat tribes to meet the nutritional needs of tribal members.

Subyearling: Juvenile salmon less than 1 year of age.

Supplementation: Release of fish into the natural environment to increase the abundance of naturally reproducing fish populations.

Take: Under the ESA, the term "take" means to "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Take for hatchery activities includes, for example, the collection of listed fish (adults and juveniles) for hatchery broodstock, the collection of listed hatchery-origin fish to prevent them from spawning naturally, and the collection of listed fish (juvenile and adult fish) for scientific purposes.

Threat: A human action or natural event that causes or contributes to limiting factors; threats may be caused by past, present, or future actions or events.

Threatened species: As defined by section 4 of the ESA, any species that is likely to become endangered within the foreseeable future throughout all or a significant portion of its range.

Tributary: A stream or river that flows into a larger stream or river.

Viability: As used in this EIS, a measure of the status of listed salmon and steelhead that uses four criteria: abundance, productivity, spatial distribution, and diversity.

Viable salmonid population (VSP): An independent population of salmon or steelhead that has a negligible risk of extinction over a 100-year timeframe (McElhany et al. 2000).

Volitional: A term used to describe the method of passively releasing fish that allows fish to leave hatchery facilities when the fish are ready.

Water intake screen: A screen used to prevent entrainment of salmonids into a water diversion or intake. See also **Diversion screen**.

Watershed: An area of land where all of the water that is under it or drains off of it goes into the same place.

Weir: An adjustable dam placed across a river to regulate the flow of water downstream; a fence placed across a river to catch fish.

Yearling: Juvenile salmon or steelhead that has reared at least 1 year in the hatchery.

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Chapter 1

1 PURPOSE OF AND NEED FOR THE PROPOSED ACTION

1.1 Background

1.1.1 Administering the Endangered Species Act

NOAA's National Marine Fisheries Service (NMFS) is the lead agency responsible for administering the Endangered Species Act (ESA) 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 June 19, 2000, NMFS issued a final rule pursuant to ESA section 4(d) (4(d) Rule), adopting regulations necessary and advisable to conserve threatened species (50 Code of Federal Regulations [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 also sets forth specific circumstances when the prohibitions will not apply, known as 4(d) limits. With regard to hatchery programs described in hatchery and genetic management plans (HGMPs) (Box 1-1), NMFS declared under Limit 5 and Limit 6 of the 4(d) Rule that section 9 take prohibitions would not apply to activities carried out under those HGMPs when NMFS determines that the HGMPs meet the requirements of Limit 5 and, where applicable, Limit 6.

Box 1-1. What are hatchery and genetic management plans and hatchery resource management plans? What are the differences between hatchery programs and hatchery facilities?

Hatchery and Genetic Management Plans – Hatchery and genetic management plans, or HGMPs, are specific to the ESA and are outlined under Limit 5 of the 4(d) Rule. They are the plans that describe hatchery programs and reflect the fish species propagated, the main hatchery facility used, the life stage when the fish are released, and the location of fish releases. In general, several hatchery programs and their associated HGMPs may be associated with each primary hatchery facility. For example, the Dungeness Hatchery facilities support steelhead, spring Chinook salmon, coho salmon, and pink salmon programs described in four HGMPs (Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities).

Box 1-1. What are hatchery and genetic management plans and hatchery resource management plans? What are the differences between hatchery programs and hatchery facilities? (continued)

Resource Management Plans – Resource management plans, or RMPs, are also specific to the ESA and are outlined under Limit 6 of the 4(d) Rule. They can pertain to fishery management plans or hatchery management plans. HGMPs can serve as RMPs for hatchery programs. They are jointly prepared by the Washington Department of Fish and Wildlife and Puget Sound treaty tribes. The plans may encompass tribal, state, and Federal hatchery programs and facilities, which often operate in the same watersheds, exchange eggs, and share rearing space to maximize effectiveness.

Hatchery Programs and Facilities – Hatchery programs are defined by how the artificial production for individual species at facilities are managed and operated. Hatchery facilities are defined by the physical structures required for artificial production (e.g., hatchery buildings, adult holding or juvenile rearing ponds).

1.1.2 Hatchery and Genetic Management Plan Submittal

The Washington Department of Fish and Wildlife (WDFW) and Jamestown S'Klallam Tribe, Lummi Nation, Nooksack Tribe, Stillaguamish Tribe, and Tulalip Tribes as co-managers of the fisheries resource under *United States v. Washington* (1974) (hereafter referred to as "the co-managers") (Box 1-2), have provided NMFS with five HGMPs describing five hatchery programs for early returning (hereafter referred to as "early") winter steelhead and associated monitoring and evaluation actions in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins that affect ESA-listed Puget Sound Chinook salmon, Hood Canal summer chum salmon, and Puget Sound steelhead (Table 1) (Scott 2014). The HGMPs provide the frameworks through which the Washington State and Tribal jurisdictions can jointly and adaptively manage hatchery operations, monitoring, and evaluation activities, while meeting requirements specified under the ESA.

The co-managers developed the plans jointly, and have provided the HGMPs for review and determination by NMFS as to whether they address the criteria of Limit 6 of the 4(d) Rule, using the specific criteria for hatchery programs under Limit 5 of the 4(d) Rule. For the purposes of the proposed recommendation, NMFS considers the five joint HGMPs, submitted for consideration under Limit 6, to be a Resource Management Plan (RMP). For more information on the 4(d) Rule, see Subsection 1.5.3, NMFS's Determination as to Compliance with the 4(d) Rule.

Box 1-2. What is *United States v. Washington*, and what does it do?

United States v. Washington is the 1974 Federal court proceeding that enforces and implements treaty fishing rights for salmon and steelhead (and other species) returning to Puget Sound (and other areas). Fishing rights and access to fishing areas in Puget Sound were reserved in treaties that the Federal government signed with the tribes in the 1850s. Under *United States v. Washington*, the Puget Sound Salmon Management Plan is the implementation framework for the allocation, conservation, and equitable sharing principles defined in *United States v. Washington* that governs the joint management of harvest of salmon and steelhead resources between the Puget Sound treaty tribes and State of Washington. The joint hatchery RMPs reviewed in this EIS, and joint harvest RMPs such as the Puget Sound Chinook harvest management plan, are components of the Puget Sound Salmon Management Plan.

Table 1. HGMPs describing hatchery programs for five early winter steelhead hatchery programs (Dungeness River, Nooksack River, Stillaguamish River, Skykomish River, and Snoqualmie River).

Hatchery Program	Location	Facilities	Operator	HGMP Last Updated
Dungeness River Early Winter Steelhead Hatchery Program	Dungeness River Basin	Dungeness River Hatchery Hurd Creek Hatchery	WDFW	July 26, 2014
Kendall Creek Winter Steelhead Hatchery Program	Nooksack River Basin	Kendall Creek Hatchery McKinnon Pond	WDFW	July 26, 2014
Whitehorse Ponds Winter Steelhead Hatchery Program	Stillaguamish River Basin	Whitehorse Ponds Hatchery	WDFW	July 26, 2014
Snohomish/Skykomish Winter Steelhead Hatchery Program	Skykomish River Basin	Wallace River Hatchery Reiter Ponds	WDFW	November 25, 2014
Tokul Creek Winter Steelhead Hatchery Program	Snoqualmie River Basin	Tokul Creek Hatchery	WDFW	November 25, 2014

1.1.3 Related National Environmental Policy Act Reviews

NMFS conducted two previous NEPA analyses relevant to this EIS, specifically, a draft EIS reviewing two RMPs and appended HGMPs for Puget Sound salmon and steelhead hatcheries (i.e., Draft Environmental Impact Statement on Two Joint State and Tribal Resource Management Plans for Puget Sound Salmon and Steelhead Hatchery Programs – herein referred to as the PS Hatcheries DEIS [NMFS 2014a]) (79 Fed. Reg. 43465, July 25, 2014), subsequently terminated (80 Fed. Reg. 15986, March 26, 2015), and, a draft environmental assessment (EA) for three early winter steelhead programs in the Dungeness, Nooksack, and Stillaguamish River basins (i.e., Draft Environmental Assessment to Analyze the Impacts of NOAA's National Marine Fisheries Service Proposed 4(d) Determination Under Limit 4 for Three Early Winter Steelhead Hatchery Programs in the Dungeness, Nooksack, and Stillaguamish River Basins – herein referred to as the EWS Hatcheries DEA [NMFS 2015a]) (80 Fed. Reg. 15985, March 26, 2015). As discussed in the Federal Register Notice terminating review of two RMPs and appended HGMPs for hatchery programs in Puget Sound basin, NMFS determined that, following the public comment period on the PS Hatcheries DEIS (NMFS 2014a), NEPA analyses organized around smaller numbers of HGMPs would allow for a more detailed analyses of potential effects of individual HGMPs than the scope of review in the PS Hatcheries DEIS (NMFS 2014a). Additionally, analyses of all hatchery programs in the Puget Sound basin under one NEPA review is not necessary to fully consider effects of those programs. Although currently over 100 salmon and steelhead hatchery programs operate in the Puget Sound basin (Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities), they are not connected; they have different operators (e.g., state and tribal), do not rely on each other for their operation or justification, and recently either have been or are expected to be submitted by the co-managers to NMFS for approval generally on a watershed-specific basis. The combined effects of hatchery programs within the Puget Sound basin are addressed in this EIS in Chapter 5, Cumulative Effects.

Public comments on the EWS Hatcheries DEA (NMFS 2015a) lead NMFS to conclude that preparation of this EIS was warranted to analyze the same three early winter steelhead hatchery programs. Furthermore, in addition to the three hatchery programs analyzed in the EWS Hatcheries DEA (NMFS 2015a), this EIS includes HGMPs describing early winter steelhead hatchery programs in the Skykomish and Snoqualmie River basins. The five HGMPs were grouped into this EIS review because all five hatchery programs pertain to early winter steelhead and would affect similar resources.

This EIS incorporates information by reference from the PS Hatcheries DEIS (NMFS 2014a), including detailed discussions on the ESA (PS Hatcheries DEIS, Subsection 1.1.1, The Endangered Species Act) and take of listed species with specific information related to Puget Sound Hatchery RMPs and HGMPs and background on the use of hatcheries in Puget Sound (PS Hatcheries DEIS, Subsection 1.1.2, Take of a Listed Species). Other information incorporated by reference from the PS Hatcheries DEIS (NMFS 2014a) is summarized within various sections of this EIS.

1.2 Description of the Proposed Action

Under the Proposed Action, NMFS would make a determination that the HGMPs submitted as RMPs meet the requirements of Limit 6 of the 4(d) Rule. Activities included in the HGMPs are as follows:

- Broodstock collection through operation of weirs, fish traps, and collection ponds (Table 2)
- Transport of broodstock from Dungeness River Hatchery to Hurd Creek Hatchery
- Holding, identification, and spawning of adult fish at Dungeness River, Hurd Creek, Kendall Creek, Whitehorse Ponds, and Wallace River Hatcheries, Reiter Ponds, and Tokul Creek Hatchery (Table 2)
- Egg incubation at Dungeness River, Hurd Creek, Kendall Creek, Whitehorse Ponds, Wallace River, and Tokul Creek Hatcheries (Table 2)
- Fish rearing at Dungeness River, Hurd Creek, Kendall Creek, Whitehorse Ponds, Wallace River, and Tokul Creek Hatcheries, and McKinnon Pond and Reiter Ponds (Table 2)
- Clipping the adipose fin of 100 percent of the hatchery-origin juveniles prior to release
- Release of up to 10,000 steelhead yearlings into the Dungeness River basin, 150,000 steelhead yearlings into the Nooksack River basin, 130,000 steelhead yearlings into the Stillaguamish River basin, 256,000 steelhead yearlings into the Skykomish River basin, and 74,000 steelhead into the Snoqualmie River basin, for a total of 620,000 fish
- Removal of adult hatchery-origin steelhead returning to the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins at weirs, fish traps, and other collection facilities
- Monitoring and evaluation activities to assess the performance of the programs in meeting conservation, harvest augmentation, and listed fish risk minimization objectives (Table 2)

1 Table 2. Activities, hatchery facilities, and locations associated with five early winter steelhead
2 programs in Puget Sound.

Activity	Facility	Location	Does Facility Exist under Baseline Conditions?	Is Facility Operated under Baseline Conditions?
Broodstock collection	Dungeness River Hatchery	RM 10.5 on the Dungeness River	Yes	Yes
	Kendall Creek Hatchery	Located at the mouth of Kendall Creek (WRIA 01.0406), tributary to the NF Nooksack River (WRIA 01.0120) at RM 46	Yes	Yes
	Whitehorse Ponds Hatchery	Located at RM 1.5 of Whitehorse Springs Creek (WRIA 05.0254A), tributary to the NF Stillaguamish River (WRIA 05.0135) at RM 28	Yes	Yes
	Wallace River Hatchery	Wallace River (WRIA 07.0940), RM 4 at the confluence with May Creek (WRIA 07.0943); enters Skykomish River (WRIA 07.0012) at RM 36, which continues as Snohomish River at RM 20.51	Yes	Yes
	Reiter Ponds	Skykomish River (WRIA 07.0012) at RM 46, which continues as Snohomish River at RM 20.51	Yes	Yes
	Tokul Creek Hatchery	Located on Tokul Creek (WRIA 07.0440) at RM 0.5; tributary to Snoqualmie River (WRIA 07.0219) at RM 39.6; tributary to the Snohomish River (WRIA 07.0001) at RM 20.5	Yes	Yes
Spawning	Dungeness River Hatchery	RM 10.5 on the Dungeness River	Yes	Yes
	Kendall Creek Hatchery	Located at the mouth of Kendall Creek (WRIA 01.0406), tributary to the North Fork Nooksack River (WRIA 01.0120) at RM 46	Yes	Yes
	Whitehorse Ponds Hatchery	Located at RM 1.5 of Whitehorse Springs Creek (WRIA 05.0254A), tributary to the North Fork Stillaguamish River (WRIA 05.0135) at RM 28	Yes	Yes

Table 2. Activities, hatchery facilities, and locations associated with five early winter steelhead programs in Puget Sound (continued).

Activity	Facility	Location	Does Facility Exist under Baseline Conditions?	Is Facility Operated under Baseline Conditions?
	Wallace River Hatchery	Wallace River (WRIA 07.0940), RM 4 at the confluence with May Creek (WRIA 07.0943); enters Skykomish River (WRIA 07.0012) at RM 36, which continues as Snohomish River at RM 20.51	Yes	Yes
	Reiter Ponds	Skykomish River (WRIA 07.0012) at RM 46, which continues as Snohomish River at RM 20.51	Yes	Yes
	Tokul Creek Hatchery	Located on Tokul Creek (WRIA 07.0440) at RM 0.5; tributary to Snoqualmie River (WRIA 07.0219) at RM 39.6; tributary to the Snohomish River (WRIA 07.0001) at RM 20.5	Yes	Yes
Incubation	Dungeness River Hatchery	RM 10.5 on the Dungeness River	Yes	Yes
	Hurd Creek Hatchery	RM 0.2 on Hurd Creek, tributary to the Dungeness River at RM 2.7	Yes	Yes
	Kendall Creek Hatchery	Located at the mouth of Kendall Creek (WRIA 01.0406), tributary to the North Fork Nooksack River (WRIA 01.0120) at RM 46	Yes	Yes
	Whitehorse Ponds Hatchery	Located at RM 1.5 of Whitehorse Springs Creek (WRIA 05.0254A), tributary to the NF Stillaguamish River (WRIA 05.0135) at RM 28	Yes	Yes
	Wallace River Hatchery	Wallace River (WRIA 07.0940), RM 4 at the confluence with May Creek (WRIA 07.0943); enters Skykomish River (WRIA 07.0012) at RM 36, which continues as Snohomish River at RM 20.51	Yes	Yes
	Tokul Creek Hatchery	Located on Tokul Creek (WRIA 07.0440) at RM 0.5; tributary to Snoqualmie River (WRIA 07.0219) at RM 39.6; tributary to the Snohomish River (WRIA 07.0001) at RM 20.5	Yes	Yes

Table 2. Activities, hatchery facilities, and locations associated with five early winter steelhead programs in Puget Sound (continued).

Activity	Facility	Location	Does Facility Exist under Baseline Conditions?	Is Facility Operated under Baseline Conditions?
Rearing	Dungeness River Hatchery	RM 10.5 on the Dungeness River	Yes	Yes
	Hurd Creek Hatchery	RM 0.2 on Hurd Creek, tributary to the Dungeness River at RM 2.7	Yes	Yes
	Kendall Creek Hatchery	Located at the mouth of Kendall Creek (WRIA 01.0406), tributary to the North Fork Nooksack River (WRIA 01.0120) at RM 46	Yes	Yes
	McKinnon Pond	Located just downstream from the Mosquito Lake Road Bridge on the left bank of the Middle Fork Nooksack River with water from and outlet to a creek (WRIA 01.0352, known locally as "Peat Bog Creek"), which emanates from Peat Bog, tributary to Middle Fork Nooksack River (WRIA 01.0339) at RM 4.4.	Yes	Yes
	Whitehorse Ponds Hatchery	Located at RM 1.5 of Whitehorse Springs Creek (WRIA 05.0254A), tributary to the North Fork Stillaguamish River (WRIA 05.0135) at RM 28	Yes	Yes
	Wallace River Hatchery	Wallace River (WRIA 07.0940), RM 4 at the confluence with May Creek (WRIA 07.0943); enters Skykomish River (WRIA 07.0012) at RM 36, which continues as Snohomish River at RM 20.51	Yes	Yes
	Reiter Ponds	Skykomish River (WRIA 07.0012) at RM 46, which continues as Snohomish River at RM 20.51	Yes	Yes
	Tokul Creek Hatchery	Located on Tokul Creek (WRIA 07.0440) at RM 0.5; tributary to Snoqualmie River (WRIA 07.0219) at RM 39.6; tributary to the Snohomish River (WRIA 07.0001) at RM 20.5	Yes	Yes

Table 2. Activities, hatchery facilities, and locations associated with five early winter steelhead programs in Puget Sound (continued).

Activity	Facility	Location	Does Facility Exist under Baseline Conditions?	Is Facility Operated under Baseline Conditions?
Juvenile Fish Release	Dungeness River Hatchery	RM 10.5 on the Dungeness River	Yes	Yes
	Kendall Creek Hatchery	Located at the mouth of Kendall Creek (WRIA 01.0406), tributary to the NF Nooksack River (WRIA 01.0120) at RM 46	Yes	Yes
	Whitehorse Ponds Hatchery	Located at RM 1.5 of Whitehorse Springs Creek (WRIA 05.0254A), tributary to the NF Stillaguamish River (WRIA 05.0135) at RM 28	Yes	Yes
	Whitehorse fish in excess of release goals are released into various King and Snohomish County lakes for harvest.	Various lakes that are functionally isolated from anadromous-accessible freshwater	Yes	Yes
	Wallace River Hatchery	Wallace River (WRIA 07.0940), RM 4 at the confluence with May Creek (WRIA 07.0943); enters Skykomish River (WRIA 07.0012) at RM 36, which continues as Snohomish River at RM 20.51	Yes	Yes
	Reiter Ponds	Skykomish River (WRIA 07.0012) at RM 46, which continues as Snohomish River at RM 20.51	Yes	Yes
	Tokul Creek Hatchery	Located on Tokul Creek (WRIA 07.0440) at RM 0.5; tributary to Snoqualmie River (WRIA 07.0219) at RM 39.6; tributary to the Snohomish River (WRIA 07.0001) at RM 20.5	Yes	Yes
	Tokul Creek fish in excess of release goals are released into various King County lakes for harvest.	Various lakes that are functionally isolated from anadromous-accessible freshwater	Yes	Yes

Table 2. Activities, hatchery facilities, and locations associated with five early winter steelhead programs in Puget Sound (continued).

Activity	Facility	Location	Does Facility Exist under Baseline Conditions?	Is Facility Operated under Baseline Conditions?
Monitoring and evaluation	Dungeness River Hatchery	RM 10.5 on the Dungeness River	Yes	Yes
	Hurd Creek Hatchery	RM 0.2 on Hurd Creek, tributary to the Dungeness River at RM 2.7	Yes	Yes
	Kendall Creek Hatchery	Located at the mouth of Kendall Creek (WRIA 01.0406), tributary to the NF Nooksack River (WRIA 01.0120) at RM 46	Yes	Yes
	Whitehorse Ponds Hatchery	Located at RM 1.5 of Whitehorse Springs Creek (WRIA 05.0254A), tributary to the NF Stillaguamish River (WRIA 05.0135) at RM 28	Yes	Yes
	Wallace River Hatchery	Wallace River (WRIA 07.0940), RM 4 at the confluence with May Creek (WRIA 07.0943); enters Skykomish River (WRIA 07.0012) at RM 36, which continues as Snohomish River at RM 20.51	Yes	Yes
	Reiter Ponds	Skykomish River (WRIA 07.0012) at RM 46, which continues as Snohomish River at RM 20.51	Yes	Yes
	Tokul Creek Hatchery	Located on Tokul Creek (WRIA 07.0440) at RM 0.5; tributary to Snoqualmie River (WRIA 07.0219) at RM 39.6; tributary to the Snohomish River (WRIA 07.0001) at RM 20.5	Yes	Yes
	Watershed areas accessible to natural salmon and steelhead migration, spawning and rearing	Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basin areas, including tributaries, extending from the river mouths through the upstream extent of anadromous fish access.	N/A	N/A

Sources: WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e.

RM: River mile, measured from the farthest downstream point on the stream in question.

WRIA: Water Resources Inventory Area, typically defining geographic areas where surface-water run-off drains into a common surface-water body, such as a lake, section of a stream, or a bay.

1.3 Purpose of and Need for the Proposed Action

This EIS identifies the purpose and need for the NMFS action as well as that of the state and tribal fisheries co-managers.

NMFS's purpose for the Proposed Action is to ensure the sustainability and recovery of Puget Sound salmon and steelhead by conserving the productivity, abundance, diversity, and distribution of listed species of salmon and steelhead in Puget Sound.

NMFS's need for the Proposed Action is to:

- Respond to the co-managers' request for an exemption from take prohibitions of section 9 of the ESA for their hatchery programs triggered by submission of HGMPs as RMPs under Limit 6 of the 4(d) Rule.
- Provide, as appropriate, tribal and non-tribal fishing opportunities as described under the state and tribal co-managers' Puget Sound Salmon Management Plan implemented under *United States v. Washington*.

The co-managers' purpose in developing and submitting HGMPs as RMPs under Limit 6 is 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 ESA's 4(d) Rule.

The co-managers' need for the Proposed Action is to continue to maintain and operate salmon and steelhead hatchery programs using existing facilities for conservation, mitigation, and tribal and non-tribal fishing opportunity pursuant to the Puget Sound Salmon Management Plan implemented under *United States v. Washington*, and treaty rights preservation purposes while meeting ESA requirements.

WDFW and the Puget Sound treaty tribes strive to protect, restore, and enhance the productivity, abundance, and diversity of Puget Sound salmon and steelhead 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.

As described in Box 1-3, NMFS has an obligation to administer the provisions of the ESA and to protect listed salmon and steelhead, and also has a Federal trust responsibility to treaty Indian tribes. Thus, NMFS seeks to harmonize the reduction in the negative effects of hatchery programs with the provision of hatchery-origin fish for tribal harvest and for conservation purposes.

Box 1-3. How does NMFS harmonize its conservation mandate under the ESA with stewardship of treaty Indian fishing rights?

In addition to the biological requirements for conservation under the ESA, NMFS has a Federal trust responsibility to treaty Indian tribes. In recognition of its treaty rights stewardship obligation and consistent with Secretarial Order 3206 (see Subsection 1.7.7, Secretarial Order 3206), NMFS, as a matter of policy, will make every effort to harmonize the protection of listed species and the provision for tribal fishing opportunity. NMFS recognizes that the treaty tribes have a right to conduct their fisheries within the limits of conservation constraints. Because of the Federal government's trust responsibility to the tribes, NMFS is committed to considering the tribal co-managers' judgment and expertise regarding conservation of trust resources. Limit 6 of the 4(d) Rule explicitly requires this. However, the opinion of tribal co-managers and their immediate interest in fishing must be balanced with NMFS' responsibilities under the ESA.

This EIS will not document whether specific actions of hatchery programs meet the requirements of Limit 6 of the 4(d) Rule under the ESA. Those ESA decisions will be made in separate processes consistent with applicable regulations as required by the ESA.

1.4 Project and Analysis Areas

The project area is the geographic area where the Proposed Action would take place. It includes the places where the proposed steelhead hatchery programs would (1) collect broodstock; (2) spawn, incubate, and rear fish; (3) release fish; or (4) remove surplus hatchery-origin adult steelhead that return to hatchery facilities; and (5) conduct monitoring and evaluation activities. The project area includes the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins, as well as the following hatchery and satellite facilities and their immediate surroundings:

- Dungeness River Hatchery
- Hurd Creek Hatchery
- Kendall Creek Hatchery
- McKinnon Pond
- Whitehorse Ponds
- Wallace River Hatchery
- Reiter Ponds
- Tokul Creek Hatchery

The analysis area is the geographic extent that is being evaluated for a particular resource. For some resources, the analysis area may be larger than the project area, since some of the effects of the alternatives may occur outside the project area. The analysis area is described at the beginning of Chapter 3, Affected Environment, for each resource.

1.5 Decisions to be Made

NMFS must decide on the following before the Proposed Action can be implemented:

- The preferred alternative following an analysis of all alternatives in this EIS and review of public comment on the EIS
- Whether the Proposed Action complies with ESA criteria under the section 4(d) Rule

1.5.1 Preferred Alternative to be Identified in the Final EIS

A preferred alternative is not identified in this draft EIS; it will be identified in the final EIS. The preferred alternative for all programs could be the Proposed Action, or it could be comprised of components of the alternatives evaluated in the final EIS. Information from the public review process will be used in selecting a preferred alternative.

1.5.2 Record of Decision

This NEPA process will culminate in a Record of Decision (ROD) that will record the selected alternative. The ROD will identify the environmentally preferred alternative; describe the preferred alternative and the selected alternative; and summarize the impacts expected to result from implementation of the selected alternative. As for the preferred alternative in the final EIS, the selected alternative in the ROD could be the preferred alternative or could be comprised of components of alternatives evaluated in the final EIS. The ROD will also consider comments on the final EIS. The ROD will be completed after public review and comment on the final EIS, and after the ESA determinations and associated public review processes are completed.

1.5.3 NMFS's Determination as to Compliance with the 4(d) Rule

Discussions between the co-managers and NMFS during development of hatchery RMPs are conducted with the knowledge and understanding that the specific criteria under Limit 5 and Limit 6 of the 4(d) Rule must be met before take coverage under the ESA can be issued. Criteria for ESA evaluation of HGMPs that form RMPs submitted under Limit 6 are the same as for Limit 5 (Artificial Propagation). HGMPs must:

1. Specify the goals and objectives for the hatchery program.
2. Specify the donor population's critical and viable threshold levels.
3. Prioritize broodstock collection programs to benefit listed fish.

4. Specify the protocols that will be used for spawning and raising the hatchery-origin fish.
5. Determine the genetic and ecological effects arising from the hatchery program.
6. Describe how the hatchery operation relates to fishery management.
7. Ensure that the hatchery facility can adequately accommodate listed fish if collected for the program.
8. Monitor and evaluate the management plan to ensure that it accomplishes its objective.
9. Be consistent with tribal trust obligations (65 Fed. Reg. 42422, July 10, 2000).

NMFS has a limited role (i.e., approve or deny) under Limit 6 of the 4(d) Rule. The decision as to whether the ESA 4(d) Rule Limit 5 and Limit 6 criteria have been met will be documented in NMFS's ESA decision documents at the end of the ESA evaluation process. Included with the ESA decision documents will be responses to comments on the HGMPs received during public review as required by the 4(d) Rule.

1.5.4 Biological Opinion on NMFS's Determination as to Compliance with the 4(d) Rule

ESA section 7(a)(2) provides that any action authorized, funded, or carried out by a Federal agency shall not jeopardize the continued existence of any endangered or threatened species or result in the adverse modification or destruction of designated critical habitat. NMFS's actions under section 4(d) are Federal actions, and NMFS must comply with section 7(a)(2). NMFS's consultations under section 7 on those actions may be informed by this NEPA analysis. The results of these consultations are documented in biological opinions developed by NMFS and the U.S. Fish and Wildlife Service (the Services) for the species under their jurisdiction. Biological opinions are produced near the end of the ESA evaluation and determination process, providing the Services conclusions regarding the likelihood that the proposed hatchery actions will jeopardize the continued existence of any listed species or adversely modify designated critical habitat for any listed species.

1.6 Scoping and Relevant Issues

The first step in preparing an EIS is to conduct scoping of the issues that may be associated with the Proposed Action. This occurs through internal agency and public scoping processes. The purpose of that scoping is to identify the relevant human environmental issues, to eliminate insignificant issues from detailed study, and to identify the alternatives to be analyzed in the EIS. Scoping can also help determine the level of analysis and the types of data required for analysis.

1.6.1 Scoping Process

This EIS involved activities that included both internal and public scoping that are described in the following paragraphs.

1.6.2 Internal Scoping

NMFS initially conducted internal project scoping on early winter steelhead hatchery programs in 2014, as part of the process of developing the draft EA for three early winter steelhead hatchery programs, and convened later, internal-only, meetings for the process of developing this EIS. Internal scoping for this EIS was informed by public comments on previous NEPA analyses including the PS Hatcheries DEIS (NMFS 2014a) and the EWS Hatcheries DEA (NMFS 2015a).

A review of available NEPA analyses of salmon and steelhead hatchery programs in Puget Sound watersheds including the PS Hatcheries DEIS (NMFS 2014a) and EWS Hatcheries DEA (NMFS 2015a), the Final Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Five Hatchery Programs for Elwha River Salmon and Steelhead as Described in Joint State-Tribal Hatchery and Genetic Management Plans and One Tribal Harvest Plan Satisfy the Endangered Species Act Section 4(d) Rule – herein referred to as the Elwha FEA (NMFS 2012) (77 Fed. Reg. 75611, December 21, 2012), Final Supplemental Environmental Assessment to Analyze Impacts of NOAA's National Marine Fisheries Service Determination that Five Hatchery Programs for Elwha River Salmon and Steelhead as Described in Joint State-Tribal Hatchery and Genetic Management Plans and One Tribal Harvest Plan Satisfy the Endangered Species Act 4(d) Rule – herein referred to as the Elwha FSEA (NMFS 2014b) (79 Fed. Reg. 35318, June 20, 2014), and Draft Environmental Assessment to Analyze the Impacts of NOAA's National Marine Fisheries Service Determination that Three Hatchery Programs for Dungeness River Basin Salmon as Described in Joint State-Tribal Hatchery and Genetic Management Plans Satisfy the Endangered Species Act Section 4(d) Rule – herein referred to as Dungeness Hatcheries DEA (NMFS 2015b) (80 Fed. Reg. 9260, February 20, 2015), found that the proposed actions had negligible effects on some resources or parts of resources. These resources were wildlife, water quality, and human health. Analyses of these resources in the above documents are incorporated by reference; further analyses were not proposed to be reviewed in Chapter 3, Affected Environment, and Chapter 4, Environmental Consequences, in this EIS.

1.6.3 Notices of Public Scoping

Public scoping for this EIS commenced with publication of a Notice of Intent in the Federal Register on July 14, 2015 (80 Fed. Reg. 41011, July 14, 2015). That notice started a 30-day public comment period (July 14, 2015, to August 13, 2015) to gather information on the scope of the issues and the range of alternatives to be analyzed in the EIS. NMFS developed a website for the EIS at http://www.westcoast.fisheries.noaa.gov/hatcheries/salmon_and_steelhead_hatcheries.html. The website was available during the scoping period and will be updated and available throughout the project duration.

During 2015, NMFS held two public scoping workshops in the project area, in Mount Vernon (on July 20), and in Lynnwood (on July 21), Washington. Presentations were made by NMFS personnel, and a question-and-answer session followed. At these workshops, NMFS provided clarifying information and requested that public comments be submitted on issues and alternatives associated with the project. Notifications about the workshops, the public scoping process, and the EIS schedule were distributed in a press release and in emails to a list of over 2,000 addresses that had been compiled from people that commented on the EWS Hatcheries DEA (NMFS 2015a) and PS Hatcheries DEIS (NMFS 2014a). Electronic and other notifications were sent to agencies, private individuals, businesses, and non-governmental organizations, which contained a link to the website for this EIS and the address to the EIS electronic mailbox. Invitations to attend the public workshops were also advertised through a NMFS press release and on applicable organization and agency websites.

1.6.4 Written Comments

Written comments received on this EIS during the public scoping process included:

- 1 from a governmental agency
- 1 from a tribal organization
- 5 from non-governmental organizations
- 639 from individual citizens

1.6.5 Issues Identified During Scoping

Based on all input received during the scoping process and the purpose and need for the Proposed Action, input relevant to development of EIS alternatives include:

- Modify hatchery programs to help conserve species listed under the ESA.
- Modify hatchery programs to provide more fishing opportunities for steelhead.

Comments from public scoping were also received on resources to be analyzed, the importance of habitat to steelhead, and new information. Scoping identified water quantity, salmon and steelhead, Southern Resident killer whales, socioeconomics, and environmental justice as the resources to be analyzed, along with cumulative effects. Scoping comments emphasized the importance of habitat to natural-origin steelhead, life history and adult return-timing considerations, and identified recently available information (e.g., steelhead genetic data from WDFW, and Salish Sea juvenile steelhead survival studies) to be considered in the EIS.

1.6.6 Future Public Review and Comment

Under NEPA, this draft EIS has been issued for a 45-day public review period, which was announced in newspapers, through electronic distribution to interested parties, and by publication in the Federal Register. Following this public review period, responses to public comments will be prepared and included in the final EIS (Table 3). Responses will identify any changes to the EIS resulting from public comments, as warranted. Following a 30-day public review period for the final EIS, the ROD (Subsection 1.5.2, Record of Decision) will be signed and made publicly available.

Under the ESA 4(d) Rule Limit 6, NMFS will prepare Pending Evaluation and Proposed Determination (PEPD) documents for the proposed RMPs. The PEPD documents will be made available for public review and comment (Table 3).

To the extent that HGMPs reviewed in this EIS substantively change over time in response to new information or proposed actions, additional NEPA and ESA compliance may be warranted. The nature and extent of changes to plans or new information will determine the type of additional NEPA and ESA compliance that may be needed. Subsequent public review opportunities may be warranted as part of these additional NEPA and ESA reviews.

Table 3. NMFS documents and decisions required under the ESA and NEPA regarding early winter steelhead hatchery programs, public notices, and comment opportunities.

Determination	Federal Register Notice of Intent and Public Scoping Comment Period	Federal Register Notice of Availability and Public Comment Period	Federal Register Notice of Availability and Public Access/Review	Decision Document
ESA				
NMFS 4(d)		Pending Evaluation and Determination (30-day comment period)		Evaluation and Recommendation Determination[1]
NMFS BiOp[2]				Signed BiOp
USFWS BiOp				Signed BiOp
NEPA				
EIS[3]	Notice of Intent (30-day comment period)	Draft EIS (45-day comment period)	Final EIS (30-day "cooling off" period)	Record of Decision
Progression of Steps for Each Determination	Start →			End

[1] Notification of decision published in Federal Register.
[2] BiOp = Biological Opinion under section 7 of the ESA.
[3] EIS = Environmental Impact Statement.

1.7 Relationship to Other Plans and Policies

In addition to NEPA and ESA, other plans, regulations, agreements, treaties, laws, and Secretarial and Executive Orders also affect hatchery operations in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. They are summarized below to provide additional context for the hatchery programs and their proposed HGMPs (see Box 1-1).

1.7.1 Clean Water Act

The Clean Water Act (33 USC 1251, 1977, as amended in 1987), administered by the U.S. Environmental Protection Agency and state water quality agencies, is the principal Federal legislation directed at protecting water quality. Each state implements and carries forth Federal provisions, as well as approves and reviews National Pollutant Discharge Elimination System (NPDES) applications, and establishes total maximum daily loads for rivers, lakes, and streams. The states 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, codified as Revised Code of Washington 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) 173. Hatchery operations are required to comply with the Clean Water Act.

1.7.2 Bald Eagle and Golden Eagle Protection Act

The Bald Eagle and Golden Eagle Protection Act (16 USC. 668-668c), enacted in 1940, and amended several times since then, 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, 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.” Changes in hatchery production have the potential to affect eagle productivity through changes in its salmon and steelhead prey sources.

1.7.3 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972 (16 USC 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 MMPA.

The MMPA prohibits, with certain exceptions, the take of marine mammals in United States waters and by United States citizens 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 MMPA, means to "harass, hunt, capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal." The MMPA 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."

NMFS is responsible for reviewing Federal actions for compliance with the MMPA. Changes in fish production can indirectly affect marine mammals by altering the number of available salmon and steelhead prey sources.

1.7.4 Executive Order 12898

In 1994, the President issued Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority and Low-income Populations*. 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. Changes in hatchery production have the potential to affect the extent of harvest available for minority and low-income populations.

1.7.5 Treaties of Point Elliot, 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. 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 Lummi Nation, Nooksack Tribe, Stillaguamish Tribe, and Tulalip Tribes are signatory to the Treaty of Point Elliot, the lands settlement treaty between the United States government and the Native American tribes of the North Puget Sound and Strait of Georgia regions, in the recently-formed Washington Territory. The Treaty of Point Elliot was signed on January 22, 1855, at Muckl-te-oh or Point Elliott, now Mukilteo, Washington.

The Jamestown S'Klallam Tribe is signatory to the Treaty of Point No Point, the lands settlement treaty between the United States government and the Native American tribes of the Strait of Juan de Fuca and Hood Canal regions (then, the S'Klallam, the Chimakum, and the Skokomish Tribes), also in the recently-formed Washington Territory. The Treaty of Point No Point was signed on January 26, 1855, at Hahdskus – the Salish dialect name for Point No Point – on the northern tip of the Kitsap Peninsula.

1.7.6 *United States v. Washington*

Salmon and steelhead fisheries within the project area are jointly managed by the 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 regards to salmon and steelhead returning to Puget Sound. Hatcheries in Puget Sound provide salmon and steelhead for these fisheries. Without many of these hatcheries, there would be few, if any, fish for the tribes to harvest (Stay 2012; NWIFC 2013). These fishing rights and attendant access were established by treaties that the Federal government signed with the tribes in the 1850s. In those treaties, the tribes agreed to allow the peaceful settlement of Indian lands in western Washington in exchange for their continued right to fish, gather shellfish, hunt, and exercise other sovereign rights. Under Phase II of *United States v. Washington*, the Federal District Court ensured tribes the rights to the protection of fish habitat subject to treaty catch and a right to the fish that are produced by hatcheries. 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.

1.7.7 Secretarial Order 3206

Secretarial Order 3206 (*American Indian Tribal Rights, Federal-Tribal Trust Responsibilities and the ESA*, http://www.nmfs.noaa.gov/sfa/reg_svcs/Councils/Webinar/secretarial_order.pdf) issued by the secretaries of the Departments of Interior and Commerce, 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 Secretarial 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, NMFS and the U.S. Fish and Wildlife Service (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."

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 has 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."

1.7.8 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*, 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 of the United States as the trust corpus (Cohen 2005; Newton et al. 2005). 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).

1.7.9 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 steel head 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*."

1.7.10 Washington State Endangered, Threatened, and Sensitive Species Act

This EIS will consider the effects of hatchery programs and harvest actions on state endangered, threatened, and sensitive species. The State of Washington has species of concern listings (Washington Administrative Code Chapters 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 prevent them from becoming endangered, threatened, or sensitive. The state-listed species are identified on WDFW's website (http://wdfw.wa.gov/conservation/endangered/lists/); the most recent update occurred in May 2015. The criteria for listing and de-listing, and the requirements for recovery and management plans for these species are provided in WAC Chapter 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 Chapter 222-16-080. Species listed under the state endangered, threatened, and sensitive species list are reviewed in this EIS if actions could affect these species.

1.7.11 Hatchery and Fishery Reform Policy

WDFW's Hatchery and Fishery Reform Policy (Policy C-3619) was adopted by the Washington Fish and Wildlife Commission in 2009 (WFWC 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 state hatcheries and its intent is to improve hatchery effectiveness, ensure compatibility between hatchery production and salmon recovery plans and rebuilding programs, and support sustainable fisheries.

1.7.12 Recovery Plans for Puget Sound Salmon and Steelhead

Federal recovery plans are in place for the ESA-listed Puget Sound Chinook Salmon (SSPS 2007; 72 Fed. Reg. 2493, January 19, 2007) and Hood Canal Summer Chum Salmon ESUs (Hood Canal Coordinating Council 2005; 72 Fed. Reg. 29121, May 24, 2007). Broad partnerships of Federal, state, local, and tribal governments and community organizations collaborated in the development of the two completed salmon recovery plans under Washington's Salmon Recovery Act. The comprehensive recovery plans include conservation goals and proposed habitat, hatchery, and harvest actions needed to achieve the conservation goals for each watershed within the geographic boundaries of the two listed ESUs. Although the Puget Sound Steelhead DPS was listed in 2007, a recovery plan has not yet been completed, but is currently in the process of assembly. It is projected to be completed in 2017 (http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/puget_sound/overview_puget_sound_steelhead_recovery_2.html).

1.7.13 Federal Wilderness Act

The 1964 Wilderness Act directs Federal agencies to manage wilderness so as to preserve its wilderness character. Lands classified as wilderness through the Wilderness Act may be under the jurisdiction of the U.S. Forest Service, National Park Service, U.S. Fish and Wildlife Service, or the U.S. Bureau of Land Management. With some exceptions, the Wilderness Act prohibits motorized and mechanized vehicles, timber harvest, new grazing and mining activity, or any kind of development. In 1988, Congress designated 95 percent of the Olympic National Park as wilderness under the Wilderness Act. The Olympic Wilderness Area is under the jurisdiction of the National Park Service. Some of the Dungeness River basin is within the Olympic Wilderness Area and within the Buckhorn Wilderness Area. All three forks of the Nooksack River originate in the Mount Baker Wilderness. One tributary of the Stillaguamish River – Boulder River – originates in the Boulder River Wilderness Area. Parts of the Skykomish River originate in the Henry M. Jackson Wilderness Area and the Wild Sky Wilderness Area. Parts of the Snoqualmie River originate in the Alpine Lakes Wilderness Area.

1.8 Organization of this Draft EIS

This EIS has been prepared in accordance with NEPA (40 CFR 1500 to 1508) and with the NEPA implementing regulations adopted by NMFS (NOAA 1999). The EIS should be reviewed in conjunction with the co-managers' HGMPs for the five early winter steelhead hatchery programs (http://wdfw.wa.gov/hatcheries/hgmp/2012_puget_sound.html), which contain more detailed information and explanations of hatchery programs affecting Puget Sound resources. Links to online sources of information used in the EIS are active at the time of publication; however, NMFS cannot guarantee that they will remain active over time. The contents of this draft EIS are described briefly below:

- **Introductory Materials**. Prior to Chapter 1 are a cover sheet, summary, list of acronyms, glossary of key terms, and table of contents.
- **Chapter 1**. This chapter provides the background and context leading to the development of the Proposed Action. It describes the purpose and need for the action; background and decisions to be made; scoping and relevant issues; and the relationship of this action to other plans, regulations, and laws.
- **Chapter 2**. This chapter describes each of the alternatives and lists their major components. The No-action Alternative is included, along with three action alternatives, including the Proposed Action, and alternatives considered but not analyzed in detail.
- **Chapter 3**. This chapter describes the existing environmental setting that would be affected by the alternatives (i.e., existing conditions). It includes subsections on water quantity, salmon and steelhead, wildlife (Southern Resident killer whales), socioeconomics, and environmental justice resources.
- **Chapter 4**. This chapter contains a description and analyses of the potential direct and indirect effects of each alternative on the resources identified in Chapter 3. It also compares the action alternatives to the No-action Alternative.
- **Chapter 5**. This chapter addresses cumulative impacts, which are the incremental effects of an action when added to other past, present, and reasonably foreseeable actions, regardless of what agency or person undertakes such actions. Climate change is addressed in this chapter.
- **Remaining Material**. This material includes a list of references, distribution list, list of preparers, and appendices.

Chapter 2

2 ALTERNATIVES INCLUDING THE PROPOSED ACTION

This chapter describes the four alternatives evaluated in this EIS. The alternatives are fully described in this chapter, and their environmental effects are presented in Chapter 4, Environmental Consequences. Specifically, this chapter describes the following:

- How the alternatives were developed
- Alternatives that were analyzed in detail
- Alternatives that were considered but eliminated from detailed analysis
- The process for developing a preferred alternative and an environmentally preferred alternative

2.1 Development of Alternatives

In 2015, NMFS solicited and considered public comment on the development of alternatives for this EIS (Subsection 1.6, Scoping and Relevant Issues). Two workshops were convened by NMFS and included the general public, the co-managers, and NMFS staff to discuss issues associated with possible EIS alternatives. In the Notice of Intent to develop this EIS (80 Fed. Reg. 41011, July 14, 2015), NMFS identified four alternatives for possible analysis: the Proposed Action (NMFS's approval under the ESA of implementation of the co-managers' HGMPs), no action (no hatchery releases of early winter steelhead), a 50 percent decrease in number of early winter hatchery-origin steelhead released, and a change in program type such that they would transition to use of locally-returning native steelhead as broodstock.

The public scoping process (Subsection 1.6, Scoping and Relevant Issues) identified 11 potential alternatives, including those proposed in the Notice of Intent. Of these 11 alternatives, 4 were found to represent the full range of reasonable alternatives because their components differed meaningfully from the other alternatives analyzed. The three alternatives other than the No-action Alternative meet the purpose and need for the Proposed Action. Seven potential alternatives were carefully considered but eliminated from detailed analysis because (1) they are already encompassed by other alternatives analyzed in detail and thus would not provide substantive new information for the decision-maker to consider, or (2) do not meet the purpose and need for the Proposed Action.

2.2 Alternatives Analyzed in Detail

Four alternatives are considered in this EIS: (1) NMFS would not make a determination under the 4(d) Rule (No Action); (2) NMFS would make a determination that the submitted HGMPs meet requirements of the 4(d) Rule (Proposed Action); (3) NMFS would make a determination that revised HGMPs with reduced production levels would meet requirements of the 4(d) Rule (Reduced Production); (4) NMFS would make a determination that revised HGMPs that replace Chambers Creek stock with a native broodstock meet requirements of the 4(d) Rule (Native Broodstock). These alternatives are described below.

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 for any of the five HGMPs, and WDFW would discontinue its early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. All steelhead currently being raised within the proposed hatchery programs would be killed, and no additional broodstock would be collected. This No-action Alternative represents NMFS's best estimate of what would happen in the absence of the Proposed Action – a determination that the co-managers' submitted HGMPs meet requirements of the 4(d) Rule.

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

Under this alternative, NMFS would make a determination that the HGMPs submitted by the co-managers meet requirements of the 4(d) Rule. The early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be implemented as described in the five submitted HGMPs (WDFW 2014a, WDFW 2014b, and WDFW 2014c, WDFW 2014d, WDFW 2014e).

Under Alternative 2, the total annual maximum release level would be 620,000 steelhead yearlings into the following river basins:

- Dungeness River basin: up to 10,000 steelhead yearlings
- Nooksack River basin: up to 150,000 steelhead yearlings
- Stillaguamish River basin: up to 130,000 steelhead yearlings
- Skykomish River basin: up to 256,000 steelhead yearlings
- Snoqualmie River basin: up to 74,000 steelhead yearlings

The hatchery programs would utilize existing hatchery capacity for operations, and would be adaptively managed over time to incorporate best management practices as new information is available. These may include practices such as reducing release levels during times of extremely poor ocean survival, or developing water re-use or recirculation systems, or contingency plans for hatchery operations at times of low flow and high water temperature.

2.2.3 Alternative 3 (Reduced Production) – Make a Determination that Revised HGMPs with Released Production Levels Meet Requirements of the 4(d) Rule

Under this alternative, WDFW would reduce the number of fish released from each of the five proposed hatchery programs. Revised HGMPs would be submitted reflecting these reduced production levels, and NMFS would make a determination that the revised HGMPs meet the requirements of the 4(d) Rule.

For the purposes of analysis, NMFS will evaluate a 50 percent reduction from the proposed hatchery program (310,000 steelhead yearlings) because it represents a mid-point between the Proposed Action (Alternative 2) and the No-action Alternative (Alternative 1). Note that NMFS's 4(d) regulations do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs. NMFS's 4(d) regulations require NMFS to make a determination that the HGMPs *as proposed* either meet or do not meet the standards prescribed under Limit 5 and Limit 6 under the 4(d) Rule. Nonetheless, NMFS supports analysis of this alternative to assist with a full understanding of potential effects on the human environment under various management scenarios.

2.2.4 Alternative 4 (Native Broodstock) - Make a Determination that Revised HGMPs that Replace Chambers Creek Stock with a Native Broodstock Meet Requirements of the 4(d) Rule

Under this alternative, WDFW would change its program management to transition the programs from the current non-native Chambers Creek stock to broodstock derived from fish native to the respective watershed in the project area. While this could be done in multiple ways, involving different periods of time and various objectives, for the purpose of this analysis NMFS assumes that use of Chambers Creek stock fish in the broodstock would be terminated immediately. Fish taken for broodstock would then only be those determined to be native to the given watershed.

Broodstock collection would be contingent upon availability of natural-origin fish, ensuring first that an appropriate minimum number of fish would be able to spawn naturally; after that critical threshold is ensured, then a proportion of additional returns would be taken into the hatchery facilities. Broodstock collection would occur through fish volunteering to the hatcheries, but might also require additional collection methods, including at weirs, via hook and line, or through seining. The Proportionate Natural Influence (PNI, described in Subsection 3.2.3.1, Genetic Risks) would be 0.67 or higher, and no more than 10 percent of the naturally spawning fish in the river would be hatchery-origin spawners.

Note that NMFS's 4(d) regulations do not provide NMFS with the authority to order changes of this magnitude as a condition of approval of the HGMPs. NMFS's 4(d) regulations 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 supports analysis of 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 additional seven alternatives identified during scoping (Subsection 1.6, Scoping and Relevant Issues), were carefully considered, but NMFS determined that (1) they are already encompassed by other alternatives analyzed in detail and thus would not provide substantive new information for the decision-maker to consider, or (2) do not meet the purpose and need for the Proposed Action (Subsection 1.3, Purpose of and Need for the Proposed Action).

- <u>Hatchery programs with greater levels of hatchery production than those proposed</u> – Under this potential alternative, WDFW would revise its HGMPs to incorporate higher production levels than those proposed. This alternative is not analyzed in detail because higher production levels would be expected to have incrementally higher environmental impacts than production levels under the Proposed Action, and thus would not meet the element of the purpose and need regarding compliance with the ESA. Specifically, a criterion that NMFS considers for approval of an HGMP under the 4(d) Rule is whether the HGMP "evaluates, minimizes, and accounts for the propagation program's genetic and ecological effects on natural populations . . . .". WDFW has submitted HGMPs that it believes "minimize" such effects; presumably programs with greater effects would not do so. In addition, the increased production levels would require additional capacity and development of additional hatchery facilities, which would not meet the purpose of and need for action, which includes use of existing capacity.

- <u>Implement all Hatchery Scientific Review Group (HSRG) recommendations</u> – This potential alternative would implement all recommendations made by the HSRG as an action alternative. The Washington Recreation and Conservation Office (RCO 2014) indicates that continuing and substantial progress has been made in increasing the percentage of WDFW's Puget Sound steelhead hatchery programs that meet HSRG standards (92 percent of the programs met HSRG standards in 2014). In addition, the co-managers intend to continue to implement HSRG recommendations over time using adaptive management under the Proposed Action. Thus, this potential alternative will not be analyzed in detail because it would not be substantially different from the Proposed Action.

- Confine early winter steelhead programs to pHOS less than 2 percent – Included under this potential alternative would be early winter steelhead programs having percentages of hatchery-origin spawners (pHOS) based on census methods demonstrated to be less than 2 percent (or pHOS of 5 percent maximum, regardless of effective pHOS). The pHOS metric reflects levels of hatchery-origin spawners in natural spawning areas. The co-managers, especially WDFW as a matter of policy, use pHOS to help keep genetic risks to natural-origin salmon and steelhead from hatchery programs within acceptable limits. The Proposed Action involves early winter steelhead hatchery programs that already are at or are close to those limits, and also involves rigorous genetic monitoring to detect how well the programs perform in relation to the targeted limits. Therefore, this potential alternative will not be analyzed in detail because it would not be measurably different from the Proposed Action.

- Release levels no greater than in recent years – Under this potential alternative, numbers of early winter steelhead released would be no greater than what has occurred in recent years. Release levels under the Proposed Action reflect recent steelhead program reductions and discontinuations. Thus, this potential alternative will not be analyzed in detail because it would not be measurably different from the Proposed Action.

- Production levels same as Proposed Action, but suspend releases from programs having the lowest marine survival during periods of extremely low marine survival – Under this potential alternative, early winter steelhead hatchery programs would produce hatchery fish at the same levels as under the Proposed Action; however, in years in which marine survival is extremely low, production would be suspended from programs displaying the poorest marine survival. Such practices and other best management practices would occur under the Proposed Action. Furthermore, reductions in production levels are analyzed under Alternative 3 (Reduced Production). Therefore, this potential alternative will not be analyzed in detail because it would not be measurably different from other alternatives analyzed in detail.

- Maximize recovery potential for listed species – Under this potential alternative, early winter steelhead hatchery programs would be designed to reduce risks to and increase benefits for recovery of listed species. Under the No-action Alternative, early winter steelhead hatchery programs would be terminated, effectively eliminating risks to listed species from the programs. Under Alternative 4 (Native Broodstock), early winter steelhead programs would be terminated, and new steelhead programs using local, native broodstock would be developed, consistent with the status of the listed natural-origin populations in the respective watershed. These new programs would be carefully implemented and managed under the ESA to minimize risks to the listed hatchery and natural-origin fish, and could contribute to the viability of the local natural-origin steelhead populations. Therefore, this potential alternative will not be analyzed in detail because it would not be measurably different from other alternatives analyzed in detail.

- Develop plans for water re-use or recirculation, and plan for low flow and high temperatures – Under this potential alternative, WDFW would revise its HGMPs to address water issues by developing plans for re-use or recirculation, and contingency plans for implementation during periods when flows are especially low, and water temperatures are especially high. Under this potential alternative, these and other best management practices would continue to reduce the risk of negative impacts of the hatchery programs on natural-origin salmon and steelhead populations. NMFS would determine the revised HGMPs meet requirements of the 4(d) Rule. However, because the HGMPs have already incorporated best management practices identified by independent reviewers, and because the HGMPs allow for incorporation of additional best management practices in the future as a result of monitoring and evaluation activities and adaptive management, this alternative would not be measurably different from the Proposed Action and will not be analyzed in detail.

2.4 Selection of a Preferred Alternative and an Environmentally Preferred Alternative

As explained in Subsection 1.6.6, Future Public Review and Comment, NMFS will review public comments received on the draft EIS and prepare a final EIS. A preferred alternative will be identified in the final EIS. The agency's preferred alternative is "the alternative which the agency believes would fulfill its statutory mission and responsibilities, giving consideration to economic, environmental, technical, and other factors" (CEQ 1981). The preferred alternative may be one of the alternatives or a combination of components of more than one alternative, possibly varying for each hatchery program. Information from the public review process will be used in choosing a preferred alternative.

NMFS will also identify an environmentally preferred alternative in the ROD. This alternative may or may not be the same as the preferred alternative. The environmentally preferable alternative is "the alternative that will promote the national environmental policy as expressed in NEPA's Section 101. Ordinarily, this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural, and natural resources (CEQ 1981)."

Chapter 3

3 AFFECTED ENVIRONMENT

Chapter 3, Affected Environment, describes existing conditions for six resources that may be affected by implementation of the EIS alternatives:

- Water Quantity (Subsection 3.1)
- Salmon and Steelhead (Subsection 3.2)
- Other Fish Species (Subsection 3.3)
- Wildlife – Southern Resident Killer Whale (Subsection 3.4)
- Socioeconomics (Subsection 3.5)
- Environmental Justice (Subsection 3.6)

No other resources were identified during scoping that would have the potential to be significantly impacted by the Proposed Action or alternatives (Subsection 1.6, Scoping and Relevant Issues). Additionally, a review of available NEPA analyses of salmon and steelhead hatchery programs in Puget Sound watersheds including the Elwha FEA (NMFS 2012), PS Hatcheries DEIS (NMFS 2014a), Elwha FSEA (NMFS 2014b), EWS Hatcheries DEA (NMFS 2015a), and Dungeness Hatcheries DEA (NMFS 2015b), suggests that water quality and wildlife (other than Southern Resident killer whale) resources are unlikely to have the potential to be significantly impacted by the Proposed Action or alternatives. Therefore, analyses of water quality and wildlife (other than Southern Resident killer whale) in the above documents are incorporated by reference; thus there are no further analyses in Chapter 3, Affected Environment, and Chapter 4, Environmental Consequences, in this EIS.

Existing conditions within the project area include effects of the past and present operation of the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins (Subsection 1.4, Project and Analysis Areas). Under existing conditions, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins produce up to 620,000 yearling smolts annually, as follows:

- Dungeness River basin: up to 10,000 yearlings
- Nooksack River basin: up to 150,000 yearlings
- Stillaguamish River basin: up to 130,000 yearlings
- Skykomish River basin: up to 256,000 yearlings
- Snoqualmie River basin: up to 74,000 yearlings

Since the entry of the Consent Decree in Wild Fish Conservancy v. WDFW (W.D. Wash.) on April 25, 2014, WDFW has not released these early winter steelhead smolts into waters connected to Puget Sound, with the exception of up to 180,000 smolts into the Skykomish River basin. However, the agreement not to release early winter steelhead smolts expires 2½ years after entry of the decree.

The alternatives are likely to result in more direct, indirect, and cumulative effects to salmon and steelhead than to other resources. Consequently, this EIS contains more information on salmon and steelhead resources, and early winter hatchery-origin steelhead in particular, than on the other resources analyzed. This is because in contrast to the other resources, effects of the hatchery programs on salmon and steelhead resources under the alternatives would be expected to occur in areas beyond the locations of the hatchery facilities used to produce fish from the hatchery programs. Effects would also be expected to occur in areas farther away, including marine areas through which juvenile and adult salmon and steelhead pass on their way to and from the ocean.

The project area is the geographic area where the Proposed Action would occur (Subsection 1.4, Project and Analysis Areas). It includes the places where early winter hatchery steelhead would be spawned, incubated, reared, acclimated, released, or harvested in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins (Subsection 1.4, Project and Analysis Areas). The analysis area for each resource includes the project area and each of the rivers to its confluence with the Puget Sound as a minimum area, but may include locations beyond the project area to fully analyze effects of various resources under the alternatives. The analysis area for each resource is described in Chapter 3, Affected Environment.

The effects of the hatchery programs under current conditions are summarized using the following terms:

Undetectable:	The impact is not detectable.
Negligible:	The impact is at the lower levels of detection, and can be either positive or negative.
Low:	The impact is slight, but detectable, and can be either positive or negative.
Moderate:	The impact is readily apparent, and can be either positive or negative.
High:	The impact is greatly positive or severely negative.

3.1 Water Quantity

Hatchery programs can affect water quantity when they take water from a well (groundwater) or a neighboring river or tributary stream (surface water) to use in the hatchery facility for broodstock holding, egg incubation, juvenile rearing, and juvenile acclimation. All water, minus evaporation, that is diverted from a river or taken from a well is discharged into the water course adjacent to the hatchery rearing location after it circulates through the hatchery facility (non-consumptive use). When hatchery programs use groundwater (i.e., from wells), they may reduce the amount of water for other users in the same aquifer. When hatchery programs use surface water, they 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. Generally, water intake and discharge structures are located as closely together as possible to minimize the area of the stream that may be impacted by a water withdrawal. Additional information on water quantity conditions in the analysis area associated with hatchery programs can be found in Subsection 3.6, Water Quality and Quantity, in the PS Hatcheries DEIS (NMFS 2014a).

As shown in Table 1, there are eight hatchery facilities currently used to support the five proposed early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. The early winter steelhead hatchery programs and associated hatchery facilities are:

• Dungeness River Program	Dungeness River Hatchery
	Hurd Creek Hatchery
• Kendall Creek Program	Kendall Creek Hatchery
	McKinnon Pond
• Whitehorse Ponds Program	Whitehorse Ponds Hatchery
• Snohomish/Skykomish Program	Wallace River Hatchery
	Reiter Ponds
• Tokul Creek Program	Tokul Creek Hatchery

Four of the hatchery facilities use surface water exclusively (Dungeness River Hatchery, McKinnon Pond, Wallace River Hatchery, and Reiter Ponds), and four of the hatchery facilities use both groundwater and surface water (Kendall Creek Hatchery, Hurd Creek Hatchery, Whitehorse Ponds Hatchery, and Tokul Creek Hatchery). The description of the existing conditions for water quantity focuses on water quantity resources at these eight hatchery facilities where the action alternatives would occur.

A water right permit is required for all groundwater withdrawals except those supporting single-family homes. All wells used by hatchery facilities supporting the proposed early winter steelhead hatchery programs are permitted by Ecology. Water available for use under water rights permits are maximums. Hatchery programs would generally not be expected to use 100 percent of the permitted water because of the timing of water availability as explained below.

Surface flows fluctuate seasonally, based on rainfall levels and snowmelt with flows generally highest in winter and spring. Surface water withdrawal needs for the hatchery programs also fluctuate seasonally, with the highest hatchery water withdrawal needs occurring in the late winter and spring months because that is when fish are at their largest size and need high rearing flows for fish health maintenance. Hatchery water withdrawal needs for fish rearing are lowest in the late summer months when river flows are at their lowest level because the fish being reared are small and require less water for fish health maintenance than they do during the winter and spring months.

Stream gauges are not operated at each facility, and thus, surface flow data are not available from each hatchery location. For the analyses in this EIS, surrogate surface water source flow data have been used. Sources for surrogate flow data are from U.S. Geological Survey (USGS) stream gauging stations nearest to each facility in the respective river basins, and for which discharges are available for a time period spanning at least 5 years. These flow data reflect the water in the streams at the locations of measurement. These water quantity data can also be found in Table 4.

Table 4. Water use at the eight hatchery facilities that support five early winter steelhead programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River Basins.

Hatchery Facility	Max Ground Water Use (cfs)	Max Surface Water Use (cfs)	Percent of Hatchery Facility Used to Rear Steelhead (%)[1]	Max Use of Water to Support Steelhead Programs (cfs)[2]	Surface Water Source	Annual Surface Water Flow (min/mean/max) (cfs)[3]	Max Percentage of Water Flow Diverted During Low Flow Conditions (%)[4]
Dungeness River Hatchery	NA	40.0	5	Surface: 2.0	Dungeness River	Min: 56 Mean: 397 Max: 3,310	3.6
	NA	8.5		Surface: 0.4	Canyon Creek	Min: 2 Mean: 8 Max: 2,025	20.0
Hurd Creek Hatchery	5	1.4	19	Ground: 0.95 Surface: 0.26	Hurd Creek	Min: 2 Mean: 5 Max: 2,007	13.0
Kendall Creek Hatchery	27.2	23.8	28	Ground: 7.7 Surface: 6.7	Kendall Creek	Min: 522 Mean: 3,847 Max: 43,700	1.3
McKinnon Pond	NA	2.0	100 from December through February	Surface: 2.0	Peat Bog Creek	Min: 32 Mean: 520 Max: 8,650	0.3 (note that steelhead are not reared in McKinnon Pond during low flow conditions so this is the proportion used during average flow conditions)
Whitehorse Ponds Hatchery	1.1	5.6	42	Ground: 0.5 Surface: 2.4	Whitehorse Spring Creek	Min: 123 Mean: 1,908 Max: 36,800	1.2

Table 4. Water use at the eight hatchery facilities that support five early winter steelhead programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River Basins (continued).

Hatchery Facility	Max Ground Water Use (cfs)	Max Surface Water Use (cfs)	Percent of Hatchery Facility Used to Rear Steelhead (%)[1]	Max Use of Water to Support Steelhead Programs (cfs)[2]	Surface Water Source	Annual Surface Water Flow (min/mean/max) (cfs)[3]	Max Percentage of Water Flow Diverted During Low Flow Conditions (%)[4]
Wallace River Hatchery	NA[5]	40.0	16	Surface: 6.4	Wallace River	Min: 303 Mean: 3,985 Max: 88,400	0.7
	NA	14.0		Surface: 2.2	May Creek	Min: 303 Mean: 3,985 Max: 88,400	1.6
Reiter Ponds	NA	10.0	49	Surface: 4.9	Austin Creek	Min: 303 Mean: 3,985 Max: 88,400	1.6
	NA	10.0		Surface: 4.9	Hogarty Creek	Min: 303 Mean: 3,985 Max: 88,400	1.6
Tokul Creek Hatchery	NA	12.0	45	Surface: 5.4	Tokul Creek	Min: 303 Mean: 3,985 Max: 88,400	1.8
		6.0		Surface: 2.7	Unnamed spring		0.9

Sources: Maximum ground and surface water use levels are from Table 4.1.1 in HGMPs WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e.

[1] Percentages reflect the percent of the total production (in pounds) comprising steelhead, during times steelhead are reared at each facility.

[2] Flows to support steelhead are derived from values in the table by multiplying the maximum water use by the percent used to rear steelhead.

[3] Surface water source and flow data are from USGS stream gauging stations in the respective river basins nearest to each facility, and reporting discharge for a period of record greater than 5 years; mean of mean daily flow, minimum of mean daily flow, maximum of mean daily flow for all months. Flow gauging stations are not available at each hatchery facility site. Information on each water source used is as follows. Dungeness River: October through September 5-year (2006-2011) mean, minimum, and maximum flow data for the lower Dungeness River from Washington Department of Ecology (WDOE 2012a) Dungeness River Stream Flow Monitoring Station 18A050, accessible at: https://fortress.wa.gov/ecy/wrx/wrx/flows/station.asp?wria=18#block2 Flow data collection reach is downstream of five irrigation withdrawal points on the river. Additional source of flow data is Elwha Dungeness Planning Unit (EDPU 2005) available at: http://www.clallam.net/environment/elwhadungenesswria.html. Flows presented for the upper Dungeness River are the estimated incremental average annual flows from EDPU (2005). The Dungeness River Management Team recommended minimum instream flows for the lower Dungeness River at seasonal flow levels recommended by the Dungeness Instream Flow Group (Wampler and Hiss 1991; Hiss 1993): November through March: 575 cfs; April through July: 475 cfs; and August through October: 180 cfs. These minimum flows are not based on seasonal, historical Dungeness River flows, but represent flows required to maintain optimal potential fish habitat area (EDPU 2005). Stream gauge locations by river mile (RM): Nooksack RM 30.9 and Middle Fork Nooksack RM 5.6; North Fork Stillaguamish RM 6.5; Skykomish RM 43.0. Gallons-per-minute to cubic-feet-per-second conversion factor: cfs = gpm/7.48/60.

[4] Percentages are derived by dividing cfs values for maximum use of water for steelhead by the minimum surface water flows.

[5] NA = not applicable

The analysis area for water quantity is the same as the project area (Subsection 1.4, Project and Analysis Areas). The following sections summarize water withdrawals at the facilities that support the early winter steelhead programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins.

Dungeness River Basin: The Dungeness River Hatchery uses surface water exclusively, withdrawn through three water intakes on the Dungeness River and one on Canyon Creek, an adjacent tributary. The Hurd Creek Hatchery facility uses a combination of groundwater withdrawn from five wells, and surface water withdrawn from Hurd Creek as an emergency back-up source.

The Dungeness River Hatchery withdraws up to 2.0 cubic feet per second (cfs) of water from the Dungeness River and up to 0.4 cfs from Canyon Creek to support the Dungeness River early winter steelhead program (Table 4). All water (minus evaporation) is returned to the river after circulating through the hatchery. Water quantity is only affected between the water intake and discharge structures. Water flows in the Dungeness River average 397 cfs with minimum flows of 56 cfs. Because the early winter steelhead hatchery program diverts up to 2.0 cfs of water from the Dungeness River, which is 3.6 percent of the water in the Dungeness River during low flow conditions, effects of the water withdrawal are considered low under existing conditions. Water flows in Canyon Creek average 8.0 cfs with minimum flows of 2.0 cfs. Because the early winter steelhead hatchery program diverts up to 0.26 cfs of water, which is 20 percent of the water in Canyon Creek during low flow conditions, the water withdrawal is assessed as a moderate negative effect under existing conditions.

The Hurd Creek Hatchery withdraws up to 0.26 cfs from Hurd Creek and 0.95 cfs from five wells to support the Dungeness River early winter steelhead program (Table 4). All water (minus evaporation) is returned to the creek after circulating through the hatchery. Water quantity is only affected between the water intake and discharge structures. Water flows in Hurd Creek average 5.0 cfs with minimum flows of 2.0 cfs. Because the early winter steelhead hatchery program diverts up to 0.26 cfs of water from Hurd Creek, which is 13 percent of the water in Hurd Creek during low flow conditions, the water withdrawal is assessed as a moderate negative effect under existing conditions. In addition, the withdrawal of 0.95 cfs of the maximum of 5 cfs that is permitted from five wells (Table 4) is assessed as a low negative effect on groundwater under existing conditions.

Monitoring and measurement of water usage are reported by the applicant in monthly National Pollutant Discharge Elimination System (NPDES) reports to Ecology.

Nooksack River Basin: The Kendall Creek Hatchery uses well and surface water (when available). The McKinnon Pond uses gravity fed surface water from a stream locally known as "Peat Bog Creek" (WRIA 01.0352).

The Kendall Creek Hatchery withdraws up to 6.7 cfs from Kendall Creek and 7.7 cfs from wells to support the Kendall Creek early winter steelhead program (Table 4). All water (minus evaporation) is returned to the creek after circulating through the hatchery. Water quantity is only affected between the water intake and discharge structures. Water flows in Kendall Creek average 3,847 cfs with minimum flows of 522 cfs. Because the early winter steelhead hatchery program diverts up to 6.7 cfs of water from Kendall Creek, which is 1.3 percent of the water in Kendall Creek during low flow conditions, the water withdrawal has a negligible negative effect under existing conditions. In addition, the withdrawal of 7.7 cfs of the maximum of 27.2 cfs that is permitted (Table 4) is assessed as a low negative effect on groundwater under existing conditions.

The McKinnon Pond may withdraw up to 2.0 cfs from Peat Bog Creek from December through February to rear early winter steelhead (Table 4). Steelhead are not reared in McKinnon Pond during the remainder of the year. All water (minus evaporation) is returned to the creek after circulating through the rearing pond. Water quantity is only affected between the water intake and discharge structures. Water flows in Peat Bog Creek average 520 cfs with minimum flows of 32 cfs. Because the early winter steelhead hatchery program diverts up to 2.0 cfs of water from Peat Bog Creek, which is 0.3 percent of the water in Peat Bog Creek during average flow conditions, the water withdrawal is assessed as a negligible negative effect under existing conditions.

Monitoring and measurement of water usage are reported by the applicant in monthly NPDES permit reports to Ecology.

Stillaguamish River Basin: Whitehorse Ponds Hatchery uses well and surface water. The Whitehorse Ponds Hatchery withdraws up to 2.4 cfs from Whitehorse Springs Creek and up to 0.5 cfs from wells to support the early winter steelhead hatchery program (Table 4). All water (minus evaporation) is returned to the creek after circulating through the hatchery. Water quantity is only affected between the water intake and discharge structures. Water flows in Whitehorse Springs Creek average 1,908 cfs with minimum flows of 123 cfs. Because the early winter steelhead hatchery program diverts up to 2.4 cfs of water from Whitehorse Springs Creek, which is 1.2 percent of the water in Whitehorse Springs Creek during low flow conditions, the water withdrawal has a negligible negative effect under existing conditions. In addition, the withdrawal of 0.5 cfs of the maximum of 1.1 cfs that is permitted (Table 4) is assessed as a low negative effect on groundwater under existing conditions.

Skykomish River Basin: The Wallace River Hatchery uses only surface water. The Wallace River Hatchery has two water intake structures, one on the Wallace River and one on May Creek. The Wallace River Hatchery withdraws up to 6.4 cfs from Wallace River and up to 2.2 cfs from May Creek to support the early winter steelhead hatchery program (Table 4). All water (minus evaporation) is returned to the river after circulating through the facilities. Water quantity is only affected between the water intakes and discharge structures. Water flows in the Wallace River average 3,985 cfs with minimum flows of 303 cfs. Because the early winter steelhead hatchery program diverts up to 6.4 cfs of water from the Wallace River and 2.2 cfs from May Creek, which is 0.7 percent of the water in the Wallace River and 1.6 percent of the water in May Creek during low flow conditions, the water withdrawals are assessed as a negligible negative effect under existing conditions.

Reiter Ponds also has two intakes structures (one on Austin Creek and one on Hogarty Creek). Reiter Ponds withdraws up to 4.9 cfs from Austin Creek and up to 4.9 cfs from Hogarty Creek to support the early winter steelhead hatchery program (Table 4). All water (minus evaporation) is returned to the creeks after circulating through the facilities. Water quantity is only affected between the water intakes and discharge structures. Water flows in Austin Creek and Hogarty Creek average 3,985 cfs, with minimum flows of 303 cfs each. Because the Reiter Ponds early winter steelhead hatchery program diverts up to 4.9 cfs of water from each creek, which is 1.6 percent of the water in from either Austin Creek and Hogarty Creek during low flow conditions, the water withdrawal is assessed as a negligible negative effect under existing conditions.

Monitoring and measurement of water usage are reported by the applicant in monthly NPDES reports to Ecology.

Snoqualmie River Basin: The Tokul Creek Hatchery uses surface water. The Tokul Creek Hatchery withdraws up to 5.4 cfs from Tokul Creek and up to 2.7 cfs from a spring to support the early winter steelhead hatchery program (Table 4). All water (minus evaporation) is returned to the creek after circulating through the hatchery. Water quantity is only affected between the water intake and discharge structures. Water flows in Tokul Creek average 3,985 cfs with minimum flows of 303 cfs. Because the early winter steelhead hatchery program diverts up to 5.4 cfs of water from Tokul Creek, which is 1.8 percent of the water in Tokul Creek during low flow conditions, the water withdrawal has a negligible negative effect under existing conditions.

In addition, the withdrawal of 0.9 cfs is assessed as a negligible negative effect on the spring source under existing conditions.

Monitoring and measurement of water usage are reported by the applicant in monthly NPDES reports to Ecology.

3.2 Salmon and Steelhead

This subsection describes existing conditions for salmon and steelhead that may be affected by the alternatives, specifically, changes in release numbers and hatchery program type. 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 existing salmon and steelhead hatchery programs in the river basins associated with the proposed early winter steelhead hatchery programs. Additional information on salmon and steelhead in the analysis area and effects associated with Puget Sound hatchery programs can be found in Subsection 3.2, Fish, in the PS Hatcheries DEIS (NMFS 2014a).

Since 1991, 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 require protection under the ESA (64 Fed. Reg. 14308, March 24, 1999; 72 Fed. Reg. 26722, May 11, 2007; 76 Fed. Reg. 50488, August 5, 2011). There are four additional non-listed salmon species in Puget Sound (fall chum salmon, pink salmon, sockeye salmon, and coho salmon).

The analysis area for salmon and steelhead includes the geographic area where the Proposed Action would occur (Subsection 1.4, Project and Analysis Areas), and includes marine areas of Puget Sound (Subsection 1.4, Project and Analysis Areas). Table 5 summarizes which salmon and steelhead species are found in the analysis area.

Critical habitat has been designated for Puget Sound Chinook salmon (70 Fed. Reg. 52630, September 2, 2005) and Hood Canal summer chum salmon (70 Fed. Reg. 52630). NMFS has proposed designation of critical habitat for Puget Sound steelhead (78 Fed. Reg. 2726, January 14, 2013). Critical habitat has not been designated for fall chum salmon, pink salmon, and coho salmon because these species are not listed under the ESA. The analysis area includes critical habitat for Puget Sound Chinook salmon and Hood Canal summer chum salmon and proposed critical habitat for Puget Sound steelhead.

Table 5. A summary of natural-origin salmon and steelhead populations in the analysis area.

Species or Stock	Listing Status under ESA	Dungeness River Basin	Nooksack River Basin	Stillaguamish River Basin	Snohomish River Basin	Occurrence in Puget Sound Marine Areas
Spring/Summer Chinook Salmon	Threatened	X	X	X	X	X
Fall Chinook Salmon	Threatened			X	X	X
Summer Chum Salmon	Threatened	X				X
Winter Steelhead[1]	Threatened	X	X	X	X	X
Summer Steelhead	Threatened		X	X	X	X
Fall Chum Salmon	Not listed		X	X	X	X
Pink Salmon	Not listed	X	X	X	X	X
Coho Salmon	Not listed	X	X	X	X	X
Sockeye Salmon	Not listed	X	X[2]	X[2]		X

[1] Although populations of steelhead in the Puget Sound DPS include both summer and winter run life history types, the DPS is composed primarily of winter run populations (Myers et al. 2015).
[2] It is unknown whether the sockeye salmon in the Nooksack and Stillaguamish River basins are self-sustaining riverine stocks or if they represent strays from adjacent watersheds where self-sustaining sockeye populations are present.

3.2.1 General Factors that Affect the Presence and Abundance of Salmon and Steelhead

Although Subsection 3.2, Salmon and Steelhead, is focused on the effects of five early winter steelhead hatchery programs on listed and non-listed salmon and steelhead in the analysis area, it is important to recognize that these hatchery programs are but one of a variety of natural and human-caused changes that have and will continue to affect these species. Some of these changes are briefly described below. These changes have affected the abundance, productivity, diversity, and distribution of salmon and steelhead in Puget Sound. In addition to hatchery programs, previous NMFS salmon status reviews (Myers et al. 1998; Good et al. 2005; Ford 2011), recovery plans (72 Fed. Reg. 2493, January 19, 2007; 72 Fed. Reg. 29121, May 24, 2007), and other documents (WSCC 2005), describe a range of past and current factors that have contributed to the decline of salmon and steelhead in Puget Sound, including:

Habitat: Freshwater habitat has been modified from development and land use practices related to agriculture, forestry, industry, and residential use. These modifications have altered steam hydrology and natural stream channels, reduced riparian cover and large woody debris in streams, and increased sedimentation and flooding.

Dams and Diversions: Construction of dams, water diversion structures, and hydroelectric operations can block salmon and steelhead migration routes, entrain migrating juveniles, change stream flow patterns, and alter natural water temperature regimes.

Predation: Direct predation by aquatic, terrestrial, and avian species result in salmon and steelhead mortality.

Oceanic Conditions: Broad-scale, cyclic changes in climatic and ocean conditions drive salmon productivity (e.g., El Niño events), and are important to how and where populations of salmon are sustained over the short and long term (e.g., ISAB 2015).

Climate Change: Changes in the climate can alter the abundance, productivity, and distribution of salmon and steelhead through changes in water temperatures and seasonal stream flow regimes, which then affect the type and extent of aquatic habitat that is suitable for viable salmon and steelhead.

These changes are described in more detail in Subsection 3.2.2, General Factors that Affect the Presence and Abundance of Salmon and Steelhead, in the PS Hatcheries DEIS (NMFS 2014a).

In a review of these and other factors, NMFS concluded that the impacts to salmon and steelhead habitat continue to suppress prospects for recovery of listed natural-origin salmon and steelhead, including current and continuing degradation and loss of habitat essential for their survival and productivity (NMFS 2011b). All of the past and current factors as described above have negatively affected salmon and steelhead populations, distribution, and overall survival.

3.2.2 Salmon and Steelhead Hatchery Programs

3.2.2.1 General Effects of Puget Sound Salmon and Steelhead Hatchery Programs

Hatchery programs for salmon and steelhead have the potential to negatively affect natural-origin salmon and steelhead and their habitat through genetic risks, competition and predation, hatchery facility effects, incidental fishing effects, and disease transfer. The PS Hatcheries DEIS (NMFS 2014a) and the Final Environmental Impact Statement to Inform Columbia River Basin Hatchery Operations and the Funding of Mitchell Act Hatchery Programs – herein referred to as the Mitchell Act Hatcheries FEIS (NMFS 2014c), describe in more detail these general mechanisms, and both are incorporated by reference (Subsection 1.1.3, Related National Environmental Policy Act Reviews), to this EIS.

Based on a review of hatchery plans currently submitted to NMFS, the co-managers release a total of about 160 million juvenile hatchery-origin salmon and steelhead into Puget Sound freshwater and marine areas each year, including 47.4 million Chinook salmon, 14.9 million coho salmon, 50 million chum salmon, 4.1 million pink salmon, 42.3 million sockeye salmon, and 1.2 million steelhead (Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities). This total current release level is similar to the total Puget Sound production level of 147 million salmon and steelhead that was analyzed in the PS Hatcheries DEIS (NMFS 2014a). Thus, the PS Hatcheries DEIS (NMFS 2014a) provides a useful reference describing effects of hatchery production under existing conditions. To the extent that effects identified in the PS Hatcheries DEIS (NMFS 2014a) are greater because the hatchery production levels for some species analyzed were higher than current levels, then the existing conditions used in the PS Hatcheries DEIS (NMFS 2014a) support a risk-averse context from which to evaluate the alternatives in this EIS.

The PS Hatcheries DEIS (NMFS 2014a) described effects based on production levels of 45.3 million Chinook salmon, 14.6 million coho salmon, 45 million fall chum salmon, 4.5 million pink salmon, 35.1 million sockeye salmon, and 2.5 million steelhead (Table 2.4-1 in PS Hatcheries DEIS [NMFS 2014a]). A summary of differences in production levels between the PS Hatcheries DEIS (NMFS 2014a) and this EIS (Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities), shows that with only one exception (sockeye salmon), current hatchery releases are lower than (steelhead) or within the range of releases levels analyzed in the PS Hatcheries DEIS (NMFS 2014a). Lower release levels for steelhead are due primarily to program terminations, whereby the current release level of hatchery-origin steelhead has been reduced from the 2.5-million level analyzed in the PS Hatcheries DEIS (NMFS 2014a) to 1.2 million while still comprising a small percentage (1 to 2 percent) of the total salmon and steelhead production in Puget Sound. Current sockeye salmon release levels are higher than those analyzed in the PS Hatcheries DEIS (NMFS 2014a) because of increased releases in one of the two sockeye salmon programs in the analysis area – Baker River. In Puget Sound, run size and escapement monitoring indicate that for recent years, hatchery-origin fish make up 76 percent of total adult returns of Chinook salmon, 47 percent of coho salmon, 29 percent of fall chum salmon, 30 percent of sockeye salmon, 2 percent of pink salmon, and an unknown proportion of total steelhead returns (PS Hatcheries DEIS [NMFS 2014a]).

The general mechanisms through which hatchery programs can affect natural-origin salmon and steelhead populations are described in Table 6 below. These effects are also described in Chapter 3, Affected Environment, and Appendix H, Steelhead Effects Analysis by Basin, in the PS Hatcheries DEIS (NMFS 2014a).

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

Effect Category	Description of Effect
Genetic Risks	• Interbreeding with hatchery-origin fish can change the genetic character of the local salmon or steelhead populations. • Interbreeding with hatchery-origin fish may reduce the reproductive performance of the local salmon or steelhead 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.
Hatchery Facility Effects	• Hatchery facilities can reduce water quantity or quality in adjacent streams through water withdrawal and discharge. • Weirs for broodstock collection or to control the number of hatchery-origin fish on the spawning grounds can have the following unintentional consequences: o Isolation of formerly connected populations o Limiting or slowing movement of migrating fish species, which may enable poaching or increase predation o Alteration of stream flow o Alteration of streambed and riparian habitat o Alteration of the distribution of spawning within a population o Increased mortality or stress due to capture and handling o Impingement of downstream migrating fish o Forced downstream spawning by fish that do not pass through the weir o 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 Effects	• Fisheries targeting hatchery-origin fish have incidental impacts on natural-origin fish.
Disease Transfer	• 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.
Mining	• Use of natural-origin fish for broodstock can reduce the abundance and spatial structure of the natural-origin population.
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: Hatchery programs could increase the productivity of a natural-origin population if naturally spawning hatchery- origin fish match natural-origin fish in reproductive fitness and when the natural-origin population's abundance is low enough to limit natural-origin productivity (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.

3.2.2.2 Existing Conditions and Effects of Current Salmon and Steelhead Hatchery Programs in Puget Sound

This subsection provides a summary of the affected environment associated with effects of hatchery programs described in the PS Hatcheries DEIS (NMFS 2014a). In the PS Hatcheries DEIS (NMFS 2014a), the No-action Alternative identified potential effects to listed and non-listed salmon and steelhead species in Puget Sound from the total number of salmon and steelhead released into the project area at the time of the analysis (Alternative 1 in Table S-4 in PS Hatcheries DEIS [NMFS 2014a]). For the listed Puget Sound Steelhead DPS, that analysis found overall salmon and steelhead production poses a moderate risk and low benefit (Table 3.2-16 in the PS Hatcheries DEIS [NMFS 2014a]). For the steelhead DPS overall, the competition risk is moderate, genetic risk is low, and hatchery facilities risk (including disease transfer) is low (PS Hatcheries DEIS [NMFS 2014a]). Similarly, total salmon and steelhead production poses a moderate risk and low benefit to the listed Puget Sound Chinook salmon ESU. For that ESU overall, the competition risk in freshwater is moderate, predation risk in freshwater is high, genetic risk is moderate, and hatchery facilities risk (including disease transfer) is low (Table 3.2-10 in the PS Hatcheries DEIS [NMFS 2014a]).

For non-listed natural-origin salmon species (coho salmon, fall chum salmon, pink salmon, and sockeye salmon) in the analysis area, the analyses in the PS Hatcheries DEIS (NMFS 2014a) found overall salmon and steelhead production poses competition, predation, genetics, and hatchery facilities and operation risks (Alternative 1 in Table S-4 in the PS Hatcheries DEIS [NMFS 2014a]).

As described in Subsection 4.2.8.3, Risks and Benefits (Coho Salmon) in the PS Hatcheries DEIS (NMFS 2014a), yearling releases of coho salmon, Chinook salmon, and steelhead pose the greatest risk to coho salmon in freshwater from competition and predation, and genetic risks occur when hatchery-origin coho salmon that have been affected by hatchery-influenced selection stray into and spawn with natural-origin coho salmon in natural spawning areas. Hatchery operations risks are not substantial.

As described in Subsection 4.2.9.3, Risks and Benefits (Fall Chum Salmon) in the PS Hatcheries DEIS (NMFS 2014a), releases of pink salmon pose competition risks to fall-run chum salmon in marine areas due to their similar size and spatial and temporal overlap. Predation risks to fall-run chum salmon are greatest in freshwater (and are possible in marine waters) from the larger yearling hatchery-origin Chinook and coho salmon when they overlap in space and time with the smaller fall-run chum. Hatchery operations risks are not substantial.

As described in Subsection 4.2.10.3, Risks and Benefits (Pink Salmon) in the PS Hatcheries DEIS (NMFS 2014a), risks to natural-origin pink salmon from hatchery-origin fish occur primarily from competition with similar-sized hatchery-origin chum salmon in fresh water and adjacent marine waters, and from predation by larger hatchery-origin steelhead, yearling coho salmon, and subyearling and yearling Chinook salmon in freshwater and marine waters. Hatchery operations risks to pink salmon are negligible, because there are few pink salmon hatchery programs in the analysis area.

As described in Subsection 4.2.11.3, Risks and Benefits (Sockeye Salmon) in the PS Hatcheries DEIS (NMFS 2014a), releases of hatchery-origin coho salmon yearlings have the greatest potential to affect similarly sized natural-origin sockeye salmon through competition in marine areas and in rivers and streams below lakes used by juvenile sockeye salmon for migration to marine areas. In addition, releases of larger hatchery-origin steelhead have the greatest potential to impact smaller natural-origin sockeye salmon through predation in freshwater (in waters below lakes used by juvenile sockeye salmon for migration to marine areas). Hatchery operations risks to sockeye salmon are negligible, because there are only two sockeye salmon hatchery programs in the analysis area.

As described in Subsection 2.1.1.2, Competition – Estuarine and Marine Areas, and Subsection 2.1.2.2, Predation – Estuarine and Marine Areas, in Appendix B of the PS Hatcheries DEIS (NMFS 2104a), competition and predation from hatchery-origin salmon and steelhead juveniles in estuarine and marine areas can lead to negative impacts on natural-origin fish. Negative impacts on natural-origin fish from competition would be expected to be greatest where preferred food may be limiting (SIWG 1984). 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.

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 (SIWG 1984). 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 (Subsection 2.1.2.2, Predation – Estuarine and Marine Areas, in Appendix B of the PS Hatcheries DEIS [NMFS 2104a]).

3.2.2.3 Salmon Hatchery Programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River Basins

The river basins that support the five early winter steelhead programs are also where several other hatchery programs are located. WDFW and three Puget Sound treaty tribes operate 25 additional salmon hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins.

Dungeness River Basin Hatchery Programs: There are three additional salmon hatchery programs in the Dungeness River basin, as described in the Dungeness Hatcheries DEA (NMFS 2015b). WDFW, with some funding assistance from the Jamestown S'Klallam Tribe, operates three salmon hatchery programs in the Dungeness River basin. Two programs operate for conservation-directed supplementation purposes, and one program produces coho salmon largely to provide fish for harvest. The Dungeness River hatchery programs are operated to conserve at-risk native salmon populations (Chinook salmon and pink salmon) and partially mitigate for lost natural-origin fish production largely resulting from past and on-going loss and degradation of natural fish habitat, and impending climate change.

Nooksack River Basin Hatchery Programs: There are 12 additional salmon hatchery programs operating in the Nooksack River basin, of which two are operated cooperatively by WDFW and the Lummi Nation for stock conservation purposes, with the remainder implemented by WDFW (five programs) and the Lummi Nation (five programs) to provide fish for harvest. All of the hatchery programs in the Nooksack River basin operate to partially offset natural-origin salmon and steelhead population reductions resulting from past and on-going land-use practices, including forestry and agriculture (SSPS 2005).

Stillaguamish River Basin Hatchery Programs: There are four additional salmon hatchery programs in the Stillaguamish River basin. WDFW operates one additional salmon hatchery program (operated jointly with the Stillaguamish Tribe for conservation purposes), and the Stillaguamish Tribe operates an additional three programs (one for stock conservation and two for harvest augmentation). These hatchery programs operate in the Stillaguamish River basin to offset existing severe constraints on natural-origin fish production due to poor freshwater habitat conditions (Stillaguamish 2007).

Skykomish River Basin Hatchery Programs: There are six additional hatchery programs operating in the Snohomish/Skykomish River basin. The Tulalip Tribes operate three programs for harvest augmentation, and WDFW operates two programs and one net pen for harvest augmentation. These hatchery programs operate in the Skykomish River basin to offset constraints on natural-origin fish production due to poor habitat conditions (Tulalip 2012, 2013a, 2013b; WDFW 2013a, 2013b, 2013c).

Snoqualmie River Basin Hatchery Programs: No hatchery programs operate in the Snoqualmie River basin other than the early winter steelhead program at the Tokul Creek Hatchery.

Salmon and steelhead hatchery programs and facilities operating throughout the analysis area are described in Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities, and their effects on the salmon and steelhead resource are described in Subsection 3.2.2.2, Existing Conditions and Effects of Current Salmon and Steelhead Hatchery Programs in Puget Sound.

3.2.2.4 Background on Existing Early Winter Steelhead Hatchery Programs

Steelhead hatchery programs in Puget Sound were initiated in the early 1900s to augment harvest opportunity in their respective river basins. Beginning in 1935, steelhead returning to Chambers Creek were used to establish a hatchery stock that was subsequently released throughout much of Puget Sound (Crawford 1979), including in the Nooksack (Kendall Creek Hatchery beginning in 1998), Stillaguamish (Whitehorse Ponds Hatchery in 1964), and Dungeness River basins (Dungeness River Hatchery in 1995), Snoqualmie River (Tokul Creek Hatchery in 1951), and Skykomish River basins (Wallace River Hatchery in 1999) (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). Advances in fish cultural techniques in the 1960s led to further development of the Chambers Creek hatchery-origin stock (also known as the early winter steelhead stock) through broodstock selection and accelerated rearing (Crawford 1979). Currently, a total of about 1.2 million hatchery-origin winter-run and summer-run steelhead are released into Puget Sound rivers (Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities).

The early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins are isolated[1] hatchery programs that seek to minimize interactions between hatchery-origin and natural-origin fish. The programs are not designed to augment the abundance of natural spawners and do not contribute to the population viability or recovery of listed steelhead; they are designed to contribute to harvest in their respective river basins while minimizing negative impacts on natural-origin populations. Since Puget Sound steelhead were listed under the ESA, several risk reduction measures have been implemented in early winter steelhead hatchery programs in Puget Sound (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). including:

- Greater than 50 percent reduction in total number of early winter hatchery-origin steelhead released in the Puget Sound tributaries
- Greater than 65 percent reduction in the number of early winter steelhead release locations

[1] In an isolated hatchery program the hatchery-origin population is reproductively segregated from the natural-origin population, in particular by using only hatchery fish for broodstock, and other practices. These programs produce fish that are different from local populations. These programs do not contribute to conservation or recovery of populations included in an ESU or DPS. Isolated programs are also called segregated programs.

- Elimination of cross-basin transfers, off-station releases, and adult recycling
- Volitional smolt releases to ensure the fish are ready to migrate out of the freshwater system, thus minimizing the amount of time for ecological interactions between hatchery-origin and natural-origin fish
- Hatchery broodstock collection by January 31 to enhance separation between hatchery-origin steelhead and the later-returning, native natural-origin steelhead populations
- Genetic monitoring of steelhead
- Hatchery traps now remain open through March 15 (or later as conditions allow) to provide the opportunity for all adult hatchery-origin fish to return to the hatcheries to reduced straying
- Eggs are only collected from fish that return to the hatchery to promote fidelity of homing to the hatcheries

3.2.3 Effects of Current Early Winter Steelhead Hatchery Programs on Salmon and Steelhead

The affected environment associated with the past and current operation of the five early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins is discussed in Subsection 3.2.3.1, Genetic Risks, through Subsection 3.2.3.9, Nutrient Cycling.

3.2.3.1 Genetic Risks

Hatchery-origin steelhead do not interbreed with salmon species and, therefore, do not pose a genetic risk to natural-origin salmon populations. Consequently, there are no genetic risks to salmon species from early winter steelhead hatchery programs; therefore, genetic risks to salmon are not analyzed in this EIS. Detailed information on genetic risks of early winter steelhead hatchery programs to natural-origin steelhead can be found in Appendix B, Genetic Effects Analysis of Early Winter Steelhead Programs Proposed for the Nooksack, Stillaguamish, Dungeness, Skykomish, and Snoqualmie River Basins of Washington. Additional information on genetic risks of hatchery programs to salmon and steelhead can be found in Subsection 2.1.3, Genetics, in Appendix B, Hatchery Effects and Methods, in the PS Hatcheries DEIS (NMFS 2014a).

As described in Subsection 3.2, Salmon and Steelhead, the five Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie early winter steelhead hatchery programs operate as isolated hatchery programs and produce fish that are derived from Chambers Creek steelhead, a non-local stock whose time of return and spawning has been advanced through fish culture practices (i.e., hatchery-influenced selection, sometimes called domestication). Although the hatchery-origin steelhead from these five isolated hatchery programs spawn earlier than the natural-origin steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins, and, thus, not at the optimal time for successful reproduction, they may have some success spawning in the wild. In addition, there may be overlap in timing between the latest spawning early winter hatchery-origin steelhead and the earliest spawning winter-run steelhead (Figure 1). For more detail on spawner overlap see Appendix B, Genetic Effects Analysis of Early Winter Steelhead Programs Proposed for the Nooksack, Stillaguamish, Dungeness, Skykomish, and Snoqualmie River Basins of Washington; Seamons et al. (2012); and McMillan (2015). This potential overlap creates the potential for interbreeding between early winter hatchery-origin steelhead from the proposed five hatchery programs and natural-origin steelhead found in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. The traits that are intentionally and inadvertently selected for in the hatchery environment (e.g., early run timing) make early winter hatchery-origin steelhead ill-suited for survival and productivity in the natural environment. Therefore, any successful reproduction of early winter steelhead, especially interbreeding between early winter hatchery-origin steelhead and natural-origin steelhead, may have affected the genetic integrity and productivity of natural-origin steelhead populations in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins.

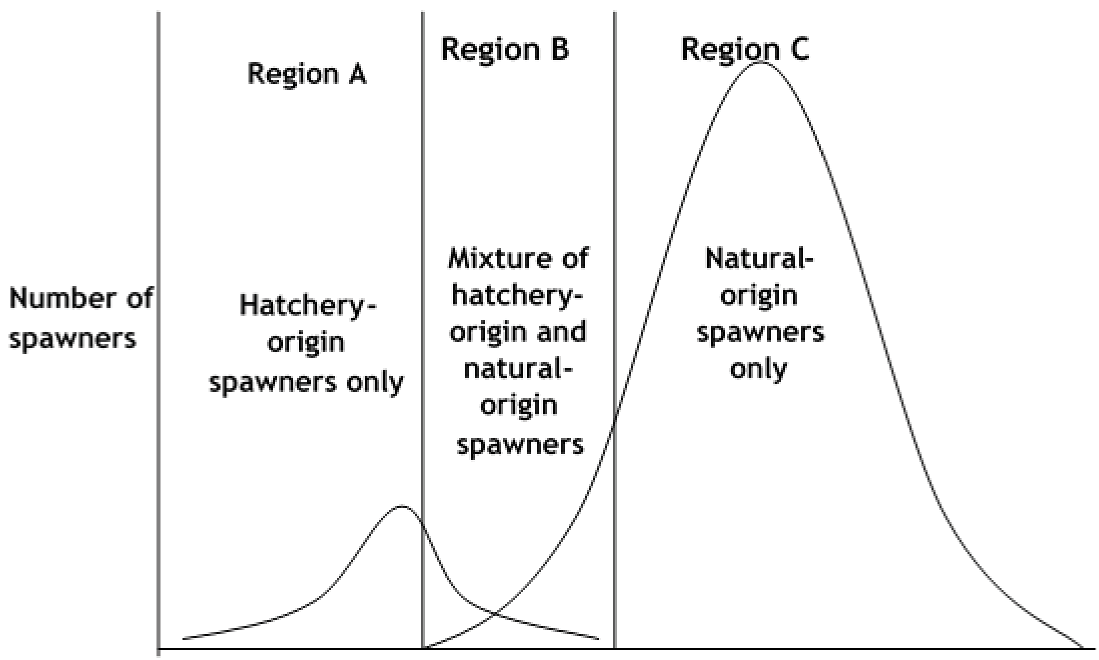

Figure 1. Schematic of temporal spawning overlap between early winter hatchery steelhead and natural-origin winter steelhead. Shape, sizes and placement of curves is conceptual and is not meant to represent any specific situation (Scott and Gill 2008, Fig. 4-7).

In 2004, the HSRG released its recommendations for hatchery reform (HSRG 2005). While not addressing the early winter steelhead hatchery programs specifically in their guidelines, the HSRG discussed risks posed by highly diverged hatchery stocks and concluded that ". . . if non-harvested fish spawn naturally, then these isolated programs can impose significant genetic risks to naturally spawning populations. Indeed, any natural spawning by fish from these broodstocks may be considered unacceptable because of the potential genetic impacts on natural populations . . . to minimize these risks, isolated hatchery programs need to be located in areas where virtually all returning adults can be harvested or recaptured, or where natural spawning or ecological interactions with natural-origin fish are considered minimal or inconsequential" (HSRG 2005). In 2009, the HSRG recommended that primary populations (those of high conservation concern) affected by isolated hatchery programs have a proportion of hatchery-origin spawners (pHOS) of no more than 5 percent (HSRG 2009)[2]. The HSRG recommended that integrated[3] hatchery programs affecting primary populations have a Proportionate Natural Influence (PNI)[4] of 0.67 (HSRG 2009). More recently, the HSRG suggested that perhaps pHOS levels should be lower than 5 percent for isolated programs and suggested that 2 percent would be more appropriate for some programs based on their modeling (HSRG 2014). As a result, based on available information, NMFS concludes that isolated programs with a pHOS of less than 2 percent and integrated programs with a PNI of greater than 0.67 pose a low genetic risk to natural-origin populations. WDFW's current statewide steelhead management plan is consistent with the HSRG's recommendations for isolated hatchery programs and states that isolated programs will result in average gene flow levels of less than 2 percent (WDFW 2008) (note that pHOS is a surrogate metric for gene flow). This conclusion was based on analysis of early winter steelhead programs that used the Ford (2002) model, the same model used to establish the HSRG guidelines.

[2] pHOS is the proportion of natural spawners that consist of hatchery-origin fish, and is a surrogate measure for gene flow. WDFW has developed two additional methods for directly measuring for gene flow: (1) the Warheit method, which uses genetic data to estimate proportionate effective hatchery contribution (PEHC) (Warheit 2014a) and (2) a demographic method, referred to as the Scott-Gill method (Scott and Gill 2008).

[3] The intent of an integrated hatchery program is for 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 included in an ESU or DPS.

[4] PNI is a measure of hatchery influence on natural populations that is a function of both the proportion of hatchery-origin spawners spawning in the natural environment (pHOS) and the percent of natural-origin broodstock incorporated into a hatchery program (pNOB). PNI can also be thought of as a percentage of time all the genes of a population collectively have spent in the natural environment.

Assessments of steelhead spawning (and pHOS) are difficult because high spring flows and associated turbidity hamper detection of redds. Available genetic information has documented introgression from hatchery-origin to natural-origin steelhead populations in Puget Sound in the past (e.g., Phelps et al. 1997; Winans et al. 2008; Pflug et al. 2013). However, currently it appears, based on genetic data (Warheit Method), that gene flow into the Nooksack, Stillaguamish, and Skykomish basins is under 2 percent (Table 7). Using another method (Scott Gill Method), based on demographic information, gene flow into these two basins and the Dungeness River basin is also estimated to be under 2 percent (Table 7; Table B-6 in Appendix B, Genetic Effects Analysis of Early Winter Steelhead Hatchery Programs Proposed for the Nooksack, Stillaguamish, Dungeness, Skykomish, and Snoqualmie River Basins of Washington). Using both methods, gene flow into the Snoqualmie River basin is above 2 percent but below 5 percent. Therefore, there is a low negative effect to natural-origin steelhead population from early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, and Skykomish River basins, and a low to moderate negative effect to the natural-origin population in the Snoqualmie River basin.

Table 7. Summary of analyses of gene flow from five Puget Sound early winter steelhead hatchery programs into listed steelhead populations.

River Basin	Listed Population[1]	Warheit Method (PEHC) (%)	Scott_Gill Method (Gene Flow) (%)
Nooksack	Nooksack (W)	0 (0-2)	0.57
	SF Nooksack (S)	0 (0-2)	-
Stillaguamish	Stillaguamish (W)	0 (0-7)	1.05
	Deer Creek (S)	0 (0-1)	-
	Canyon Creek (S)	0 (0-2)	-
Dungeness	Dungeness (S/W)	-	0.50
Snohomish/Skykomish	Pilchuck (W)	1 (0-12)	0.0
	Skykomish (W)	0 (0-0)	1.70
	North Fork Skykomish (S)	1 (1-3)	-
Snoqualmie	Snoqualmie (W)	4 (0-12)	2.93
	Tolt (S)	1 (0-3)	-

Sources: Appendix B; Warheit 2014a; Warheit 2014b; Scott and Gill 2008; Hoffman 2015a; Hoffman 2015b.
[1] W = winter-run; S = summer-run.

3.2.3.2 Competition and Predation

Competition and predation between hatchery-origin fish and natural-origin fish may occur in both freshwater and marine areas, as well as between juveniles and adults and between different species of salmon and steelhead. Detailed information on competition and predation risks of hatchery programs to natural-origin salmon and steelhead can be found in Subsection 2.1.1, Competition, and Subsection 2.1.2, Predation, in Appendix B, Hatchery Effects and Methods, in the PS Hatcheries DEIS (NMFS 2014a).

The five Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basin early winter steelhead hatchery programs release steelhead at the yearling smolt stage, and they have the potential to compete with or predate on other salmon and steelhead (Table 8).

Table 8. Ecological relationship between hatchery-origin steelhead and natural-origin salmon and steelhead in the analysis area.

	Ecological Relationship with Hatchery-origin Steelhead			Location of Ecological Interaction		
Species	**Predator of Hatchery-Origin Steelhead**	**Competitor with Hatchery-Origin Steelhead**	**Prey of Hatchery-Origin Steelhead**	**Freshwater**	**Estuary**	**Marine**
Spring Chinook Salmon		X		X	X	
Fall Chinook Salmon			X	X	X	Unknown
Summer Chum Salmon[1]						
Winter Steelhead		X		X	X	
Summer Steelhead		X		X	X	
Fall Chum Salmon			X	X	X	Unknown
Pink Salmon			X	X	X	Unknown
Coho Salmon		X		X	X	
Sockeye Salmon			X	X	X	Unknown

[1] No relationships because Dungeness Hatchery steelhead are released after any natural-origin summer chum have emigrated seaward. Summer chum are not present in the Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins.

Hatchery-origin steelhead smolts likely compete with natural-origin steelhead, Chinook salmon, and coho salmon smolts in the freshwater and estuary areas (Table 8), because they are a similar size and would likely eat similar prey. Competition between hatchery-origin steelhead smolts and natural-origin salmon and steelhead smolts is not expected to occur in the marine areas because, once steelhead smolts enter the marine environment, the fish tend to move directly offshore into areas where steelhead are dispersed and not present in numbers that would contribute to density-dependent effects (Hartt and Dell 1986; Light et al. 1989).

Hatchery-origin steelhead smolts may prey upon juvenile natural-origin salmonids at several stages of their life history. Newly released hatchery-origin smolts have the potential to consume naturally produced fry and fingerlings that are encountered in freshwater during downstream migration. Some reports suggest that hatchery-origin fish can prey on fish that are up to one half of their length (Pearsons and Fritts 1999; HSRG 2005), but other studies have concluded that salmonid predators prey on fish one third or less of their length (Horner 1978; Hillman and Mullan 1989; Beauchamp 1990; Cannamela 1992; CBFWA 1996). Hatchery-origin steelhead that do not emigrate and instead take upstream residence near the point of release (residuals) have the potential to prey on rearing natural-origin juvenile fish over a more prolonged period.

Therefore, the risk of hatchery-origin steelhead predation on natural-origin juvenile fish in freshwater and the estuary is dependent upon three factors: (1) the hatchery-origin fish and their potential natural-origin prey must overlap temporally; (2) the hatchery-origin fish and their prey must overlap spatially; and (3) the prey should be less than one third of the length of the predatory fish. Based on comparative fish sizes and timings, early winter steelhead smolts that would be released through the hatchery programs would have spatial and temporal overlap in freshwater and the estuary with smaller subyearling Chinook salmon, fall chum salmon fry, pink salmon fry, and potentially sockeye salmon fry. When combined with spatial and temporal overlap, the large average size of the early winter steelhead smolts poses a risk of predator-prey interactions in freshwater and the estuary for these species and life stages. It is unknown whether these predation risks continue after the species have emigrated from fresh water and dispersed in marine areas. The few diet studies that have been conducted in Puget Sound indicate that the predation risk posed by larger hatchery-origin fish to juvenile salmon is low (Buckley 1999; WDFW 2013a). Predation may be low for the following reasons: (1) due to rapid growth, natural-origin salmon are better able to elude predators and are accessible to a smaller proportion of predators due to size alone; (2) because juvenile salmon disperse soon after entering seawater, they are present in low densities relative to other fish species (e.g., herring); and (3) there has either been learning or selection for some predator avoidance (Cardwell and Fresh 1979).

3.2.3.3 Hatchery Facility Risks

Operating hatchery facilities can impact instream fish habitat in the following ways: (1) reduction in available fish habitat from 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).

Water withdrawals may affect instream fish habitat if they reduce the amount of water in a river between the hatchery's water intake and discharge structures. A full discussion of the effects of water withdrawal can be found in Subsection 3.1, Water Quantity. More detailed information on the risks of salmon and steelhead hatchery facilities on natural-origin salmon and steelhead can be found in Subsection 2.1.4, Hatchery Facilities and Operations, in Appendix B, Hatchery Effects and Methods, in the PS Hatcheries DEIS (NMFS 2014a).

The five early winter steelhead programs (and 25 hatchery programs for salmon, Subsection 3.2.2.3, Salmon Hatchery Programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River Basins) in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins use hatchery facilities that have several instream structures such as water intakes, fish ladders, and weirs. All hatchery intakes on salmon and steelhead streams are screened to prevent fish injury from impingement or permanent removal from streams. NMFS's screening criteria for water withdrawal devices set forth conservative standards that help minimize the biological risk of harming naturally produced salmonids and other aquatic fauna (NMFS 2011a). NMFS periodically updates its screening criteria based on best available science and technology. Consequently, some hatcheries have water intake screens that do not meet NMFS's most current screening criteria, although they meet the screening criteria that were in place when the water intake was installed. Hatchery facilities upgrade their water intake screens as funding becomes available.

McKinnon Pond and Tokul Creek Hatchery water intakes are screened consistent with NMFS's 2011 screening criteria (Table 9). Hurd Creek Hatchery, Kendall Creek Hatchery, Whitehorse Ponds Hatchery, Wallace Hatchery, and Reiter Ponds are screened consistent with older NMFS screening criteria. Screening for the Dungeness River Hatchery's water intake structures (one on the Dungeness River and one on Canyon Creek) are in compliance with NMFS's 2011 screening criteria, but are not in compliance with NMFS's fish passage criteria. The Canyon Creek water intake to the Dungeness River Hatchery is adjacent to a small dam that until recently completely blocked access to upstream salmon spawning habitat. WDFW is in the process of correcting fish passage problems at the location of the Dungeness River structure, with plans to complete work in 2017. The current three structures used to withdraw water from the Dungeness River will be reduced to one structure, which will be passable to upstream and downstream migrating fish (WDFW 2013a). The water intakes at Dungeness River Hatchery and Hurd Creek Hatchery will be screened and made passable to fish consistent with NMFS's 2011 criteria by the summer of 2017. The Kendall Creek Hatchery screens have been identified for replacement but are a lower priority than at other hatcheries, as listed fish do not utilize habitat upstream of the rack on Kendall Creek (WDFW 2014b). The Whitehorse Ponds Hatchery screen has not been identified for replacement. However, listed fish do not utilize habitat upstream of the water intake structure (WDFW 2014c).

Table 9. Compliance of instream structures at hatchery facilities used for five Puget Sound early winter steelhead hatchery programs with NMFS's screening and fish passage criteria.

Facility	Criteria				
	Do Water Intake Screens Meet NMFS' Current Screening Criteria? (NMFS 2011a)	Do Water Intake Screens Meet Older NMFS' Screening Criteria?	Does the Hatchery Facility Operate Any Weirs?	Are Weirs Compliant with NMFS' Current Fish passage Criteria? (NMFS 2011a)	Are All Water Intake Structures Compliant With NMFS' Fish Passage Criteria? (NMFS 2011a)
Dungeness River Hatchery	Yes	No	Yes	Yes	No
Hurd Creek Hatchery	No	Yes	No	N/A	No
Kendall Creek Hatchery	No	Yes	Yes	Yes	No
McKinnon Pond	Yes	Yes	No	N/A	Yes
Whitehorse Ponds Hatchery	No	Yes	Yes	Yes	No
Wallace River Hatchery	No	Yes	Yes	No	No
Reiter Ponds	No	Yes	No	NA	NA
Tokul Creek Hatchery	Yes	Yes	Yes	No	No

Sources: WDFW 2013a; WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e.

A retrofitted intake at the Wallace River Hatchery has been identified as a high priority and design funds have been secured, but project completion depends on the availability of capital funds (WDFW 2014d). Listed species are not associated with the two water supply streams at Reiter Ponds, so the intake structures do not pose a risk to listed species. The water intake at the Tokul Creek Hatchery poses an upstream migration barrier and does not meet NMFS's 2011 fish passage criteria. Specific passage improvements in Tokul Creek are aimed at improving passage for adult Chinook salmon above the diversion dam into about 0.55 mile of potential habitat, and to improve fish screening at the water intake. Fish passage improvements are currently in the permitting phase (WDFW 2014e). The U.S. Army Corps of Engineers is the lead agency responsible for NEPA analyses of the potential improvements under the Clean Water Act.

The early winter steelhead and salmon hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins use several weirs to collect broodstock and/or manage adult returns. With the exception of the Tokul Creek Hatchery, all weirs are compliant with NMFS's 2011 criteria for fish passage (Table 9). A weir is a barrier to fish movement. The biological risks associated with weirs include the following:

- Isolation of formerly connected populations
- Limiting or slowing movement of non-target fish species
- 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

By blocking migration and concentrating salmon and steelhead into a confined area, weirs may also increase predation efficiency of mammalian predators (RIST 2009). The following summarizes the use of weirs at hatchery facilities that rear early winter steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins.

Dungeness River Hatchery: The weir and trap used to collect early winter steelhead as broodstock for the Dungeness River Hatchery program does not present any biological risks to natural fish populations. Steelhead broodstock are collected as volunteers to Dungeness River Hatchery. The facility is located away from listed natural-origin salmon and steelhead migration and rearing areas.

Hurd Creek Hatchery: No weir operates in conjunction with the early winter steelhead program.

Kendall Creek Hatchery: The weirs and trap for adult steelhead broodstock collection at Kendall Creek Hatchery do not affect migration or spatial distribution of natural-origin juvenile and adult Chinook salmon, steelhead, fall chum salmon, and pink salmon because the weirs are removed from migration and rearing areas for these fish species. Natural-origin coho salmon and sea-run cutthroat trout are encountered at the Kendall Creek weirs. Measures are applied to ensure that any coho salmon and cutthroat trout reaching the first weir and entering the adult collection pond are passed upstream above the second weir without delay to allow the fish to spawn naturally. Due to large picket spacing that allows unimpeded passage for juvenile fish, the Kendall Creek Hatchery weirs pose no risks to downstream migrating juvenile coho salmon or cutthroat trout.

McKinnon Pond: No weir operates in conjunction with the early winter steelhead program.

Whitehorse Ponds Hatchery: The weir for adult steelhead broodstock collection at Whitehorse Ponds Hatchery does not affect any natural-origin juvenile and adult salmon and steelhead because it is located in a small, off-channel creek, which is located away from natural-origin salmon and steelhead migration and rearing areas.

Wallace River Hatchery: The Wallace River Hatchery uses two water intakes, one in May Creek and another on the Wallace River. An instream trap is located in May Creek, and a weir placed across the Wallace River in early June each year, are used to obtain early winter steelhead broodstock. The weir in the Wallace River is removed around October 1 each year. Chinook salmon are not passed above the May Creek weir, but they are passed above the Wallace River intake and weir.

Reiter Ponds: No weir operates in conjunction with the early winter steelhead program.

Tokul Creek Hatchery: No weirs are operated in conjunction with the Tokul Creek Hatchery. A trap is used to collect early winter hatchery-origin steelhead broodstock that volunteer to the Tokul Creek Hatchery and does not present any biological risks to natural fish populations.

Instream maintenance may include clearing of debris and bedload from hatchery intake screens and fish ladders or protecting banks from erosion. Instream maintenance such as clearing of debris and bedload from hatchery intake screens and fish ladders or protecting banks from erosion may increase stream sedimentation, but maintenance activities are usually small in scale and duration, and return conditions to what they were when structures were first constructed.

3.2.3.4 Masking

As described in Subsection 3.2.3.1, Genetic Risks, although there is some overlap in spawn timing, the spawning time of early winter hatchery-origin steelhead substantially precedes the spawning time of natural-origin winter steelhead (Myers et al. 2015). Historically, it is believed that natural-origin early returning and later returning steelhead spawned in Puget Sound river basins, but the natural-origin early returning component is minimally present currently. However, in a recent unpublished report on fish spawning in Skagit River tributaries, McMillan (2015) suggests that overlap may be greater than indicated by the literature. However, for the purposes of this analysis, due to the separation in spawning timing, NMFS concludes that the negative effect of early winter hatchery-origin steelhead on determining the status of natural-origin steelhead is negligible.

3.2.3.5 Incidental Fishing Effects

Fisheries targeting hatchery-origin fish may have incidental impacts on natural-origin fish. Information on the risks to natural-origin fish from harvest can be found in Subsection 2.1.5, Harvest Management, in Appendix B, Hatchery Effects and Methods, in the PS Hatcheries DEIS (NMFS 2014a).

Implementation of mark-selective fishing rules for steelhead began in Puget Sound in the 1990s. Under selective fishing rules, anglers have only been able to retain steelhead with a clipped adipose fin. One hundred percent of the early winter hatchery-origin steelhead are mass-marked by having their adipose fins removed prior to their release (adipose clipped). The fisheries targeting early winter hatchery-origin steelhead generally start in November and end by late February. Cool water temperatures during those months minimize incidental mortality on listed natural-origin steelhead that are caught and released[5]. In addition, because the steelhead fisheries targeting early winter hatchery-origin steelhead close before most of the natural-origin steelhead arrive, the number of natural-origin steelhead that are caught and released would be low. However, in a recent unpublished report describing fish spawning in Skagit River tributaries, McMillan (2015) suggests that overlap may be greater. Because of their earlier freshwater migration timing, natural-origin summer steelhead in the Nooksack, Stillaguamish, and Snoqualmie/Tolt Rivers may be subject to catch and release effects to a greater extent than winter run steelhead[6]. Effects would remain low, however, because of the tendency for summer steelhead to migrate into and hold in upstream areas and tributaries of the watershed where they would be less susceptible to harvest in fisheries targeting early winter steelhead.

[5] Direct studies on hook and releases mortality of steelhead have not been done in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River Basins. Nelson et al. (2005) showed catch and release mortalities of 1.4 percent to 5.8 percent in 1999 and 2000 respectively on steelhead caught in recreational fisheries on the Chilliwack River in British Columbia. This study also showed no indication of increased mortality on fish that had been caught and released multiple times. A hook-and-line mortality study conducted in the Samish River on winter-run steelhead also showed similar results, although it indicated that there may be a negative relationship between a fish being caught in a sport fishery and their survival to out-migration as kelts (Ashbrook et al. in press). Taylor and Barnhart (1999) determined that summer steelhead caught and released in the Mad and Trinity Rivers of California had a 9.5 percent mortality rate, with 83 percent of the mortalities occurring at water temperatures of 21°C or greater. Based on best available information, hooking mortality associated with recreational harvest is generally believed to be less than 10 percent of fish hooked and released.

[6] Adults from extant populations of winter steelhead return from December to May, and peak spawning occurs in March through May. Summer steelhead adults return from May through October and peak spawning occurs the following January to May (Hard et al. 2007).

Prior to the 1990s, hatchery-origin steelhead were not mass-marked with an adipose clip. Therefore, anglers could not easily differentiate between natural-origin and hatchery-origin steelhead. Fish managers tried to minimize harvest impacts on natural-origin winter-run steelhead by closing the fisheries that targeted earlier arriving hatchery-origin steelhead before the natural-origin winter-run populations arrived. However, fishermen may have inadvertently harvested the earliest-returning natural-origin steelhead, which may have changed the overall run timing of the population (i.e., evidence suggests that, historically, the natural-origin winter-run steelhead population had a larger proportion of adult fish returning prior to February [Myers et al. 2015]; see also McMillan 2015).

Where the status of a natural-origin salmon or steelhead population is healthy enough, catch and release or harvest fishing opportunities for those natural-origin fish may be developed and approved even for natural-origin populations that are listed as threatened under the ESA. For example, such recreational fisheries have been approved for listed natural-origin coho salmon (NMFS 2009). However, no such circumstances or targeted fisheries currently exist for natural-origin steelhead in Puget Sound, although some interests promote that approach in some cases (e.g., catch and release fishing for natural-origin Skagit River steelhead).

3.2.3.6 Risk of Disease Transfer

Interactions between hatchery-origin fish and natural-origin fish in the environment may result in the transmission of pathogens if either the hatchery-origin or the natural-origin fish are harboring fish disease (Table 10). This impact may occur in tributary areas where hatchery-origin fish are released and throughout the migration corridor where hatchery-origin and natural-origin fish may interact. As the pathogens responsible for fish diseases are present in both hatchery-origin and natural-origin populations, there is some uncertainty associated with determining the source of the pathogen (Williams and Amend 1976; Hastein and Lindstad 1991). Hatchery-origin fish may have an increased risk of carrying fish disease pathogens because of relatively high rearing densities that increase stress and can lead to greater manifestation and spread of disease within the hatchery-origin population. Consequently, it is possible that the release of hatchery-origin salmon and steelhead may lead to an increase of disease in natural-origin salmon and steelhead populations.

Table 10. Common fish pathogens found in hatchery facilities.

Pathogen	Disease	Species Affected
Renibacterium salmoninarum	Bacterial Kidney Disease (BKD)	Chinook salmon, chum salmon, coho salmon, steelhead, and sockeye salmon
Ceratomyxa shasta	Ceratomyxosis	Chinook salmon, steelhead, coho salmon, and chum salmon
Flavobacterium psychrophilum	Coldwater Disease	Chinook salmon, chum salmon, coho salmon, steelhead, and sockeye salmon
Flavobacterium columnare	Columnaris	Chinook salmon, chum salmon, coho salmon, steelhead, and sockeye salmon
Yersinia ruckeri	Enteric Redmouth	Chinook salmon, chum salmon, steelhead, and sockeye salmon
Aermonas salmonicida	Furunculosis	Chinook salmon, chum salmon, coho salmon, steelhead, and sockeye salmon
Infectious hematopoetic necrosis	IHN	Chinook salmon, steelhead, chum salmon, and sockeye salmon
Saprolegnia parasitica	Saprolegniasis	Chinook salmon, coho salmon, steelhead, chum salmon, and sockeye salmon

Sources: IHN database http://gis.nacse.org/ihnv/ ;
http://www.nwr.noaa.gov/Salmon-HarvestHatcheries/Hatcheries/Hatchery-Genetic-Mngmnt-Plans.cfm.

WDFW's hatchery facilities are operated in compliance with all applicable fish health guidelines (Pacific Northwest Fish Health Protection Committee 1989; IHOT 1995; WDFW and WWTIT 1998, updated 2006). These fish health guidelines ensure that fish health is monitored, sanitation practices are applied, and hatchery-origin fish are reared and released in healthy conditions. Pathologists from WDFW's Fish Health Section monitor hatchery programs monthly (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). Exams performed at each life stage may include tests for virus, bacteria, parasites, or pathological changes.

3.2.3.7 Risk of "Mining" Natural-origin Salmon and Steelhead

Incorporating natural-origin fish into a hatchery broodstock can reduce the abundance and spatial structure of the natural-origin population, which is commonly referred to as "mining." Under existing conditions, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins, there is no risk of "mining," because the programs do not "mine" the natural-origin populations by incorporating natural-origin fish into their broodstock (Table 11). This risk only applies to hatchery programs that use natural-origin fish for broodstock.

Table 11. Broodstock needs and natural-origin abundance information for five early winter steelhead hatchery programs Puget Sound.

River Basin of Hatchery Program	Broodstock Needs	Percentage of Natural-origin Steelhead in Broodstock (%)	Percentage of Hatchery-origin Steelhead in Broodstock (%)	Average Abundance of Natural-origin Winter Steelhead Population	TRT Interim Viable Abundance Target
Dungeness	Up to 30 with a 1:1 sex ratio	0	100	487[a]	1,232
Nooksack	Up to 100 with a 1:1 sex ratio	0	100	1,760[b]	11,023
Stillaguamish	Up to 120 with a 1:1 sex ratio	0	100	1,852[c]	9,559
Skykomish	Up to 300 with a 1:1 sex ratio	0	100	1,683[d]	10,695
Snoqualmie	Up to 100 with a 1:1 sex ratio	0	100	955[d]	8,370

Sources: WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e; Hard et al. (2015).
[a]Abundance based on average abundance in 2011 and 2013. Surveys in 2010, and particularly in 2012, were cut short due to high water levels associated with spring rain and snow runoff; however escapement estimates can be obtained through the use of timing curves from other comparable river systems. The Jamestown S'Klallam Tribe has completed estimates of spawners for the entire season for 2011 and 2013. An estimated 410 fish spawned in 2011, and an estimated 564 fish spawned in 2013 after March 10. Prior to 2010, the last escapement estimate for Dungeness winter steelhead was in the 2000/2001 season with an estimated escapement of 183 based on index areas.
[b] Average escapement 2004 through 2012.
[c] Average abundance 2001 through 2012.
[d] Average abundance 2001 through 2013.

3.2.3.8 Population Viability Benefits

Some salmon and steelhead hatchery programs can contribute to the viability of natural-origin populations in terms of their abundance, spatial structure, diversity, and productivity. Hatchery programs may also have negative effects on population viability via mechanisms discussed in Subsection 3.2, Salmon and Steelhead (especially Subsection 3.2.3.1, Genetic Risks; and Subsection 3.2.3.2, Competition and Predation). Detailed information on the population viability benefits of hatchery programs to natural-origin salmon and steelhead can be found in Subsection 2.2.2, Benefits – Viability, in Appendix B, Hatchery Effects and Methods, in the PS Hatcheries DEIS (NMFS 2014a).

3.2.3.9 Nutrient Cycling

Hatchery-origin adults that return and spawn naturally can contribute to the amount of marine derived nutrients in freshwater systems. For a review of marine-derived nutrients contributed by salmon and steelhead Puget Sound watersheds, see Subsection 3.2.3.7, Benefits – Marine-derived Nutrients, in the PS Hatcheries DEIS NMFS (2014a). Compared to other species, the contribution of hatchery-origin steelhead to marine-derived nutrients is negligible, and will not be considered further in this EIS. Information on the marine-derived nutrient benefits of hatchery programs on natural-origin salmon and steelhead can be found in Subsection 2.2.3, Benefits – Marine-derived Nutrients, in Appendix B, Hatchery Effects and Methods, in the PS Hatcheries DEIS (NMFS 2014a).

3.3 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 steelhead release numbers and hatchery program type may affect other fish species. Additional information on other fish species in the analysis area and effects associated with Puget Sound hatchery programs can be found in Subsection 3.2, Fish, in the PS Hatcheries DEIS (NMFS 2014a).

Many fish species other than salmon and steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins and other adjacent nearshore marine areas have a relationship with steelhead as prey, predators, or competitors (Table 12). The analysis area for other fish species includes the geographic area where the Proposed Action would occur (Subsection 1.4, Project and Analysis Areas), and includes marine areas in Puget Sound (Subsection 1.4, Project and Analysis Areas).

The analysis area is not considered as one of the geographical areas occupied by the ESA-listed southern DPS of Pacific eulachon (76 Fed. Reg. 65324, October 20, 2011). Therefore, risks to the species will not be considered further in the EIS.

Pacific lamprey and Western brook lamprey are Federal "species of concern" and are Washington State "monitored species." In marine areas, several species of rockfish are listed as threatened under the ESA (Table 12). Pacific herring (a forage fish for salmon and steelhead) is a Federal species of concern and a State candidate species. All of these species have a range that includes the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins or nearby marine areas. However, none of these species is located exclusively in these areas, and these areas are generally a very small part of their total range (e.g., Subsection 3.2, Fish, in the PS Hatcheries DEIS [NMFS 2014a]). Therefore, risks to these species from early winter steelhead hatchery programs will not be considered further in the EIS.

Table 12. Range and status of other fish species that may be affected by five early winter steelhead hatchery programs in Puget Sound.

Species	Federal/State Listing Status	Type of Interaction with Salmon and Steelhead[1]
Bull trout	Federally listed as threatened	• Freshwater predator on salmon and steelhead eggs and juveniles • May compete with salmon and steelhead for food • May benefit from additional marine-derived nutrients
Rainbow trout	Not listed	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May interbreed with steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Coastal cutthroat trout	Not listed	• Predator of salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May interbreed with steelhead • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Pacific, river, and brook lamprey	Not listed. Pacific lamprey and river lamprey are federal species of concern, river lamprey is a Washington State candidate species,	• Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May be a parasite on salmon and steelhead while in marine waters • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
White sturgeon	Not federally listed	• May compete with salmon and steelhead for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Margined sculpin	WDFW species of concern	• Predator on salmon and steelhead eggs and fry • Potential prey item for adult salmon and steelhead • May compete with salmon and steelhead for food and space • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Umatilla and leopard dace	Not federally listed, Washington State candidate species	• May compete with salmon and steelhead for food • May benefit from additional marine-derived nutrients provided by hatchery-origin fish
Mountain sucker	Not federally listed, Washington State species of concern	• Occurs in similar freshwater habitats, but is a bottom feeder and has a different ecological niche • May benefit from additional marine-derived nutrients provided by hatchery-origin fish

Table 12. Range and status of other fish species that may be affected by five early winter steelhead hatchery programs in Puget Sound (continued).

Species	Federal/State Listing Status	Type of Interaction with Salmon and Steelhead[1]
Northern pikeminnow	Not listed	• Freshwater predator on salmon and steelhead eggs and juveniles • May compete with salmon and steelhead for food • May benefit from additional marine-derived nutrients
Rockfish	Several species are federally listed as threatened and/or have State Candidate listing status[2]	• Predators of juvenile salmon and steelhead • Juveniles are prey for juvenile and adult salmon • May compete with salmon and steelhead for food
Forage fish	Pacific herring is a federal species of concern and a Washington State candidate species	• Prey for juvenile and adult salmon and steelhead • May compete with salmon and steelhead for food

Sources: Finger 1982; Horner 1978; Krohn 1968; Maret et al 1997; Polacek et al 2006; WDFW 2013b; Beamish 1980.

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

[2] Georgia Basin bocaccio DPS (*Sebastes paucispinis*) - Federally listed as endangered and state candidate species; Georgia Basin yelloweye rockfish DPS (*S. ruberrimus*) - Federally listed as threatened and state candidate species; Georgia Basin canary rockfish DPS (*S. pinniger*) - Federally listed as threatened and state candidate species; Black, brown, China, copper, green-striped, quillback, red-stripe, tiger, and widow rockfish are state candidate species.

In addition to Chinook salmon and steelhead, bull trout in the project area are also listed as a threatened fish species under the ESA. Bull trout in the five river basins are comprised of populations that are included as part of the "core areas" for the listed Puget Sound/Washington Coastal bull trout DPS: Dungeness River, Snohomish/Skykomish River, Stillaguamish River, and Nooksack River (USFWS 2004).

Under existing conditions, bull trout may be affected by the early winter steelhead hatchery programs primarily through facility operations (water intakes) (Subsection 3.2.8, Washington Coastal-Puget Sound Bull Trout DPS in the PS Hatcheries DEIS [NMFS 2014a], and Subsection 3.4, Washington Coastal-Puget Sound Bull Trout in Appendix B of the PS Hatcheries DEIS [NMFS 2014a]). Adverse effects on the listed Puget Sound/Washington Coastal bull trout DPS or its four component populations in the analysis area are negligible to low under existing conditions, for the following reasons: (1) bull trout would largely benefit from hatchery-origin steelhead releases because they may eat juvenile steelhead; (2) few bull trout would be expected to be intercepted at hatchery weirs and during in-river broodstock collection activities because primary spawning and rearing habitat for bull trout is well away from hatchery operations.

Overall, as described in other environmental analyses of Puget Sound hatchery programs (e.g,, Subsection 3.2, Fish, in the PS Hatcheries DEIS [NMFS 2014a]; and Dungeness Hatcheries DEA [NMFS

2015b]), under existing conditions the effects of steelhead on other fish species (freshwater species, including bull trout) in the analysis area are considered low or negligible.

3.4 Wildlife – Southern Resident Killer Whale

This subsection describes existing conditions for wildlife. It is narrowed to a discussion of Southern Resident killer whales that may be affected by the alternatives (Subsection 3, Affected Environment [introduction]), specifically, how changes in steelhead release numbers and hatchery program type may affect this species. Additional information on other wildlife species in the analysis area and effects associated with Puget Sound hatchery programs can be found in Subsection 3.5, Wildlife, in the PS Hatcheries DEIS (NMFS 2014a).

Hatchery operations have the potential to affect wildlife by changing the total abundance of salmon and steelhead prey or predators in aquatic and marine environments. Many wildlife species consume salmon and steelhead, which may benefit their survival and productivity through the nourishment provided. Increases or decreases in the abundance of juvenile and adult steelhead in the river basins associated with the early winter steelhead hatchery operations may, therefore, affect the viability of wildlife species that prey on these steelhead. In general, hatcheries could affect wildlife through transfer of toxic contaminants from hatchery-origin fish to wildlife, the operation of weirs (which could block or entrap wildlife, or conversely, make salmon and steelhead easier to catch through their corralling effect), or predator control programs (which may harass or kill wildlife preying on juvenile salmon at hatchery facilities).

The analysis area for wildlife resources includes the geographic area where the Proposed Action would occur (Subsection 1.4, Project and Analysis Areas), including marine areas in Puget Sound (Subsection 1.4, Project and Analysis Areas). 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 steelhead as described in Subsection 3.5, Wildlife, in the PS Hatcheries DEIS (NMFS 2014a). The PS Hatcheries DEIS (NMFS 2014a) found that effects of salmon and steelhead hatchery programs on wildlife species are generally negligible, and wildlife species in the analysis area would continue to occupy their existing habitats in similar abundances and feed on a variety of prey, including salmon and steelhead.

Six wildlife species occur in the analysis area that are federally listed as endangered or threatened under the ESA. Four of the species (spotted owl, Canada lynx, grizzly bear, and humpback whale) have little to no relationship with salmon and steelhead in the wildlife analysis area, or with salmon and steelhead hatcheries and for whom impacts associated with the alternatives would be negligible (Subsection 3.5.3.1, ESA-listed Species, in the PS Hatcheries DEIS [NMFS 2014a]). Of the remaining listed species (Southern Resident killer whale and marbled murrelet), effects of salmon and steelhead hatchery programs would be expected to be negligible. However, although effects on Southern Resident killer whales are expected to be negligible (Subsection 3.5, Wildlife, in the PS Hatcheries DEIS [NMFS 2014a]) in the wildlife analysis area and, they are analyzed in this EIS because of their special interest to the public.

The Southern Resident killer whale is listed under the ESA as endangered and is present in marine areas in the analysis area. As described in Subsection 3.5.3.1.1, Killer Whale, in the PS Hatcheries DEIS (NMFS 2014a) and references therein, Southern Resident killer whales' primary prey in inland marine waters during the summer months is Chinook salmon, even when other salmon species are more abundant. Chum salmon are more important in their diet in inland waters in the fall. There is no evidence that Southern Resident killer whales distinguish between hatchery-origin and natural-origin salmon. Adults from hatchery releases have partially compensated for declines in natural-origin salmon and may have benefited Southern Resident killer whales.

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. Early winter steelhead likely have a negligible positive effect on the diet of Southern Resident killer whales under existing conditions because early winter hatchery-origin steelhead comprise a very small part of the food base provided by total number of juvenile and adult hatchery-origin and natural-origin salmon (especially Chinook salmon) and steelhead available from throughout the greater Puget Sound, the Strait of Georgia, and Pacific Coast area (Subsection 3.5.3.1.1, Killer Whale, in the PS Hatcheries DEIS [NMFS 2014a]).

3.5 Socioeconomics

Socioeconomics is the study of the relationship between economics and social interactions with affected regions, communities, and user groups. In addition to providing fish for harvest, hatchery programs directly affect socioeconomic conditions in regions where the hatchery facilities operate. Hatchery facilities generate economic activity (personal income and jobs) by providing employment opportunities and through local procurement of goods and services for hatchery operations (e.g., fish food). Described in this subsection are socioeconomic conditions associated with early winter steelhead hatchery programs located in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins (Table 1), including hatchery employment, program costs and expenditures; regional economic values associated with recreational fisheries supported by the hatchery programs (determined by angling effort and harvest); and communities affected by hatchery operations and steelhead fisheries.

Recreational fishing for steelhead in the State of Washington is very popular. Since the early 1990s, recreational harvest of steelhead in Puget Sound rivers has been confined to hatchery-origin steelhead, resulting from the implementation of conservation measures to protect natural-origin steelhead by allowing retention of only hatchery-origin steelhead. As described in Subsection 3.3.2.6, Steelhead Fisheries, in the PS Hatcheries DEIS (NMFS 2014a), steelhead fisheries in Puget Sound target hatchery production (primarily early winter steelhead), with the exception of hatchery-origin summer-run steelhead in the Stillaguamish River and Snohomish River systems. As described in Subsection 3.2.3.5, Incidental Fishing Effects, the run timing of early winter hatchery-origin steelhead tends to be earlier than natural-origin winter steelhead, enabling fisheries to target hatchery-origin fish with low incidental mortality to natural-origin winter steelhead. Recreational fishing for steelhead also involves anglers that prefer to catch and release fish, rather than to retain them, but estimates of the level of this activity are not available for Puget Sound, and would not be expected to change under the alternatives.

The analysis area for socioeconomics includes the geographic area where the Proposed Action would occur (Subsection 1.4, Project and Analysis Areas), and includes Clallam, Whatcom, Snohomish, and King Counties. These are the counties containing the communities that are primarily affected by fisheries targeting early winter steelhead produced in the five hatchery programs. Additional information on the socioeconomic methods can be found in Appendix C, Socioeconomics Methods.

3.5.1 Hatchery Operations

The contribution of the five hatchery programs to local and regional economies includes direct employment, operation and maintenance costs, and direct hatchery expenditures. The total number of full-time equivalent (FTE) jobs associated with the eight hatchery facilities used to support the five early winter steelhead programs is 19.3 (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). The number of FTEs associated with the five early winter steelhead programs by hatchery facility is:

Dungeness River Program
- Dungeness River Hatchery: 3.0 FTEs
- Hurd Creek Hatchery: 2.5 FTEs

Kendall Creek Program
- Kendall Creek Hatchery and McKinnon Pond: 4.3 FTEs

Whitehorse Ponds Program
- Whitehorse Ponds: 2.1 FTEs

Snohomish/Skykomish Program
- Wallace Hatchery: 3.5 FTEs
- Reiter Ponds: 1.5 FTEs

Tokul Creek Program
- Tokul Creek Hatchery: 2.4 FTEs

Annual operations and maintenance expenditures for the eight facilities are estimated to cost a total of $2.02 million (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). These expenditures provide economic benefits to local economies, particularly small communities with commercial businesses in close proximity to the hatcheries. The economies of the following small communities in the analysis area are believed to be particularly affected by early winter steelhead hatchery operations in each basin:

- Dungeness River basin: Sequim (Clallam County)
- Nooksack River basin: Bellingham and Ferndale (Whatcom County)
- Stillaguamish River basin: Stanwood, Arlington, and Darrington (Snohomish County)
- Snohomish/Skykomish River basin: Snohomish, Monroe, and Sultan (Snohomish County)
- Snoqualmie River basin: Monroe, Duvall, Carnation, and Fall City (King County)

Direct hatchery-related expenditures for labor and procurement of supplies also generate economic activity, both locally (near where the hatcheries operate) and in more distant areas where more goods and services are available. Personal income directly and indirectly attributable to hatchery operations at the eight hatchery facilities currently totals about $1.77 million annually. Of this total personal income, early winter steelhead hatchery programs account for $496,000, or 28 percent of the total, representing a low positive impact in the analysis area. This personal income not only affects the communities identified above, but other communities in the analysis area as well.

The expenditures to produce hatchery-origin juveniles that are released from early winter steelhead hatchery programs account for the costs of production, but do not describe the extent to which fish from each program contribute as fish that return as adults for harvest purposes. Producing fish that contribute to harvest is the goal of the five early winter steelhead hatchery programs (Subsection 3.2.2.4, Background on Existing Early Winter Steelhead Hatchery Programs). Survival of juveniles to the adult return stage may vary for each program. Based on the numbers of hatchery-origin adults that return from the five hatchery programs, WDFW (2009) estimated the cost of each adult fish to be $84 per fish for the Dungeness program (releases from Dungeness Hatchery and Hurd Creek Hatchery), $286 per fish for the Nooksack program (releases from Kendall Creek Hatchery), $92 per fish for the Stillaguamish program (releases from Whitehorse Ponds Hatchery), $40 per fish for the Skykomish program (releases from Wallace River Hatchery, $18 per fish for releases from Reiter Ponds, and $53 per fish for the Snoqualmie program (releases from Tokul Creek Hatchery). However, because these costs per adult values would be the same under the alternatives, this information is not analyzed further in the EIS

3.5.2 Fisheries

In addition to the economic benefits of hatchery operations to local and regional economies, steelhead produced from the five early winter steelhead hatchery programs contribute to recreational, and tribal commercial and ceremonial and subsistence fisheries in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. The Skykomish River and Snoqualmie River are major tributaries in the Snohomish River basin, and releases of early winter hatchery-origin steelhead from the hatchery programs in the Skykomish and Snoqualmie River basins also contribute to harvest and related benefits of downstream fisheries in the Snohomish River. In total, hatchery programs in the five river basins produce about 50 percent of the hatchery-origin winter and summer steelhead released into Puget Sound rivers annually for the purposes of augmenting fisheries harvests[7], including recreational fisheries and tribal commercial and ceremonial and subsistence fisheries. There is no non-tribal commercial harvest of steelhead.

Based on estimates of harvest from the 2004 to 2005 through 2013 to 2014 steelhead fishing seasons from the WDFW Sport Catch Reports (Appendix C, Socioeconomics Methods), production of early winter steelhead from the five programs is estimated to support, on average, an annual recreational harvest of 4,412 adult hatchery-origin fish. Of this total, average harvest includes 42 fish in the Dungeness River basin, 143 fish in the Nooksack River basin, 404 fish in the Stillaguamish River basin, 2,226 fish in the Skykomish River basin, and 1,597 fish in the Snoqualmie River basin (Appendix C, Socioeconomics Methods). As indicated above, early winter steelhead hatchery production also supports limited tribal fisheries, providing a small number of steelhead for commercial and ceremonial and subsistence harvests. Tribes that benefit from this production include the Lummi Nation, Nooksack Tribe, Stillaguamish Indian Tribe, Tulalip Tribes, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe.

Fisheries supported by the five hatchery programs contribute to local economies through the purchase of goods and supplies associated with fishing, and by the retention of local services such as outfitter and guiding services. For example, supplies needed for fishing include fishing gear and camping equipment; the purchase of travel-related goods and services includes food and drinks, fuel, and miscellaneous retail goods at local businesses. Angler expenditures on fishing-related goods and services would be expected to contribute to both local and non-local businesses (from expenditures by out-of-area visitors); however,

[7] The early winter steelhead programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins produce up to 620,000 fish annually for harvest augmentation purposes. The total number of steelhead released for harvest augmentation purposes in all Puget Sound tributaries is about 1,243,000 (including early winter steelhead, summer steelhead, and integrated winter steelhead) (Appendix A, Puget Sound Salmon and Steelhead Hatchery Programs and Facilities).

it is uncertain how dependent these businesses are on fishing-related expenditures, specifically those related to steelhead fishing.

Recreational fishing effort for early winter hatchery-origin steelhead in the five river basins is estimated at about 78,400 angler trips. This estimate is based on an average catch per unit of effort of 17.77 trips per fish caught (Appendix C, Socioeconomics Methods). Based on an average regional economic impact factor of $67.30 per angler trip, current production from early winter steelhead hatchery programs is estimated to generate about $5.3 million annually in regional economic income.

Salmon (and steelhead) fishing has been a focus for tribal economies, cultures, lifestyles, and identities for over 1,000 years (Gunther 1950; Stein 2000). Beyond generating jobs and income for contemporary commercial tribal fishers, salmon and steelhead are regularly eaten by individuals and families, and are served at gatherings of elders at traditional dinners and other ceremonies. To Native American tribes, salmon and steelhead are a core symbol of tribal and individual identity (Stay 2012; NWIFC 2013). The survival and well-being of salmon and steelhead are seen as extricable linked to the survival and well-being of Indian people and their cultures (Meyer Resources Inc. 1999). Salmon and steelhead evoke sharing, gifts from nature, responsibility to the resource, and connection to land and water.

Puget Sound treaty tribes use salmon and steelhead in various ways, including personal and family consumption, informal and formal distribution and community sharing, and ceremonial uses (Amoss 1987). As noted in the PS Hatcheries DEIS (NMFS 2014a) tribal commercial incidental steelhead harvest averaged 604 fish from 2002 to 2006 (range 260 to 787 fish). Most tribal steelhead fisheries occur in freshwater areas. Tribal fishers also harvest some steelhead in commercial, ceremonial, and subsistence fisheries (primarily using set nets). Therefore, for the purposes of this analysis, early winter steelhead hatchery programs are assumed to have a moderate positive effect on affected tribes.

Overall, considering the socioeconomic values from hatchery operations and fishing activities associated with the five early winter steelhead hatchery programs, for the purposes of this analysis NMFS concludes the hatchery programs have a moderate positive effect on socioeconomic conditions in the analysis area. This is because the five early winter steelhead hatchery programs support an estimated 78,400 angler trips and are estimated to generate a total $5.8 million ($496,000 in income from hatchery operations, and $5.3 million from recreational fishing) to persons and businesses in the analysis area annually. Most of the personal income benefits would be expected to occur in or near the 13 communities within the four counties identified in Subsection 3.5.1, Hatchery Operations, where most of the affected fisheries occur and where the hatchery facilities are located. The positive effects of angler spending and hatchery operations occur throughout Clallam, Whatcom, Snohomish, and King Counties where the hatchery facilities and fisheries are located, but are likely most substantial in Snohomish County where 41 percent of the production of early winter steelhead occurs (a total of 256,000 of 620,000 fish produced at Wallace Hatchery and Reiter Ponds).

3.6 Environmental Justice

This subsection was prepared in compliance with Presidential Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations* (EO 12898), dated February 11, 1994, and Title VI of the Civil Rights Act of 1964.

Executive Order 12898 (see 59 Fed. Reg. 7629, February 16, 1994) states that Federal agencies shall identify and address, as appropriate "…disproportionately high and adverse human health or environmental effects of [their] programs, policies and activities on minority populations and low-income populations…." While there are many economic, social, and cultural elements that influence the viability and location of such populations and their communities, certainly 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 EO 12898 and Title VI address persons belonging to the following target populations:

- Minority – all people of the following origins: Black, Asian, American Indian and Alaskan Native, Native Hawaiian or Other Pacific Islander, and Hispanic[8]

- Low income – persons whose household income is at or below the U.S. Department of Health and Human Services poverty guidelines.

Definitions of minority and low income areas were established on the basis of the Council on Environmental Quality's (CEQ's) *Environmental Justice Guidance under the National Environmental Policy Act* of December 10, 1997. CEQ's *Guidance* states that "minority populations should be identified where either (a) the minority population of the affected area exceeds 50 percent or (b) the population percentage of the affected area is meaningfully greater than the minority population percentage in the general population or other appropriate unit of geographical analysis." The CEQ further adds that "[t]he selection of the appropriate unit of geographical analysis may be a governing body's jurisdiction, a neighborhood, a census tract, or other similar unit that is chosen so as not to artificially dilute or inflate the affected minority population."

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

The CEQ guidelines do not specifically state the percentage considered meaningful in the case of low-income populations. For this EIS, the assumptions set forth in the CEQ guidelines for identifying and evaluating impacts on minority populations are used to identify and evaluate impacts on low-income populations. More specifically, potential environmental justice impacts are assumed to occur in an area if the percentages of minorities and percentage below poverty level are markedly greater than the percentages of minorities and percentage below poverty level in their state as a whole (i.e., Washington). Similarly, potential environmental justice impacts are assumed to occur in an area if the per capita income is markedly less than the per capita income for the state as a whole.

The analysis area for environmental justice is the same as for socioeconomics and includes the geographic area where the Proposed Action would occur (Subsection 1.4, Project and Analysis Areas), including the geographic areas of Clallam, Whatcom, Snohomish, and King Counties. The early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins raise and release fish in Clallam, Whatcom, Snohomish, and King Counties. These are also the counties that are primarily affected by fisheries targeting early winter steelhead produced in these hatchery programs.

Clallam and Whatcom Counties are environmental justice communities of concern because 5.5 percent of the population of Clallam County and 3.1 percent of the population of Whatcom County is American Indian/Alaskan Native compared to 1.8 percent for the state as a whole (Table 13). In addition, the per capita income is $25,865 for Clallam County and $26,530 for Whatcom County, which is meaningfully less than the per capita income of $30,742 for the state as a whole (Table 13). Whatcom County’s poverty level (16.4 percent of the population) also meaningfully exceeds the poverty level of the state as a whole (13.4 percent of the population) (Table 13).

Table 13. Population size, percent minority, per capita income, and percent below poverty level in Clallam, Whatcom, Snohomish, and King Counties and Washington State.

Indicator	Clallam County	Whatcom County	Snohomish County	King County	Washington State
Population (2013)	72,350	205,800	730,500	1,981,900	6,882,400
Percent Black (%)	0.9	1.1	2.7	6.5	3.8
Percent American Indian/Alaskan Native (%)	5.5	3.1	1.6	1.0	1.8
Percent Asian and Pacific Islanders (%)	1.6	4.0	9.7	15.9	8.1
Percent Hispanic (%)	5.3	8.2	9.3	9.4	11.7
Per Capita Income ($)	25,865	26,530	31,349	39,911	30,742
Percent of persons below poverty level, 2009-2013 (%)	14.6	16.4	10.4	11.5	13.4

Shading of cells represents values that meaningfully exceeded (by 10 percent or greater) those of the reference population (Washington State), making them environmental justice communities of concern.
Sources: Population statistics: 2013 Washington State Data Book. Washington Office of Financial Management. 2014. Available at : http://www.ofm.wa.gov/localdata/default.asp
Economic statistics: U.S. Bureau of Census. 2013. State/County QuickFacts. Available at: http://quickfacts.census.gov/qfd/states/53/53009.html
Both accessed July 29, 2015

Based on per capita income and poverty level, Snohomish County and King County are not environmental justice communities of concern (Table 13). However, the percentage of the King County population that is Black (6.5 percent of the population), and the percentages of the King County and Snohomish County populations that are Asian and Pacific Islander are meaningfully greater than the state as a whole (3.8 percent and 8.1 percent, respectively), so Snohomish County and King County can also be considered environmental justice communities of concern.

All counties in the analysis area are similarly affected by the early winter steelhead hatchery programs and fishing opportunities they present as described in Subsection 3.5, Socioeconomics, and early winter steelhead hatchery programs result in low positive environmental justice impacts. The most substantial impacts occur in Clallam County and Whatcom County because per capita income and the percentage of persons below the poverty level are the highest.

The EPA guidance regarding environmental justice extends beyond statistical threshold analyses to consider explicit environmental justice effects on Native American tribes (EPA 1998). Federal duties under the Environmental Justice Executive Order, the presidential directive on government-to-government relations, and the trust responsibility to Indian tribes may merge when the action proposed by another federal agency or the EPA potentially affects the natural or physical environment of a tribe. The natural or physical environment of a tribe may include resources reserved by treaty or lands held in trust; sites of special cultural, religious, or archaeological importance, such as sites protected under the National Historic Preservation Act or the Native American Graves Protection and Repatriation Act; and other areas reserved for hunting, fishing, and gathering (*usual and accustomed* areas, which may include "ceded" lands that are not within reservation boundaries). Potential effects of concern may include ecological, cultural, human health, economic, or social impacts when those impacts are interrelated to impacts on the natural or physical environment (EPA 1998).

As described in Subsection 3.5 (Socioeconomics), salmon fishing has been a focus for tribal economies, cultures, lifestyles, and identities for over 1,000 years. These activities continue to be important today, both economically and for subsistence and ceremonial purposes (Stay 2012; NWIFC 2013). Returning early winter hatchery-origin steelhead adults provide for limited tribal commercial and subsistence use, affording moderate positive effects. The following tribes or their representatives work with WDFW to develop fishing plans that target early winter hatchery-origin steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins: Lummi Nation, Nooksack Tribe, Stillaguamish Indian Tribe, Tulalip Tribes, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe.

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Chapter 4

4 ENVIRONMENTAL CONSEQUENCES

Chapter 4, Environmental Consequences, evaluates potential effects of the alternatives (including the Proposed Action) on the biological, physical, and human resources described in Chapter 3, Affected Environment. NMFS has defined the No-action Alternative as not making a determination under the 4(d) Rule, leading to termination of the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins (Subsection 2.2.1, Alternative 1). All of the hatchery facilities that support the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would continue to operate under Alternative 1 because they also raise fish for hatchery programs that are not part of the Proposed Action or its alternatives.

As discussed in Chapter 2, Alternatives Including the Proposed Action, the existing early winter steelhead hatchery programs would be terminated under Alternative 1 (No-action Alternative). The effects of Alternative 1 are described relative to the effects of existing winter steelhead hatchery programs that are ongoing within the project area, including release of smolts[9] (Chapter 3, Affected Environment). As described in the analyses below, program implementation under Alternative 2 would be similar to operations under existing conditions that are described in Chapter 3, Affected Environment.

The effects of Alternative 2 (Proposed Action) through Alternative 4 (Native Broodstock) are described relative to Alternative 1 (No Action). In addition, the effects of Alternative 1 (No Action) through Alternative 4 are described relative to existing conditions, which would be similar to Alternative 2 (Proposed Action). The relative magnitude and direction of impacts is described using the following terms:

[9] As noted in Chapter 3, Affected Environment, WDFW did not release early winter steelhead hatchery-origin smolts in 2014 or 2015 consistent with the Consent Decree in *Wild Fish Conservancy v. Anderson* (W.D. Wash.). However, Chapter 3, Affected Environment, describes the full effects of the existing early winter steelhead hatchery programs including the effects of releases from those programs.

Undetectable: The impact would not be detectable.

Negligible: The impact would be at the lower levels of detection, and could be either positive or negative.

Low: The impact would be slight, but detectable, and could be either positive or negative.

Moderate: The impact would be readily apparent, and could be either positive or negative.

High: The impact would be greatly positive or severely negative.

4.1 Water Quantity

Hatchery facility use of surface water and groundwater is both consumptive and non-consumptive as described in Subsection 3.1, Water Quantity. Loss of water from existing sources may include water diversions from an adjacent stream 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, some portion of the water source (the stream bypass reach) may be dewatered (has less water between the point of diversion and discharge return to the river). Effects to existing sources include alteration of stream flow and changes in water quantity (Subsection 3.1, Water Quantity).

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

Under Alternative 1, the early winter steelhead programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be terminated immediately (Subsection 2.2.1, Alternative 1). All of the hatchery facilities that support these hatchery programs would continue to operate since they support hatchery programs that are not part of the Proposed Action. However, the hatchery facilities would be raising 620,000 fewer early winter hatchery-origin steelhead. Therefore, short- and long-term water use would be less under Alternative 1 than under existing conditions. Less water use would positively affect low flow conditions by decreasing the percent of hatchery program water withdrawals (Table 14), and positively affect ground water supplies where ground water is used, relative to existing conditions. There would be no change in compliance with water permits or water rights at any of the hatchery facilities under Alternative 1 because less water would be used at the hatchery facilities relative to existing conditions or the permits, or water rights would no longer be necessary or applicable (Subsection 3.1, Water Quantity). Analyses of the site-specific effects of Alternative 1 is provided below.

Dungeness River Basin: The Dungeness River Hatchery uses surface water exclusively, withdrawn through three water intakes on the Dungeness River and one on Canyon Creek, an adjacent tributary. All water diverted from Dungeness River and Canyon Creek (minus evaporation) is returned after it circulates through the hatchery facility (Subsection 3.1, Water Quantity). Under existing conditions, the Dungeness River Hatchery uses approximately 2.0 cfs of surface water from the Dungeness River and 0.4 cfs of water from Canyon Creek to support the early winter steelhead program (Table 14). Water quantity is only affected between the water intake and discharge structures.

Under Alternative 1, surface water would not be temporarily diverted into the hatchery to support the early winter steelhead hatchery program, which would result in a low positive effect on water quantity in the Dungeness River, and moderate positive effect on water quantity in Canyon Creek between the water intake and discharge structures because more water would remain in the Dungeness River and Canyon Creek relative to existing conditions (Table 14).

The Hurd Creek Hatchery facility uses a combination of groundwater withdrawn from five wells and surface water withdrawn from Hurd Creek. All water diverted from Hurd Creek (minus evaporation) is returned to the creek after it circulates through the hatchery facility (Subsection 3.1, Water Quantity). Under existing conditions, the Hurd Creek Hatchery withdraws up to 0.26 cfs from Hurd Creek and 0.95 cfs from five wells to support the early winter steelhead program in the Dungeness River basin (Table 14). Water quantity is only affected between the water intake and discharge structures.

Under Alternative 1, 0.26 cfs of surface water would not be temporarily diverted into the hatchery, which would result in a moderate positive effect on water quantity in Hurd Creek between the water intake and discharge structures because more water would remain in Hurd Creek relative to existing conditions (Table 14). Under Alternative 1, 0.95 cfs of groundwater would not be used to support the early winter steelhead hatchery program and may lead to a low positive effect on groundwater supply because an additional 0.95 cfs of water would remain in the aquifer for other water users relative to existing conditions.

1 Table 14. Water diverted to support five early winter steelhead hatchery programs in Dungeness,
2 Nooksack, Stillaguamish, Skykomish, and Snoqualmie River Basins.

Facility	Maximum Use of Water to Support Steelhead Programs Under Existing Conditions (cfs)	Maximum Percentage of Minimum Flows Diverted Under Existing Conditions (%)	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Reduced Production)	Alternative 4 (Native Broodstock)
Dungeness River Hatchery	Surface: 2.0 cfs from Dungeness River Surface: 0.4 cfs from Canyon Creek	3.6 of Dungeness River 20.0 from Canyon Creek	Surface: 0	Surface: 2.0 cfs from Dungeness River Surface: 0.4 cfs from Canyon Creek	Surface: 1.0 cfs from Dungeness River Surface: 0.2 cfs from Canyon Creek	Surface: 2.0 cfs from Dungeness River Surface: 0.4 cfs from Canyon Creek
Hurd Creek Hatchery	Surface: 0.26 cfs from Hurd Creek Ground: 0.95 cfs	13.0 from Hurd Creek	Surface: 0 Ground: 0	Surface: 0.26 cfs from Hurd Creek Ground: 0.95 cfs	Surface: 0.13 cfs from Hurd Creek Ground: 0.48 cfs	Surface: 0.26 cfs from Hurd Creek Ground: 0.95 cfs
Kendall Creek Hatchery	Surface: 6.7 cfs from Kendall Creek Ground: 7.7 cfs	1.3 from Kendall Creek	Surface: 0 Ground: 0	Surface: 6.7 cfs from Kendall Creek Ground: 7.7 cfs	Surface: 3.4 cfs from Kendall Creek Ground: 3.9 cfs	Surface: 6.7 cfs from Kendall Creek Ground: 7.7 cfs
McKinnon Pond	Surface: 2.0 cfs from Peat Bog Creek	0.3 from Peat Bog Creek (note that steelhead are not reared in McKinnon Pond during low flow conditions so this is the proportion used during average flow conditions)	Surface: 0	Surface: 2.0 cfs from Peat Bog Creek	Surface: 1.0 cfs from Peat Bog Creek	Surface: 2.0 cfs from Peat Bog Creek

Table 14. Water diverted to support five early winter steelhead hatchery programs in Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River Basins (continued).

Facility	Maximum Use of Water to Support Steelhead Programs Under Existing Conditions (cfs)	Maximum Percentage of Minimum Flows Diverted Under Existing Conditions (%)	Alternative 1 (No Action)	Alternative 2 (Proposed Action)	Alternative 3 (Reduced Production)	Alternative 4 (Native Broodstock)
Whitehorse Ponds Hatchery	Surface: 2.4 cfs from Whitehorse Springs Creek Ground: 0.5 cfs	1.2 from Whitehorse Springs Creek	Surface: 0 Ground: 0	Surface: 2.4 cfs from Whitehorse Springs Creek Ground: 0.5 cfs	Surface: 1.2 cfs from Whitehorse Springs Creek Ground: 0.3 cfs	Surface: 2.4 cfs from Whitehorse Springs Creek Ground: 0.5 cfs
Wallace River Hatchery	Surface: 6.4 cfs from Wallace River Surface: 2.2 cfs from May Creek	2.1 from Wallace River 0.7 from May Creek	Surface: 0 Surface: 0	Surface: 6.4 cfs from Wallace River Surface: 2.2 cfs from May Creek	Surface: 3.2 cfs from Wallace River Surface: 1.1 cfs from May Creek	Surface: 6.4 cfs from Wallace River Surface: 2.2 cfs from May Creek
Reiter Ponds	Surface: 4.9 cfs from Austin Creek Surface: 4.9 cfs from Hogarty Creek	1.6 from Austin Creek 1.6 from Hogarty Creek	Surface: 0 Surface: 0	Surface: 4.9 cfs from Austin Creek Surface: 4.9 cfs from Hogarty Creek	Surface: 2.5 cfs from Austin Creek Surface: 2.5 cfs from Hogarty Creek	Surface: 4.9 cfs from Austin Creek Surface: 4.9 cfs from Hogarty Creek
Tokul Creek Hatchery	Surface: 5.4 cfs from Tokul Creek Surface: 2.7 cfs from unnamed spring	0.8 from Tokul Creek 0.9 from unnamed spring	Surface: 0 Surface: 0	Surface: 5.4 cfs from Tokul Creek Surface: 2.7 cfs from unnamed spring	Surface: 2.7 cfs from Tokul Creek Surface: 1.4 cfs from unnamed spring	Surface: 5.4 cfs from Tokul Creek Surface: 2.7 cfs from unnamed spring

Source: Existing conditions are found in Table 4.

Nooksack River Basin: The Kendall Creek Hatchery uses well and surface water (Subsection 3.1, Water Quantity). All water diverted from Kendall Creek (minus evaporation) is returned to the creek after it circulates through the hatchery facility (Subsection 3.1, Water Quantity). Under existing conditions, the Kendall Creek Hatchery uses approximately 6.7 cfs of surface water from Kendall Creek and 7.7 cfs of groundwater to support the early winter steelhead program (Table 14). Water quantity is only affected between the water intake and discharge structures.

Under Alternative 1, 6.7 cfs of water would not be temporarily diverted from Kendall Creek into the hatchery, which would result in a negligible positive effect on water quantity between the water intake and discharge structures because more water would remain in Kendall Creek relative to existing conditions (Table 14). Under Alternative 1, 7.7 cfs of groundwater would not be used to support the early winter steelhead hatchery program and may lead to a low positive effect on groundwater supply because an additional 7.7 cfs of water would remain in the aquifer for other water users relative to existing conditions.

McKinnon Pond uses surface water exclusively (Subsection 3.1, Water Quality). All water diverted from Peat Bog Creek (minus evaporation) is returned after it circulates through the rearing pond (Subsection 3.1, Water Quantity). Under existing conditions, McKinnon Pond uses approximately 2.0 cfs of surface water from Peat Bog Creek from December through February (Table 14).

Under Alternative 1, this water would not be temporarily diverted into the rearing pond, which would result in a positive negligible effect on water quantity in Peat Bog Creek between the water intake and discharge structures because more, but likely only a small amount more, water would remain in the Peat Bog Creek relative to existing conditions (Table 14).

Stillaguamish River Basin: The Whitehorse Ponds Hatchery uses well and surface water (Subsection 3.1, Water Quantity). All water diverted from Whitehorse Springs Creek (minus evaporation) is returned to Whitehorse Springs Creek after it circulates through the hatchery facility (Subsection 3.1, Water Quantity). Under existing conditions, the Whitehorse Ponds Hatchery uses approximately 2.4 cfs of surface water from Whitehorse Ponds Creek and 0.5 cfs of groundwater to support their early winter steelhead program (Table 14). Under Alternative 1, 2.4 cfs of water would not be temporarily diverted from Whitehorse Springs Creek into the hatchery, which would result in a negligible positive effect on water quantity in Whitehorse Springs Creek because more, though likely just somewhat more, water would remain in Whitehorse Springs Creek relative to existing conditions (Table 14). Under Alternative 1, 0.5 cfs of groundwater would not be used to support the early winter steelhead hatchery program and may lead to a low positive effect on groundwater supply because an additional 0.5 cfs of water would remain in the aquifer for other water users relative to existing conditions.

Skykomish River Basin: The Wallace River Hatchery uses surface water exclusively (Subsection 3.1, Water Quantity). All water is returned to the Wallace River and May Creek (minus evaporation) after circulating through the facilities (Subsection 3.1, Water Quantity). Under existing conditions, the Wallace River Hatchery withdraws up to 6.4 cfs from Wallace River and up to 2.2 cfs from May Creek to support the early winter steelhead hatchery program (Table 14). Water quantity is only affected between the water intakes and discharge structures. Under Alternative 1, up to 6.4 cfs would not be withdrawn from the Wallace River and 2.2 cfs would not be withdrawn from May Creek to support the early winter steelhead hatchery programs, which would lead to a negligible positive effect, because more of the water would be left in the Wallace River and May Creek relative to existing conditions.

Under existing conditions, Reiter Ponds withdraws up to 4.9 cfs from Austin Creek and up to 4.9 cfs from Hogarty Creek (Subsection 3.1, Water Quantity). All water is returned to the creeks (minus evaporation) after circulating through the facilities. Under Alternative 1, 4.9 cfs would not be temporarily withdrawn from the Austin Creek or from Hogarty Creek to support the early winter steelhead hatchery programs, which may lead to a negligible positive effect because up to 4.9 cfs would be left in Austin Creek and in Hogarty Creek relative to existing conditions. Water quantity is only affected between the water intakes and discharge structures.

Snoqualmie River Basin: The Tokul Creek Hatchery uses surface water (Subsection 3.1, Water Quantity). The Tokul Creek Hatchery withdraws up to 5.4 cfs from Tokul Creek and up to 2.7 cfs from a spring to support the early winter steelhead hatchery program (Table 14). All water is returned to the creek after circulating through the hatchery. Water quantity is only affected between the water intake and discharge structures.

Under Alternative 1, up to 5.4 cfs of water would not be temporarily withdrawn from Tokul Creek and up to 2.7 cfs would not be withdrawn from the spring to support the early winter steelhead hatchery programs, which may lead to a negligible positive effect, because more of the water would be left in Tokul Creek and in the spring relative to existing conditions.

4.1.2 Alternative 2 (Proposed Action) ‑ Make a Determination that the Submitted HGMPs Meet the Requirements of the 4(d) Rule

Under Alternative 2, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would operate as proposed in submitted HGMPs (Subsection 2.2.1, Alternative 2). Consequently, short- and long-term water use would be greater under Alternative 2 relative to Alternative 1 and the same as under existing conditions (Subsection 3.1, Water Quantity). More water use would negatively affect low flow conditions by increasing the percent of hatchery program water withdrawals (Table 14), and by decreasing ground water supplies where ground water is used, relative to Alternative 1. As under Alternative 1, there would be no change in compliance with water permits or water rights at any of the hatchery facilities under Alternative 2 because the hatchery programs have existing permits and water rights to divert water as proposed in the submitted HGMPs. Analyses of the site-specific effects of Alternative 2 are provided below.

Dungeness River Basin: The Dungeness River Hatchery uses surface water exclusively, withdrawn through three water intakes on the Dungeness River and one on Canyon Creek, an adjacent tributary. All water diverted from Dungeness River and Canyon Creek (minus evaporation) is returned after it circulates through the hatchery facility (Subsection 3.1, Water Quantity).

Under Alternative 2, the Dungeness River Hatchery would use approximately 2.0 cfs of surface water from the Dungeness River and 0.4 cfs of water from Canyon Creek to support their early winter steelhead program (Table 14). Alternative 2 would result in a moderate negative effect on water quantity in the Dungeness River and in Canyon Creek between the water intake and discharge structures relative to Alternative 1.

The Hurd Creek Hatchery facility uses a combination of groundwater withdrawn from five wells, and surface water withdrawn from Hurd Creek. All water diverted from Hurd Creek (minus evaporation) is returned after it circulates through the hatchery facility (Subsection 3.1, Water Quantity).

Under Alternative 2, the Hurd Creek Hatchery may withdraw up to 0.26 cfs from Hurd Creek to support the early winter steelhead program in the Dungeness River basin (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 2 would have a moderate negative effect on water quantity in Hurd Creek between the water intake and discharge structures relative to Alternative 1.

Under Alternative 2, the Hurd Creek Hatchery may withdraw up to 0.95 cfs from wells to support the early winter steelhead hatchery program relative to Alternative 1. This withdrawal may lead to a low negative effect on groundwater supply because 0.95 cfs of water would not remain in the aquifer for other water users in contrast to Alternative 1.

Nooksack River Basin: The Kendall Creek Hatchery uses well and surface water (Subsection 3.1, Water Quantity). All water diverted from Kendall Creek (minus evaporation) is returned to the creek after it circulates through the hatchery facility (Subsection 3.1, Water Quantity).

Under Alternative 2, the Kendall Creek Hatchery would use approximately 6.7 cfs of surface water from Kendall Creek to support the early winter steelhead program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 2 would result in a low negative effect on water quantity in Kendall Creek relative to Alternative 1.

Under Alternative 2, 7.7 cfs of groundwater would be used to support the early winter steelhead hatchery program. Because this water would not be used under Alternative 1, Alternative 2 may lead to a low negative effect on groundwater supply relative to Alternative 1.

McKinnon Pond uses surface water exclusively (Subsection 3.1, Water Quality). All water diverted from Peat Bog Creek (minus evaporation) is returned after it circulates through the rearing pond (Subsection 3.1, Water Quantity). Under Alternative 2, McKinnon Pond would use approximately 2.0 cfs of surface water from Peat Bog Creek from December through February (Table 14). These are the only months that steelhead are reared at McKinnon Pond and are the months when many streams and rivers experience higher than average flows. Because this water would not be withdrawn under Alternative 1, Alternative 2 would lead to a negligible negative effect on water quantity in Peat Bog Creek between the water intake and discharge structures relative to Alternative 1.

Stillaguamish River Basin: The Whitehorse Ponds Hatchery uses well and surface water (Subsection 3.1, Water Quantity). All water diverted from Whitehorse Springs Creek (minus evaporation) is returned to Whitehorse Springs Creek after it circulates through the hatchery facility (Subsection 3.1, Water Quantity).

Under Alternative 2, the Whitehorse Ponds Hatchery would use approximately 2.4 cfs of surface water from Whitehorse Ponds Creek to support the early winter steelhead program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 2 would lead to a negative negligible effect on water quantity in Whitehorse Springs Creek relative to Alternative 1.

Under Alternative 2, 0.5 cfs of groundwater would be used to support the early winter steelhead hatchery program. Because this water would not be withdrawn under Alternative 1, Alternative 2 may lead to a negative negligible effect on groundwater supply because 0.5 cfs of water would not remain in the aquifer for other water users in contrast to Alternative 1.

Skykomish River Basin: The Wallace River Hatchery uses surface water exclusively (Subsection 3.1, Water Quantity). All water is returned to the Wallace River and May Creek (minus evaporation) after circulating through the facilities (Subsection 3.1, Water Quantity).

Under Alternative 2, the Wallace River Hatchery would withdraw up to 6.4 cfs from Wallace River and up to 2.2 cfs from May Creek to support the early winter steelhead hatchery program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 2 would lead to a negligible negative effect on water quantity in the Wallace River and May Creek relative to Alternative 1. Water quantity would only be affected between the water intakes and discharge structures.

Reiter Ponds withdraws up to 4.9 cfs from Austin Creek and 4.9 cfs from Hogarty Creek (Subsection 3.1, Water Quantity). All water is returned to the river (minus evaporation) after circulating through the facilities. Under Alternative 2, Reiter Ponds would withdraw up to 4.9 cfs from Austin Creek and 4.9 cfs from Hogarty Creek, to support the early winter steelhead hatchery programs (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 2 would lead to a moderate negative effect on water quantity relative to Alternative 1. Water quantity would only be affected between the water intakes and discharge structures.

Snoqualmie River Basin: The Tokul Creek Hatchery uses surface water (Subsection 3.1, Water Quantity). Under Alternative 2, the Tokul Creek Hatchery would temporarily withdraw up to 2.7 cfs from Tokul Creek and up to 5.4 cfs from a spring to support the early winter steelhead hatchery program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 2 would lead to a negligible negative effect because more of the water would remain in Tokul Creek and in the spring relative to Alternative 1. All water would be returned to the creek after circulating through the hatchery. Water quantity would only be affected between the water intake and discharge structures.

4.1.3 Alternative 3 (Reduced Production) – Make a Determination that Revised HGMPs with Reduced Production Levels Meet Requirements of the 4(d) Rule

Under Alternative 3, WDFW would reduce proposed production levels by 50 percent, and water use would be reduced by 50 percent relative to Alternative 2. However, relative to Alternative 1, under which the programs would be terminated, both short- and long-term water use would be greater under Alternative 3. More water use would negatively affect low flow conditions by increasing the percent of hatchery program water withdrawals (Table 14), and by decreasing ground water supplies where ground water is used, relative to Alternative 1. However, there would be a positive change in effect compared to existing conditions because half of the water withdrawn under existing conditions would be withdrawn under Alternative 3.

All hatchery facilities would remain in compliance with water permits or water rights under Alternative 3 because less water would be used at the hatchery facilities relative to existing conditions, and all hatchery facilities would comply with required water permits or water rights described under existing conditions (Subsection 3.1, Water Quantity). Analyses of the site-specific effects of Alternative 3 are provided below.

Dungeness River Basin: The Dungeness River Hatchery uses surface water exclusively, withdrawn through three water intakes on the Dungeness River and one on Canyon Creek, an adjacent tributary. All water diverted from Dungeness River and Canyon Creek (minus evaporation) is returned after it circulates through the hatchery facility (Subsection 3.1, Water Quantity). Under Alternative 3, the Dungeness River Hatchery would use approximately 1.0 cfs of surface water from the Dungeness River and 0.2 cfs of water from Canyon Creek to support the early winter steelhead program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 3 would result in a moderate negative effect on water quantity in the Dungeness River and in Canyon Creek between the water intake and discharge structures relative to Alternative 1.

Under Alternative 3, the Hurd Creek Hatchery may withdraw up to 0.13 cfs from Hurd Creek to support the early winter steelhead program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 3 would have a moderate negative effect on water quantity in Hurd Creek between the water intake and discharge structures relative to Alternative 1.

Under Alternative 3, 0.48 cfs more groundwater would be used to support the early winter steelhead hatchery program relative to Alternative 1, which may lead to a low negative effect on groundwater supply relative to Alternative 1.

Nooksack River Basin: Under Alternative 3, the Kendall Creek Hatchery would use approximately 3.4 cfs of surface water from Kendall Creek to support the early winter steelhead program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 3 may result in a low negative effect on water quantity in Kendall Creek relative to Alternative 1.

Under Alternative 3, 3.9 cfs of groundwater would be used to support the early winter steelhead hatchery program, and because this water would not be used under Alternative 1, Alternative 3 may lead to a low negative effect on groundwater supply relative to Alternative 1.

Under Alternative 3, McKinnon Pond would use approximately 1.0 cfs of surface water from Peat Bog Creek from December through February (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 3 would lead to a negligible negative effect on water quantity in Peat Bog Creek between the water intake and discharge structures relative to Alternative 1.

Stillaguamish River Basin: Under Alternative 3, Whitehorse Ponds Hatchery would use approximately 1.2 cfs from Whitehorse Springs Creek. Because this water would not be withdrawn under Alternative 1, Alternative 3 would have a negligible negative effect on water quantity in Whitehorse Springs Creek relative to Alternative 1. Under Alternative 3, 0.3 cfs of groundwater would be used to support the early winter steelhead hatchery program. Because this water would not be withdrawn under Alternative 1, Alternative 3 would lead to a negligible negative effect on groundwater supply relative to Alternative 1.

Skykomish River Basin: Under Alternative 3, the Wallace River Hatchery would withdraw up to 3.2 cfs from Wallace River and up to 1.1 cfs from May Creek to support the early winter steelhead hatchery program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 3 would lead to a negligible negative effect on water quantity in the Wallace River and May Creek relative to Alternative 1. Water quantity would only be affected between the water intakes and discharge structures.

Under Alternative 3, Reiter Ponds would withdraw up to 2.5 cfs from Austin Creek and 2.5 cfs from Hogarty Creek, to support the early winter steelhead hatchery programs (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 3 would lead to a low negative effect on water quantity relative to Alternative 1. Water quantity would only be affected between the water intakes and discharge structures.

Snoqualmie River Basin: The Tokul Creek Hatchery uses surface water (Subsection 3.1, Water Quantity). Under Alternative 3, the Tokul Creek Hatchery would withdraw up to 1.4 cfs from Tokul Creek and up to 2.7 cfs from a spring to support the early winter steelhead hatchery program (Table 14). Because this water would not be withdrawn under Alternative 1, Alternative 3 would lead to a negligible negative effect because more of the water would be left in Tokul Creek and in the spring relative to existing conditions. All water would be returned to the creek after circulating through the hatchery. Water quantity would only be affected between the water intake and discharge structures.

Relative to the Alternative 2 and to existing conditions, Alternative 3 would reduce water use at the eight hatchery facilities that support the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins by the following amounts:

Dungeness River basin:	1.0 cfs from Dungeness River, 0.2 cfs from Canyon Creek, 0.13 cfs from Hurd Creek, and 0.95 cfs from wells (Table 14)
Nooksack River basin:	3.4 cfs from Kendall Creek, 1.0 cfs from Peat Bog Creek, and 3.9 cfs from wells (Table 14)
Stillaguamish River basin:	1.2 cfs from Whitehorse Springs Creek and 0.3 cfs from wells (Table 14)
Skykomish River basin:	3.2 cfs from Wallace River, 1.1 cfs from May Creek, 2.5 cfs from Austin Creek, and 2.5 cfs from Hogarty Creek (Table 14)
Snoqualmie River basin:	1.4 cfs from unnamed spring and 2.7 cfs from Tokul Creek (Table 14).

Because water use would be reduced by 50 percent at the eight hatchery facilities under Alternative 3, effects on surface and groundwater quantity would be low to negligible, localized, and positive, since less water would be used to support the hatchery programs compared to Alternative 2.

4.1.4 Alternative 4 (Native Broodstock) – Make a Determination that Revised HGMPs that Replace Chambers Creek Stock with a Native Broodstock Meet Requirements of the 4(d) Rule

Under Alternative 4, WDFW would produce the same number of hatchery-origin winter steelhead as under the Alternative 2, but the broodstock source would change from the early winter Chambers Creek stock to native steelhead broodstocks that are local to the river basins. Relative to existing conditions, Alternative 1, and Alternative 2, effects on water quantity would be the same as under Alternative 2 because the change in broodstock would not affect water quantity (i.e., the same amount of water would be used in the facilities).

4.2 Salmon and Steelhead

The salmon and steelhead analyses address effects of early winter steelhead hatchery programs on existing conditions described in Subsection 3.2, Salmon and Steelhead, when combined with effects anticipated under each alternative. The analysis focuses on natural-origin fish populations that are self-sustaining in the natural environment and are dependent on aquatic habitat for migration, spawning, rearing, and food. This subsection describes effects on salmon and steelhead associated with the alternatives for the effect categories described in Subsection 3.2.2.1, General Effects of Puget Sound Salmon and Steelhead Hatchery Programs as listed below:

- Genetic Risks
- Competition and Predation
- Hatchery Facility Effects
- Masking
- Incidental Fishing Effects
- Disease Transfer
- Mining
- Population viability benefits
- Nutrient Cycling

In addition to hatchery-related effects, decreases in the quality and extent of salmon and steelhead habitat, harvest, the presence of dams and diversions, and changes in oceanic conditions and climate have all contributed to impacting salmon and steelhead in the analysis area (Subsection 3.2.1, General Factors that Affect the Presence and Abundance of Salmon and Steelhead). Analysis of fish resources in Subsection 4.2, Salmon and Steelhead, is focused on the effects under the alternatives associated with early winter steelhead hatchery production, which is one of the general factors affecting salmon and steelhead in the analysis area (Subsection 3.2.1, General Factors that Affect the Presence and Abundance of Salmon and Steelhead). The effects to salmon and steelhead from other general factors (e.g., habitat, climate change) are described in Chapter 5, Cumulative Effects.

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

Under Alternative 1, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be terminated immediately (Subsection 2.2.1, Alternative 1), and 620,000 fewer early winter steelhead would be produced by hatcheries in the analysis area relative to existing conditions (Subsection 3.2, Salmon and Steelhead). Therefore, all risks to listed ESUs and DPSs, non-listed salmon species, and designated critical habitat associated with these ongoing hatchery programs would be eliminated (Subsection 3.2, Salmon and Steelhead). Relative to existing conditions, Alternative 1 would result in the following effects:

- Gene flow from early winter hatchery-origin steelhead to natural-origin steelhead would be reduced from less than 2 percent or less than 5 percent (depending on the population) under existing conditions to zero (Subsection 3.2.3.1, Genetic Risks), which would result in a low positive effect on natural-origin steelhead populations in the Dungeness, Nooksack, Stillaguamish, and Skykomish River basins, and a low to moderate positive effect in the Snoqualmie River basin, relative to existing conditions.

- The risk of predation from early winter hatchery-origin steelhead on juvenile fall Chinook salmon, fall chum salmon, pink salmon, and sockeye salmon would be reduced (Subsection 3.2.3.2, Competition and Predation), which would result in a low positive effect on natural-origin populations of these species.

- The risk of competition between hatchery-origin early winter hatchery-origin steelhead and natural-origin steelhead, spring Chinook salmon, and coho salmon would be reduced (Subsection 3.2.3.2, Competition and Predation), which would result in a low positive effect on natural-origin steelhead, spring Chinook salmon, and coho salmon populations.

- Hatchery facility risks would remain the same as under existing conditions (Subsection 3.2.3.3, Hatchery Facility Risks), since all hatchery facilities would continue to operate for other species under Alternative 1. All instream structures (including weirs) would continue to be used and maintained. There would be no change in the hatchery facility compliances with NMFS screening criteria at the Dungeness River Hatchery, Hurd Creek Hatchery, McKinnon Pond, Whitehorse Ponds Hatchery, Wallace River Hatchery, Reiter Ponds, and Tokul Creek Hatchery (Subsection 3.2.3.3, Hatchery Facility Risks). WDFW would be expected to complete its already planned upgrade to the water intake screen at Kendall Creek Hatchery and Wallace River Hatchery, and improve fish passage at the Dungeness River Hatchery and Tokul Creek Hatchery (Subsection 3.2.3.3, Hatchery Facility Risks).

- The risk that the status of natural steelhead would be masked by early winter hatchery-origin steelhead would be reduced from existing conditions to 0 (Subsection 3.2.3.4, Masking), which would result in a negligible positive effect on natural-origin steelhead populations.

- There would be no steelhead fisheries in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins targeting early winter hatchery-origin steelhead. Therefore, incidental fishing effects (Subsection 3.2.3.5, Incidental Fishing Effects) would be eliminated, which would provide a low positive effect on natural-origin steelhead populations.

- There would be no expected change in the risk of disease transfer since all of the hatchery facilities would continue to propagate other fish species (e.g., salmon or trout), which can harbor many of the same diseases as steelhead (Subsection 3.2.3.6, Risk of Disease Transfer) (Table 10); thus, the risk would be the same as under existing conditions.

- There would be no change in the risk of "mining" natural-origin populations through the collection of broodstock because no natural-origin fish would be incorporated into broodstocks under existing conditions, and there would be no broodstock under Alternative 1 (i.e., the programs would be terminated) (Subsection 3.2.3.7, Risk of "Mining" Natural-origin Salmon and Steelhead) (Table 15). Therefore, there would be no risk to natural-origin steelhead from "mining."

- There would be no change in population viability benefits to natural-origin steelhead populations because early winter hatchery-origin steelhead provide no viability benefits under existing conditions, and there would be no early winter steelhead hatchery programs under Alternative 1 (i.e., the programs would be terminated) (Subsection 3.2.3.8, Population Viability Benefits).

- There would be no change in the contribution of hatchery-origin steelhead to marine-derived nutrients because hatchery-origin steelhead contributions to nutrients are negligible under existing conditions (Subsection 3.2.3.9, Nutrient Cycling), and would not be impacted under any alternative.

Table 15. Number of natural-origin winter steelhead in the hatchery broodstock by alternative in five early winter steelhead hatchery programs in Puget Sound.

River Basin	Average Natural-origin Winter Run[1]	TRT Interim Viable Abundance Target	Number of Natural-origin Winter Steelhead in Broodstock				
			Existing Conditions	Alt. 1[2]	Alt. 2	Alt. 3	Alt. 4
Dungeness	487	1,232	0	N/A	0	0	Up to 30 with a 1:1 sex ratio
Nooksack	1,760	11,023	0	N/A	0	0	Up to 100 with a 1:1 sex ratio
Stillaguamish	1,852	9,559	0	N/A	0	0	Up to 120 with a 1:1 sex ratio
Snohomish-Skykomish	1.683	10,695	0	N/A	0	0	Up to 300 with a 1:1 sex ratio
Snohomish-Snoqualmie	955	8,370	0	N/A	0	0	Up to 100 with a 1:1 sex ratio

[1] Source: Table 11.
[2] The hatchery programs would be terminated under Alternative 1, so no broodstock would be needed.

4.2.2 Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs Meet Requirements of the 4(d) Rule

Under Alternative 2, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would operate as proposed in submitted HGMPs (Subsection 2.2.2, Alternative 2), and release levels (total of 620,000 steelhead) would be the same as under existing conditions (Chapter 3, Affected Environment). Relative to Alternative 1 under which the hatchery programs would be terminated, Alternative 2 would result in the following effects:

- Gene flow from early winter hatchery-origin steelhead would increase from zero under Alternative 1 to less than 2 percent (Subsection 3.2.3.1, Genetic Risks), in the Dungeness, Nooksack, Stillaguamish, and Skykomish River basins, which would result in a low, negative effect on natural-origin steelhead populations, which is the same as under existing conditions. Gene flow would increase from zero to under 5 percent in the Snoqualmie River basins, which would result in a low to moderate negative effect on the natural-origin steelhead population, the same as under existing conditions (Subsection 3.2.3.1, Genetic Risks).

- The risk of predation on juvenile fall Chinook salmon, fall chum salmon, pink salmon, and sockeye salmon would increase relative to Alternative 1 (Subsection 3.2.3.2, Competition and Predation), but hatchery managers would minimize competitive interactions by releasing the early winter hatchery-origin steelhead when they are fully smolted and, thus, actively migrating to marine waters (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). Therefore, Alternative 2 would result in a low, negative effect on predation of natural-origin fall Chinook salmon, fall chum salmon, pink salmon, and sockeye salmon, which would be the same as under existing conditions (Subsection 3.2.3.2, Competition and Predation).

- The risk of competition between early winter hatchery-origin steelhead and natural-origin steelhead, spring Chinook salmon, and coho salmon would increase relative to Alternative 1 (Subsection 3.2.3.2, Competition and Predation), but hatchery managers would minimize competitive interactions by releasing the hatchery-origin steelhead when they are fully smolted and thus, actively migrating to marine waters (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). Therefore, Alternative 2 would result in a low, negative effect on competition with natural-origin steelhead, spring Chinook salmon, and coho salmon populations, which would be the same as under existing conditions (Subsection 3.2.3.2, Competition and Predation).

- Hatchery facility risks would remain the same as under existing conditions (Subsection 3.2.3.3, Hatchery Facility Risks), since all hatchery facilities would continue to operate under both Alternative 1 and Alternative 2, and all instream structures (including weirs) would continue to be used and maintained. There would be no change in the hatchery facilities' compliance with NMFS screening criteria at Dungeness River Hatchery, Hurd Creek Hatchery, McKinnon Pond, Whitehorse Ponds Hatchery, Wallace River Hatchery, Reiter Ponds, and Tokul Creek hatchery (Subsection 3.2.3.3, Hatchery Facility Risks). As under Alternative 1, WDFW would be expected to complete its already planned upgrade to the water intake screen at Kendall Creek Hatchery and Wallace River Hatchery, and improve fish passage at the Dungeness River Hatchery and Tokul Creek Hatchery (Subsection 3.2.3.3, Hatchery Facility Risks).

- The risk that the status of natural-origin steelhead would be masked by early winter hatchery-origin steelhead would increase as compared to Alternative 1, but would still result in a negligible negative effect because of differences in return timing, which would be the same as under existing conditions (Subsection 3.2.3.4, Masking).Unlike under Alternative 1, there would be harvest-oriented steelhead fisheries in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. Therefore, negative incidental fishing effects would be greater than under Alternative 1. However, similar to existing conditions (Subsection 3.2.3.5, Incidental Fishing Effects), the negative incidental fishing impacts on the natural-origin populations would be low, because (1) 100 percent of the hatchery-origin fish would be marked and fisheries would be mark-selective, so impacts to unmarked natural-origin fish would be limited to hook-and-release mortalities associated with fish that are legally caught and then released back into the water, (2) the run timing of the early winter hatchery-origin and natural-origin steelhead populations is sufficiently separate, allowing harvest managers to continue to design and implement fisheries to avoid most effects on natural-origin fish, and (3) cool water temperatures during the months when the steelhead fishery is open would minimize incidental hook-and-release mortality of natural-origin steelhead (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e).

- There would be no expected change in the risk of disease transfer since all of the hatchery facilities would continue to propagate other fish species (e.g., salmon or trout), as under Alternative 1, which harbor many of the same diseases as steelhead (Subsection 3.2.3.6, Risk of Disease Transfer) (Table 10); therefore, the risk would be the same as under existing conditions.

- There would be no change in the risk of “mining” natural-origin populations through the collection of broodstock because no natural-origin fish would be incorporated into the broodstock under Alternative 1 or Alternative 2, or under existing conditions (Subsection 3.2.3.7, Risk of “Mining” Natural-origin Salmon and Steelhead) (Table 15). Therefore, there would be no risk to natural-origin steelhead from “mining.”

- There would be no change in population viability benefits to natural-origin steelhead populations because early winter hatchery-origin steelhead provide no viability benefits under Alternative 1 or under existing conditions (Subsection 3.2.3.8, Population Viability Benefits), and releases of early winter hatchery-origin steelhead under Alternative 2 would provide no population viability benefits to natural origin-steelhead.

4.2.3 Alternative 3 (Reduced Production) – Make a Determination that Revised HGMPs with Reduced Production Levels Meet Requirements of the 4(d) Rule

Under Alternative 3, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be reduced by 50 percent (to a total of 315,000 steelhead) relative to the proposed hatchery programs (Subsection 2.2.3, Alternative 3), which would be 50 percent less than under existing conditions (Subsection 3.2, Salmon and Steelhead). Relative to Alternative 1 under which the hatchery programs would be terminated, Alternative 3 would result in the following effects:

- Gene flow from early winter hatchery-origin steelhead (Subsection 3.2.3.1, Genetic Risks), would increase from zero under Alternative 1 to less than 2 percent which would result in a low negative effect on natural-origin steelhead populations in the Dungeness, Nooksack, Stillaguamish, and Skykomish River Basins. Gene flow would increase from zero to under 5 percent in the Snoqualmie River basins, which would result in a low to moderate negative effect on the natural-origin steelhead population.

- The risk of predation on juvenile fall Chinook salmon, fall chum salmon, pink salmon, and sockeye salmon would increase relative to Alternative 1 (Subsection 3.2.3.2, Competition and Predation), but hatchery managers would minimize competitive interactions by releasing the early winter hatchery-origin steelhead when they are fully smolted, and, thus, actively migrating to marine waters (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). Therefore, Alternative 3 would result in a low, negative effect on predation of natural-origin fall Chinook salmon, fall chum salmon, pink salmon, and sockeye salmon.

- The risk of competition between hatchery-origin steelhead and natural-origin steelhead, spring Chinook salmon, and coho salmon would increase relative to Alternative 1 (Subsection 3.2.3.2, Competition and Predation), but hatchery managers would minimize competitive interactions by releasing the early winter hatchery-origin steelhead when they are fully smolted, and, thus, actively migrating to marine waters (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). Therefore, Alternative 3 would result in a low, negative effect on competition with natural-origin steelhead, spring Chinook salmon, and coho salmon populations.

- Hatchery facility risks would be the same as under existing conditions (Subsection 3.2.3.3, Hatchery Facility Risks) and Alternative 1, since all hatchery facilities would continue to operate under both Alternative 1 and Alternative 3, and all instream structures (including weirs) would continue to be used and maintained. There would be no change in the hatchery facilities' compliance with NMFS screening criteria at Dungeness River Hatchery, Hurd Creek Hatchery, McKinnon Pond, Whitehorse Ponds Hatchery, Wallace River Hatchery, Reiter Ponds, and Tokul Creek Hatchery (Subsection 3.2.3.3, Hatchery Facility Risks). As under Alternative 1, WDFW would be expected to complete its already planned upgrade to the water intake screen at Kendall Creek Hatchery and Wallace River Hatchery, and improve fish passage at the Dungeness River Hatchery and Tokul Creek Hatchery (Subsection 3.2.3.3, Hatchery Facility Risks).

- The risk that the status of natural-origin steelhead would be masked by early winter hatchery-origin steelhead would increase relative to Alternative 1, but would still result in a negligible negative effect because of differences in run timing between the hatchery and natural-origin populations, which would be the same as under existing conditions (Subsection 3.2.3.4, Masking).

- Unlike under Alternative 1, there would be harvest-oriented steelhead fisheries in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. Therefore, negative incidental fishing effects would be greater than under Alternative 1. However, similar to existing conditions (Subsection 3.2.3.5, Incidental Fishing Effects), the negative incidental fishing impacts on the natural-origin population would be low, because (1) 100 percent of the hatchery-origin fish would be marked and fisheries would be mark-selective, so impacts to unmarked natural-origin fish would be limited to hook-and-release mortalities associated with fish that are legally caught and then released back into the water, (2) the adult return timing for the early winter hatchery-origin and natural-origin steelhead populations is sufficiently separate, allowing harvest managers to design and implement fisheries to avoid most effects on natural-origin fish, and (3) cool water temperatures during the months when the steelhead fishery is open would minimize incidental hook-and-release mortality of natural-origin steelhead (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e).

- There would be no expected change in the risk of disease transfer since all of the hatchery facilities would continue to propagate other fish species (e.g., salmon or trout) as under Alternative 1, which harbor many of the same diseases as steelhead (Subsection 3.2.3.6, Risk of Disease Transfer) (Table 10); therefore the risk would be the same as under existing conditions.

- There would be no change in the risk of "mining" the natural-origin population through the collection of broodstock because no natural-origin fish would be incorporated into the broodstock under Alternative 1 or Alternative 3, or under existing conditions (Subsection 3.2.3.7, Risk of "Mining" Natural-origin Steelhead) (Table 15). Therefore, there would be no risk to natural-origin steelhead from "mining."

- There would be no change in population viability benefits to natural-origin steelhead populations because early winter hatchery-origin steelhead provide no viability benefits under Alternative 1 or under existing conditions (Subsection 3.2.3.8, Population Viability Benefits), and releases of early winter hatchery-origin steelhead under Alternative 3 would provide no population viability benefits to natural origin-steelhead.

Relative to Alternative 2 and existing conditions, Alternative 3 would result the following effects:

- Less gene flow, competition and predation risks, and incidental fishing effects because fewer hatchery-origin fish would be released under Alternative 3 relative to Alternative 2 and existing conditions. However, these risks would be low under both alternatives for reasons discussed above.

- The same hatchery facility risks as under Alternative 2 and existing conditions, because the hatchery facilities would continue to operate under both alternatives.

- The same risk of masking as under Alternative 2 and existing conditions, although fewer hatchery-origin fish would be released under Alternative 3 relative to Alternative 2. However, these negative risks would be negligible under both alternatives because of differences in return timing between hatchery-origin and natural-origin steelhead.

- The same risk of disease transfer as under Alternative 2 and existing conditions, since all of the hatchery facilities would continue to propagate other fish species (e.g., salmon or trout), which harbor many of the same diseases as steelhead.

- The same lack of risk of "mining" the natural-origin population through the collection of broodstock as under Alternative 2 and existing conditions, because no natural-origin fish would be incorporated into the broodstock under either alternative.

- The same lack of population viability benefits to natural-origin steelhead populations as under Alternative 2 and existing conditions, because early winter hatchery-origin steelhead provide no viability benefits, and early winter hatchery-origin steelhead would be released under Alternative 2 and Alternative 3.

4.2.4 Alternative 4 (Native Broodstock) – Make a Determination that Revised HGMPs that Replace Chambers Creek Stock with a Native Broodstock Meet Requirements of the 4(d) Rule

Under Alternative 4, WDFW would produce the same number of hatchery-origin winter steelhead as under Alternative 2 (total of 620,000 steelhead) and under existing conditions, but the broodstock source would change from the early winter Chambers Creek stock to native steelhead broodstocks that are local to the respective river basins (Subsection 2.2.4, Alternative 4). The programs would be intended to provide conservation benefits, as well as potential harvest benefits once the depressed natural-origin steelhead populations become large enough. Relative to Alternative 1 under which the hatchery programs would be terminated, Alternative 4 would result in the following effects:

- Gene flow from hatchery-origin steelhead to natural-origin steelhead would increase from zero under Alternative 1 to up to 10 percent under Alternative 4 (Subsection 2.4.4, Alternative 4). Higher gene flow is intended in hatchery programs using native broodstock (integrated hatchery programs) so that the genetic characteristics of the hatchery-origin fish are similar to those of the natural-origin fish. Even though the gene flow between natural-origin steelhead populations and hatchery-origin steelhead would be higher than under Alternative 2, Alternative 3, and existing conditions, the higher gene flow levels would have a low risk of harmful genetic effects on natural-origin steelhead populations in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins because the broodstock would be derived from the local native populations (Subsection 3.2.3.1, Genetic Risks) (HSRG 2009).

- Predation on juvenile fall Chinook salmon, fall chum salmon, pink salmon, and sockeye salmon would increase relative to Alternative 1 (Subsection 3.2.3.2, Competition and Predation), but hatchery managers would minimize competitive interactions by releasing the hatchery-origin steelhead when they are fully smolted, and, thus, actively migrating to marine waters (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e). Therefore, Alternative 4 would result in a low, negative effect on predation of natural-origin fall Chinook salmon, fall chum salmon, pink salmon, and sockeye salmon, which would be the same as under existing conditions (Subsection 3.2.3.2, Competition and Predation).

- Competition between hatchery-origin steelhead and natural-origin steelhead, spring Chinook salmon, and coho salmon would increase relative to Alternative 1 (Subsection 3.2.3.2, Competition and Predation), but hatchery managers would minimize competitive interactions by releasing the hatchery-origin steelhead when they are fully smolted, and, thus, actively migrating to marine waters (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d;

WDFWe). Therefore, Alternative 4 would result in a low, negative effect on competition with natural-origin steelhead, spring Chinook salmon, and coho salmon populations, which would be the same as under existing conditions (Subsection 3.2.3.2, Competition and Predation).

- Hatchery facility risks would remain the same as under existing conditions (Subsection 3.2.3.3, Hatchery Facility Risks) and Alternative 1 since all hatchery facilities would continue to operate under both Alternative 1 and Alternative 4, and all instream structures (including weirs) would continue to be used and maintained. There would be no change in the hatchery facilities' compliance with NMFS screening criteria at Dungeness River Hatchery, Hurd Creek Hatchery, McKinnon Pond, Whitehorse Ponds Hatchery, Wallace River Hatchery, Reiter Ponds, and Tokul Creek Hatchery (Subsection 3.2.3.3, Hatchery Facility Risks). As under Alternative 1, WDFW would be expected to complete its already planned upgrade to the water intake screen at Kendall Creek Hatchery and Wallace River Hatchery, and improve fish passage at the Dungeness River Hatchery and Tokul Creek Hatchery (Subsection 3.2.3.3, Hatchery Facility Risks).

- The risk that the status of natural-origin steelhead would be masked by hatchery-origin steelhead would increase as compared to Alternative 1 and existing conditions, because the adult return and spawn timing of the hatchery-origin fish would be similar to natural-origin steelhead,. However, masking would have a low negative effect because all hatchery-origin fish would be marked as under existing conditions (Subsection 3.2.3.4, Masking).

- Unlike under Alternative 1, when returns of natural-origin winter steelhead are large enough, there would be steelhead fisheries in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins targeting hatchery-origin fish. Therefore, negative incidental fishing effects would be greater than under Alternative 1. However, similar to existing conditions (Subsection 3.2.3.5, Incidental Fishing Effects), the negative incidental fishing impacts on the natural-origin population would be low because (1) 100 percent of the hatchery-origin fish would be marked and fisheries would be mark-selective, so impacts to unmarked natural-origin fish would be limited to hook-and-release mortalities associated with fish that are legally caught and then released back into the water, (2) harvest managers would design fisheries to focus effort on hatchery-origin fish, and (3) cool water temperatures during the months when the steelhead fishery is open would minimize incidental hook-and-release mortality of natural-origin steelhead (WDFW 2014a; WDFW 2014b; WDFW 2014c; WDFW 2014d; WDFW 2014e).

- There would be no expected change in the risk of disease transfer since all of the hatchery facilities would continue to propagate other fish species (e.g., salmon or trout), as under Alternative 1, which harbor many of the same diseases as steelhead (Subsection 3.2.3.6, Risk of Disease Transfer) (Table 10), which would be the same as under existing conditions.

- While there is generally a risk of “mining” the natural-origin population through the collection of broodstock when a hatchery program incorporates natural-origin fish into the broodstock (Subsection 3.2.3.7, Risk of “Mining” Natural-origin Salmon and Steelhead), and natural-origin steelhead populations are depressed in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins (Table 15), in this case, the risk would be low under Alternative 4, because broodstock collection would be contingent upon availability of natural-origin fish, ensuring that an appropriate minimum number of fish would be able to spawn naturally; and only after that threshold is ensured would a proportion of additional returns be taken into the hatchery facilities.

- In contrast to Alternative 1, Alternative 2, Alternative 3, and under existing conditions, where no viability benefits to natural-origin steelhead would occur, it is possible that the viability of natural-origin steelhead would benefit under Alternative 4 (Subsection 3.2.3.8, Population Viability Benefits), primarily through use of local, native broodstocks whose returns would increase population abundance, and could help to conserve genetic diversity and productivity of the depressed natural-origin populations.

Relative to Alternative 2 and existing conditions, Alternative 4 would result in the following effects:

- Alternative 4 would result in higher levels of gene flow because hatchery-origin steelhead derived from local, native steelhead populations would have a more similar spawn timing compared to the hatchery-origin steelhead derived from Chambers Creek early winter steelhead lineage (Figure 1). However, because the hatchery-origin fish would be derived from the local, native steelhead populations, these higher levels of gene flow would provide a similar genetic effect (low negative) as the less than 2 percent gene flow under Alternative 2 and under existing conditions.

- Alternative 4 would result in the same levels of competition and predation risks (low, negative) as under Alternative 2 and existing conditions, because the same number of hatchery-origin fish would be released under both alternatives.

- Hatchery facility risks would remain the same as under Alternative 2 and existing conditions because all hatchery facilities would continue to operate under both Alternative 2 and Alternative 4, and all instream structures (including weirs) would continue to be used and maintained.
- The risk that the status of natural-origin steelhead would be masked by hatchery-origin steelhead would increase under Alternative 4 relative to Alternative 2 and existing conditions, because the adult return and spawn timing of the hatchery-origin fish would be more similar to natural-origin steelhead. However, Alternative 4 would still result in a low negative effect because all hatchery-origin steelhead would be marked, similar to Alternative 2 and under existing conditions.
- Incidental fishing effects may be greater under Alternative 4 relative to Alternative 2 and existing conditions, because the hatchery-origin fish derived from local, native broodstocks would have the same run timing as natural-origin steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins, the ability to design fisheries to avoid natural-origin fish may be reduced, and so more natural-origin steelhead would be subjected to incidental capture and release.
- There would be no expected change in the risk of disease transfer under Alternative 4, Alternative 2, and existing conditions since all of the hatchery facilities would continue to propagate other fish species (e.g., salmon or trout), which harbor many of the same diseases as steelhead.
- While there is generally a risk of “mining” the natural-origin population through the collection of broodstock when a hatchery program incorporates natural-origin fish into the broodstock, and natural-origin steelhead populations are depressed in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins (Table 15). In this case, the risk would be negligible under Alternative 4, because broodstock collection would be contingent upon availability of natural-origin fish, ensuring that an appropriate minimum number of fish would be able to spawn naturally; and only after that threshold is ensured would a proportion of additional returns be taken into the hatchery facilities.
- In contrast to Alternative 1, Alternative 2, and under existing conditions, where no viability benefits to natural-origin steelhead would occur from releases of early winter hatchery-origin steelhead, it is possible that the viability of natural-origin steelhead would benefit under Alternative 4, primarily through use of local, native broodstocks whose returns would increase population abundance, and could help to conserve genetic diversity and productivity of the depressed natural-origin populations.

4.3 Other Fish Species

The analyses of other fish species address effects of early winter steelhead hatchery programs on existing conditions for other fish species described in Subsection 3.3, Other Fish Species, when combined with effects anticipated under each alternative. The analysis focuses on natural-origin fish populations that are self-sustaining in the natural environment and are dependent on aquatic habitat for migration, spawning, rearing, and food.

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

Under Alternative 1, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be terminated immediately (Subsection 2.2.1, Alternative 1), and 620,000 fewer steelhead would be produced by hatcheries in the analysis area relative to existing conditions (Subsection 3.2, Salmon and Steelhead). The reduction in early winter hatchery-origin steelhead in the river basins would result in a short- and long-term reduction in competition for space and food among freshwater species relative to existing conditions (Subsection 3.3, Other Fish Species). There would also be a reduction in predation risk by hatchery-origin steelhead on other fish species, and a potentially measurable reduction in the number of prey eaten by hatchery-origin steelhead in the analysis area, relative to existing conditions.

However, because (1) the analysis area is only a small portion of each species' range and (2) hatchery-origin steelhead are not exclusive predators or prey for any of the fish species, including bull trout, Alternative 1 would be expected to have a negligible effect on other fish species (positive for some species and negative for others) relative to existing conditions. Consequently, Alternative 1 would not be expected to change any short- or long-term risks to other fish species, or state or Federal species designations relative to existing conditions (Subsection 3.3, Other Fish Species).

4.3.2 Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs Meet Requirements of the 4(d) Rule

Under Alternative 2, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would operate as proposed in submitted HGMPs (Subsection 2.2.2, Alternative 2). Relative to Alternative 1, Alternative 2 would increase the number of hatchery-origin steelhead produced in the analysis area by 620,000 smolts, which would be the same as under existing conditions (Subsection 3.3, Other Fish Species). Therefore, there would be a short- and long-term increase in risk of competition for space and food among freshwater species relative to Alternative 1. There would also be an increase in the risk of predation by hatchery-origin steelhead on other fish species, and a potentially measurable increase in the number of prey eaten by steelhead in the analysis area relative to Alternative 1, which would be similar to existing conditions.

However, because (1) the analysis area is only a small portion of each species' range, and (2) steelhead are not exclusive predators or prey for any of the fish species, including bull trout, Alternative 2 would be expected to have negligible effects (positive for fish that eat steelhead and negative for other fish that are eaten by steelhead) relative to Alternative 1. Consequently, Alternative 2 would not be expected to change any short- or long-term risks to other fish species or State or Federal species designations relative to Alternative 1 or to existing conditions (Subsection 3.3, Other Fish Species).

4.3.3 Alternative 3 (Reduced Production) – Make a Determination that Revised HGMPs with Reduced Production Levels Meet Requirements of the 4(d) Rule

Under Alternative 3, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be reduced by 50 percent relative to Alternative 2 (Subsection 2.2.3, Alternative 3). Relative to Alternative 1 under which the hatchery programs would be terminated, Alternative 3 would increase the number of juvenile steelhead released into the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins by 310,000 smolts, which would lead to a short- and long-term increase in the risk of competition for space and food among freshwater species relative to Alternative 1. There would also be an increase in the risk of predation by steelhead on other fish species, and a potentially measurable increase in the number of prey eaten by steelhead in the analysis area relative to Alternative 1.

However, because (1) the analysis area is only a small portion of each species' range, and (2) steelhead are not exclusive predators or prey for any of the fish species, Alternative 3 would also be expected to have negligible effects (positive for fish that eat steelhead and negative for fish that are eaten by steelhead), including bull trout, relative to Alternative 1. Consequently, Alternative 3 would not be expected to change any short- or long-term risks to other fish species or State or Federal species designations relative to Alternative 1 (Subsection 3.3, Other Fish Species).

Relative to existing conditions and to Alternative 2, Alternative 3 would release 310,000 fewer steelhead into the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins, which would lead to a short- and long-term reduction in the risk of competition for space and food among freshwater species relative to Alternative 2 and existing conditions. There would also be a reduction in the risk of predation by steelhead on other fish species, and a potentially measurable reduction in the number of prey eaten by steelhead in the analysis area relative to Alternative 2 and existing conditions.

However, because (1) the analysis area is only a small portion of each species' range, and (2) steelhead are not exclusive predators or prey for any of the fish species, Alternative 3 would also be expected to have a negligible effect on other fish species (positive for fish that are eaten by steelhead and negative for fish that eat steelhead), including bull trout, relative to Alternative 2. Consequently, Alternative 3 would not be expected to change any State or Federal species designations relative to Alternative 2 and existing conditions (Subsection 3.3, Other Fish Species).

4.3.4 Alternative 4 (Native Broodstock) – Make a Determination that Revised HGMPs that Replace Chambers Creek Stock with a Native Broodstock Meet Requirements of the 4(d) Rule

Under Alternative 4, relative to Alternative 1, the same number of hatchery-origin winter steelhead would be produced as under Alternative 2 and under existing conditions, but the broodstock source would change from the early winter Chambers Creek stock to native steelhead broodstocks that are local to the respective river basins (Subsection 2.2.4, Alternative 4). Effects on other fish species, including bull trout, would be identical to those under Alternative 2 (negligible) and existing conditions (Subsection 3.3, Other Fish Species), because a change in broodstock would not affect ecological interactions between hatchery-origin steelhead and other fish species.

4.4 Wildlife – Southern Resident Killer Whale

The analysis of wildlife resources addresses effects of early winter steelhead hatchery programs on Southern Resident killer whales. As described in Subsection 3.4, Wildlife – Southern Resident Killer Whale, effects of salmon and steelhead hatchery programs on wildlife species would be expected to be generally negligible, and wildlife species in the analysis area would continue to occupy their existing habitats in similar abundances and feed on a variety of prey, including salmon and steelhead, as under existing conditions. Therefore, wildlife species in the analysis area are not analyzed in this EIS, with the exception of Southern Resident killer whales (Subsection 3.4, Wildlife – Southern Resident Killer Whale).

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

Under Alternative 1, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be terminated immediately (Subsection 2.2.1, Alternative 1), and fewer steelhead (juvenile and adult) would be available as a food source for Southern Resident killer whales (Subsection 3.4, Wildlife – Southern Resident Killer Whale). Because (1) Alternative 1 would only lead to a small reduction in the total number of steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins or in the analysis area, and (2) Southern Resident killer whales do not feed exclusively on steelhead, Alternative 1 would be expected to have a negligible negative effect on the diet, survival, distribution and listing status of the species relative to the negligible positive effect under existing conditions (Subsection 3.4, Wildlife – Southern Resident Killer Whale).

4.4.2 Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs Meet Requirements of the 4(d) Rule

Under Alternative 2, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would operate as proposed in the submitted HGMPs (Subsection 2.2.2, Alternative 2). Consequently, relative to Alternative 1, more steelhead (juveniles and adults) would be available as a food source for Southern Resident killer whales (Subsection 3.4, Wildlife – Southern Resident Killer Whale). Because (1) Alternative 2 would only lead to a small increase in the total number of steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins or in the analysis area relative to Alternative 1, and (2) Southern Resident killer whales do not feed exclusively on steelhead, Alternative 2 would be expected to have a negligible positive effect on the diet, survival, distribution and listing status of the species relative to Alternative 1, similar to effects under existing conditions (Subsection 3.4, Wildlife-Southern Resident Killer Whale).

4.4.3 Alternative 3 (Reduced Production) – Make a Determination that Revised HGMPs with Reduced Production Levels Meet Requirements of the 4(d) Rule

Under Alternative 3, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be reduced by 50 percent relative to the proposed hatchery programs (Subsection 2.2.3, Alternative 3). Relative to Alternative 1 under which the hatchery programs would be terminated, Alternative 3 would increase the number of juvenile steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins, and more steelhead (juveniles and adults) would be available as a food source for Southern Resident killer whales (Subsection 3.4, Wildlife – Southern Resident Killer Whale). Because (1) Alternative 3 would only lead to a small increase in the total number of salmon and steelhead in the Dungeness, Nooksack, Stillaguamish River, Skykomish, and Snoqualmie basins or in the analysis area relative to Alternative 1, and (2) Southern Resident killer whales do not feed exclusively on steelhead, Alternative 3 would be expected to have negligible positive effects on the diet, survival, distribution, and listing status of the species relative to Alternative 1, and effects would be similar to the negligible positive effects under existing conditions (Subsection 3.4, Wildlife – Southern Resident Killer Whale).

Relative to existing conditions and Alternative 2, Alternative 3 would reduce the number of hatchery-origin steelhead released in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins by 50 percent and, therefore, reduce the total number of steelhead available as food to Southern Resident killer whales. Because (1) Alternative 3 would reduce the total number of juvenile hatchery-origin steelhead in the analysis area by a very small percentage relative to the total number of salmon and steelhead in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie basin or in the analysis area relative to existing conditions and Alternative 2, and (2) Southern Resident killer whales do not feed exclusively on steelhead, Alternative 3 would be expected to have a similar, but less pronounced negligible positive effect on the diet, survival, distribution, and listing status of the species relative to existing conditions or Alternative 2.

4.4.4 Alternative 4 (Native Broodstock) – Make a Determination that Revised HGMPs that Replace Chambers Creek Stock with a Native Broodstock Meet Requirements of the 4(d) Rule

Under Alternative 4, WDFW would produce the same number of winter hatchery-origin steelhead (620,000) as under Alternative 2, but would replace the early winter Chambers Creek steelhead broodstock with native steelhead broodstocks that are local to the respective river basins (Subsection 2.2.4, Alternative 4). Effects on Southern Resident killer whales would be identical to those under Alternative 2 (negligible positive) and existing conditions, because a change in broodstock would not affect the number of hatchery-origin steelhead available to Southern Resident killer whales as prey.

4.5 Socioeconomics

The socioeconomic analysis addresses effects of early winter steelhead hatchery programs on existing socioeconomic conditions of regional and local economies described in Subsection 3.5, Socioeconomics, when combined with effects anticipated under each alternative. This assessment of the socioeconomic effects of the alternatives evaluates predicted changes in recreational trips, hatchery operational cost values (e.g., procurement of goods and services needed to operate hatcheries), and personal income and jobs associated with fisheries on early winter hatchery-origin steelhead that would contribute to economic conditions in the analysis area.

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

Under Alternative 1, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be terminated immediately (Subsection 2.2.1, Alternative 1), and 620,000 fewer steelhead would be produced by hatcheries in the analysis area relative to existing conditions (Subsection 3.2, Salmon and Steelhead). However, all of the hatchery facilities that support these hatchery programs would continue to operate because they support hatchery programs (e.g., for salmon) that are not part of the Proposed Action or its alternatives (Subsection 3.5, Socioeconomics).

None of the 19.3 FTE jobs supporting the five early winter steelhead hatchery programs would be affected under Alternative 1, because the hatchery facilities would be used for production of other species (e.g., salmon) (Subsection 3.5.1, Hatchery Operations; Appendix C, Socioeconomics Methods). However, the hatchery programs would no longer need to procure local goods and services, which would lead to a loss of $496,000 that would have low negative impact to personal income and jobs in the regional economy, relative to existing conditions (Subsection 3.5.1, Hatchery Operations).

NMFS estimates that early winter steelhead from the hatchery programs produce 4,412 adults that contribute $5.3 million from annual angler expenditures associated with 78,400 fishing trips in the analysis area under existing conditions (Subsection 3.5.2, Fisheries), which would not occur under Alternative 1. The overall economic loss of $5.8 million under Alternative 1 ($496,000 plus $5.3 million) would have a moderate negative effect on socioeconomic resources in the analysis area, relative to existing conditions.

Under Alternative 1, the number of steelhead available to tribal members as a food source would be reduced, which may increase tribal reliance on other fish species or consumer goods, or increase travel costs to participate in other steelhead fisheries, relative to existing conditions. Further, Alternative 1 would reduce the amount of revenue that could be generated by tribes through the harvest and sale of steelhead. Therefore, Alternative 1 would be expected to have a moderate negative effect on affected tribes, relative to existing conditions.

4.5.2 Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs Meet Requirements of the 4(d) Rule

Under Alternative 2, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would operate as proposed in the submitted HGMPs (Subsection 2.2.2, Alternative 2). Relative to Alternative 1, Alternative 2 would increase the number of hatchery-origin steelhead produced in the analysis area by 620,000 smolts, which would be the same as under existing conditions (Subsection 3.2, Salmon and Steelhead).

Relative to Alternative 1, Alternative 2 would increase jobs by 19.3 FTE to support the five early winter steelhead hatchery programs, which is the same as under existing conditions (Subsection 3.5.1, Hatchery Operations; Appendix C, Socioeconomics Methods). The hatchery programs would procure local goods and services, which would contribute $496,000 and have a low positive impact on personal income and jobs in the regional economy (Subsection 3.5.1, Hatchery Operations).

Relative to Alternative 1, hatchery production under Alternative 2 would produce 4,412 adults (Appendix C, Socioeconomics Methods) which would contribute $5.3 million from annual angler expenditures associated with 78,400 fishing trips in the analysis area. The overall economic contribution of $5.8 million under Alternative 2 ($496,000 plus $5.3 million) would be the same as under existing conditions, and would have a moderate positive effect on the socioeconomic resources in the analysis areas, relative to Alternative 1.

Relative to Alternative 1, Alternative 2 would increase the number of steelhead available to tribal members as a food source and may reduce tribal reliance on other species or consumer goods, or reduce travel costs to participate in other fisheries (Subsection 3.5, Socioeconomics). Further, relative to Alternative 1, Alternative 2 would increase the amount of revenue that could be generated by tribes through the sale of fish. These effects would, however, continue to represent existing conditions. Therefore, Alternative 2 would be expected to have a moderate positive effect on affected tribes, relative to Alternative 1, but no change in effect relative to existing conditions.

4.5.3 Alternative 3 (Reduced Production) – Make a Determination that Revised HGMPs with Reduced Production Levels Meet Requirements of the 4(d) Rule

Under Alternative 3, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be reduced by 50 percent relative to the submitted HGMPs (Subsection 2.2.3, Alternative 3), and relative to existing conditions. Relative to Alternative 1, Alternative 3 would increase the number of hatchery-origin steelhead produced in the analysis area by 310,000 smolts.

None of the 19.3 FTE jobs supporting the five early winter steelhead hatchery programs would be affected under Alternative 3, because the hatchery facilities would be used for production of other species (e.g., salmon) (Subsection 3.5.1, Hatchery Operations; Appendix C, Socioeconomics Methods). However, under Alternative 3, expenditures on goods and services needed to operate the hatchery programs would be reduced (estimated at about $65,000), relative to Alternative 2 and existing conditions (Appendix C, Socioeconomics Methods), which would have a negligible positive impact on personal income and jobs in the regional economy (Subsection 3.5.1, Hatchery Operations)

Relative to Alternative 1, hatchery production under Alternative 3 would produce 2,206 adults (Appendix C, Socioeconomics Methods) which would contribute $4.4 million from annual angler expenditures associated with 59,800 fishing trips in the analysis area. The overall economic contribution of $4.8 million under Alternative 3 ($431,000 plus $4.4 million) would have a moderate positive effect on the socioeconomic resources in the analysis areas, relative to Alternative 1. This effect would be the same as under existing conditions.

Relative to Alternative 1, Alternative 3 would increase the number of steelhead available to tribal members as a food source and may reduce tribal reliance on other consumer goods or reduce travel costs to participate in other fisheries (Subsection 3.5, Socioeconomics). Further, relative to Alternative 1, Alternative 3 would increase the amount of revenue that could be generated through the sale of fish. Such increases would not likely match existing food source availability and revenues, however, because hatchery production would decrease 50 percent compared to existing conditions. Therefore, Alternative 3 would be expected to have a low positive effect on affected tribes, relative to Alternative 1.

Relative to existing conditions and Alternative 2, Alternative 3 would reduce the number of hatchery-origin steelhead released in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins[10]. This would reduce the total number of steelhead harvested annually in recreational fisheries in the river basins from about 4,412 to 2,206 adults, associated angler effort would decline by an estimated 19,600 trips (25 percent) to 59,800 trips, and overall regional economic income would be reduced $1.0 million to $4.8 million, relative to Alternative 2 and existing conditions.

Relative to existing conditions and Alternative 2, Alternative 3 also would reduce the number of steelhead available to tribal members as a food source and may increase tribal reliance on other consumer goods or increase travel costs to participate in other fisheries (Subsection 3.5, Socioeconomics). Further, relative to existing conditions and Alternative 2, Alternative 3 would reduce the amount of revenue that could be generated by tribes through the sale of fish.

4.5.4 Alternative 4 (Native Broodstock) – Make a Determination that Revised HGMPs that Replace Chambers Creek Stock with a Native Broodstock Meet Requirements of the 4(d) Rule

Under Alternative 4, relative to Alternative 1, the same number of hatchery-origin winter steelhead would be produced as under existing conditions and Alternative 2, but the broodstock source would change from the early winter Chambers Creek stock to native steelhead broodstocks that are local to the respective river basins (Subsection 2.2.4, Alternative 4). As described in Appendix C, Socioeconomic Methods, under Alternative 4, it is assumed that the smolt-to-adult survival rates of fish from early winter hatchery programs would be similar to smolt-to-adult survival rates of fish from native broodstocks, and therefore the harvest-related socioeconomic effects of Alternative 4 would not differ from existing conditions or Alternative 2. Therefore, socioeconomic effects would be identical as under existing conditions and

[10] As explained in Appendix C, Socioeconomics Methods, it is assumed that changes in operation and maintenance costs would be proportional to differences between production levels under the alternatives. In contrast, labor income from the five hatchery programs under the Alternative 1 (No Action) and Alternative 3 (Reduced Production), is assumed to remain the same as estimated for the Proposed Action (Alternative 2), because no jobs are assumed to be lost under any alternative due to operations for programs (e.g., salmon) not included in the Proposed Action. However, under Alternative 1 and Alternative 3, regional income generated by expected changes in hatchery-related expenditures associated with procurement of goods and services and from angler expenditures, would change, because procurement spending to achieve the production levels, and associated recreational angler effort, would change under the alternatives.

Alternative 2 (moderate positive effect) because the same number of fish would be produced and harvested.

4.6 Environmental Justice

The environmental justice analysis addresses effects of early winter steelhead hatchery programs on existing environmental justice conditions in the analysis area described in Subsection 3.6, Environmental Justice, when combined with effects anticipated under each alternative.

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

Under Alternative 1, the early winter steelhead hatchery programs would be terminated immediately (Subsection 2.2.1, Alternative 1), and 620,000 fewer steelhead would be produced by hatcheries in the analysis area relative to existing conditions (Subsection 3.2, Salmon and Steelhead).As a result, there would be a loss of fishing opportunities in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins relative to existing conditions. All four of the counties in the analysis area are environmental justice communities of concern because they meaningfully deviate from thresholds for low income or minority populations (Subsection 3.6, Environmental Justice) (Table 13). Therefore, overall, all counties in the analysis area would be similarly affected by the termination of the early winter steelhead hatchery programs and loss of fishing opportunities under Alternative 1 would result in low and negative environmental justice impacts, relative to existing conditions (Subsection 3.6, Environmental Justice). The most substantial impacts would be expected on the 13 communities of concern that are associated with steelhead fishing. Clallam County and Whatcom County may be affected to a greater extent than Snohomish and King Counties because per capita income and the percentage of persons below the poverty level are the highest.

Because of the unique connection of Native American tribes to salmon and steelhead, any reduction in steelhead harvest opportunities pose a disproportionate effect on Native American tribes. Therefore, Alternative 1 would have a moderate negative impact on the following tribes: Lummi Nation, Nooksack Tribe, Stillaguamish Indian Tribe, Tulalip Tribes, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe, relative to existing conditions (Subsection 3.6, Environmental Justice).

4.6.2 Alternative 2 (Proposed Action) – Make a Determination that the Submitted HGMPs Meet Requirements of the 4(d) Rule

Under Alternative 2, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would operate as proposed in the submitted HGMPs (Subsection 2.2.2, Alternative 2). Relative to Alternative 1, Alternative 2 would increase the number of hatchery-origin steelhead produced in the analysis area by 620,000 smolts, which would be the same as under existing conditions (Subsection 3.2, Salmon and Steelhead). Relative to Alternative 1, Alternative 2 would increase fishing opportunities in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. However, such increases in fishing opportunities would be at the same level as under current, existing conditions (Subsection 3.6, Environmental Justice).

Overall, all counties in the environmental justice analysis area would be similarly affected by implementation of the proposed HGMPs and fishing opportunities under Alternative 2, which would result in low positive effects, relative to Alternative 1. However, the low positive effects would continue to represent existing conditions. The most substantial impacts would be expected on the 13 communities of concern that are associated with steelhead fishing. Clallam County and Whatcom County may be affected to a greater extent than Snohomish and King Counties because per capita income and the percentage of persons below the poverty level are the highest.

Because of the unique connection of Native American tribes to salmon and steelhead, any changes in harvest opportunity would pose a disproportionate effect on Native American tribes if the change reduces harvest in their "usual and accustomed" fishing areas. Because Alternative 2 would increase harvest opportunities for tribes in the analysis area relative to Alternative 1, there would be a moderate positive impact on the following tribes: Lummi Nation, Nooksack Tribe, Stillaguamish Indian Tribe, Tulalip Tribes, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe. However, such increases in harvest opportunities would be at the same levels as under current, existing conditions (Subsection 3.6, Environmental Justice).

4.6.3 Alternative 3 (Reduced Production) – Make a Determination that Revised HGMPs with Reduced Production Levels Meet Requirements of the 4(d) Rule

Under Alternative 3, the early winter steelhead hatchery programs in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins would be reduced by 50 percent relative to the proposed hatchery programs (Subsection 2.2.3, Alternative 3), and 310,000 fewer steelhead would be produced in the analysis area relative to existing conditions (Subsection 3.2, Salmon and Steelhead). Relative to Alternative 1 under which the hatchery programs would be terminated, Alternative 3 would increase fishing opportunities in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins. Such increases would not be at the same levels as under current, existing conditions (Subsection 3.6, Environmental Justice).

Overall, all counties in the environmental justice analysis area would be similarly affected by implementation of the proposed HGMPs and fishing opportunities under Alternative 2, which would result in low positive effects relative to Alternative 1, which would be similar to existing conditions. The most substantial impacts would be expected on the 13 communities of concern that are associated with steelhead fishing. Clallam County and Whatcom County may be affected to a greater extent than Snohomish and King Counties because per capita income and the percentage of persons below the poverty level are the highest.

Because of the unique connection of Native American tribes to salmon and steelhead, any changes in harvest opportunity would pose a disproportionate effect on Native American tribes if the change reduces harvest in their "usual and accustomed" fishing areas. Because Alternative 3 would increase harvest opportunities for tribes in the analysis area relative to Alternative 1, there would be a moderate, positive impact on the following tribes: Lummi Nation, Nooksack Tribe, Stillaguamish Indian Tribe, Tulalip Tribes, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe. This benefit would, however, be lower than under existing conditions (Subsection 3.6, Environmental Justice).

Relative to existing conditions and Alternative 2, Alternative 3 would reduce harvest opportunities for tribes in the analysis area. Consequently, there would be a moderate negative impact on the following tribes: Lummi Nation, Nooksack Tribe, Stillaguamish Indian Tribe, Tulalip Tribes, Port Gamble S'Klallam Tribe, Jamestown S'Klallam Tribe, and Lower Elwha Klallam Tribe.

4.6.4 Alternative 4 (Native Broodstock) – Make a Determination that Revised HGMPs that Replace Chambers Creek Stock with a Native Broodstock Meet Requirements of the 4(d) Rule

Under Alternative 4, WDFW would produce the same number of hatchery-origin winter steelhead as under Alternative 2, but the broodstock source would change from the early winter Chambers Creek steelhead stock to native broodstocks that are local to the river basins (Subsection 2.2.4, Alternative 4). Environmental justice effects would be identical to those under Alternative 2 (low positive to environmental justice counties of concern, and moderate positive for affected tribes) because the change in broodstock would lead to the same number of hatchery-origin steelhead available for harvest.

4.7 Summary of Resource Effects

This subsection provides a summary of potential direct and indirect environmental effects on the physical, biological, and social environments that are associated with the alternatives. Cumulative effects associated with the alternatives are described in Chapter 5, Cumulative Effects. Each subsection listed below describes potential effects on a specific resource topic; each resource topic is described in a corresponding main subsection in Chapter 3, Affected Environment. The specific order of the resource effects summarized in this subsection is:

- Water Quantity (Subsection 4.1)
- Salmon and Steelhead (Subsection 4.2)
- Other Fish Species (Subsection 4.3)
- Wildlife – Southern Resident Killer Whale (Subsection 4.4)
- Socioeconomics (Subsection 4.5)
- Environmental Justice (Subsection 4.6)

Table 16 summarizes predicted effects from implementation of the No-action Alternative (Alternative 1) and the action alternatives (Alternative 2 through Alternative 4). This table summarizes the detailed resource discussions in Subsection 4.1, Water Quantity, through Subsection 4.6, Environmental Justice. Refer to those subsections for context and background to support conclusions stated in Table 16. No preferred alternative has been identified in this draft EIS (Subsection 2.4, Selection of a Preferred Alternative and an Environmentally Preferred Alternative).

Table 16. Summary of environmental consequences by resource and alternative.

Resource	Alternative 1 (No Action – termination)	Alternative 2[1] (Proposed Action)	Alternative 3[1] (Reduced Production)	Alternative 4[1] (Native Broodstock)
Water Quantity	Compared to existing conditions, the early winter steelhead hatchery programs would be terminated, but all of the hatchery facilities that support the programs would continue to operate to produce fish for programs that are not part of the Proposed Action. Short- and long-term water use may be less than under existing conditions because no early winter steelhead would be produced.	The hatchery programs would continue to operate at existing levels, and would have negligible to moderate negative effects on water quantity, depending on the hatchery program, compared to Alternative 1.	Same as Alternative 2, although water use would be reduced to support lower production levels of early winter steelhead.	Same as Alternative 2.
Salmon and Steelhead	Because early winter steelhead hatchery production would be terminated, negative and positive effects to salmon or steelhead from the programs would be eliminated, compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would generally have negligible to moderate negative effects on gene flow, competition and predation, hatchery facilities, masking, incidental fishing, and disease transfer effects; and negligible positive effects from nutrient cycling, depending on the hatchery program and affected species. As under existing conditions, there would be no benefit to the population viability of the listed steelhead DPS.	Same as Alternative 2, except that negative effects from gene flow, competition and predation, hatchery facilities, masking, incidental fishing, and disease transfer from early winter steelhead would be reduced. There would be no change to the population viability benefit of the listed steelhead DPS, compared to Alternative 2.	Same as Alternative 2 except that collection of local native broodstock could have a low negative effect on the abundance and spatial structure of the natural-origin populations (i.e., mining), and a potential positive benefit to viability of the listed steelhead DPS.

Table 16. Summary of environmental consequences by resource and alternative (continued).

Resource	Alternative 1 (No Action – termination)	Alternative 2[1] (Proposed Action)	Alternative 3[1] (Reduced Production)	Alternative 4[1] (Native Broodstock)
Other Fish Species	Because early winter steelhead hatchery production would be terminated, other fish species would be affected if they compete with, are prey of (positive effect), or prey on (negative effect) early winter steelhead, compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would have low negative to negligible positive effects on other fish species if they compete with or are prey of (negative effect), or prey on fish from early winter steelhead hatchery programs (positive effect), compared to Alternative 1.	Same as Alternative 2, except that the food supply for fish species that benefit from steelhead as prey would be reduced, and risk to other fish species that compete with, are prey of, or prey on steelhead would be reduced, compared to Alternative 2.	Same as Alternative 2.
Wildlife – Southern Resident killer whale	Because early winter steelhead hatchery production would be terminated, early winter steelhead prey that would have been available to Southern Resident killer whales under existing conditions would be eliminated. This reduction from existing conditions would likely result in a negligible negative effect. Southern Resident killer whales would continue to occupy their existing habitats with a similar abundance, and would continue to prey on available salmon and other steelhead, especially Chinook salmon, as under existing conditions.	The hatchery programs would continue to operate at existing levels, and would have a negligible positive effect on Southern Resident killer whales, which would continue to occupy their existing habitats with a similar abundance, and would continue to prey on salmon and steelhead, especially Chinook salmon, compared to Alternative 1.	Similar to Alternative 2, except that early winter steelhead hatchery production and adult returns would decrease, reducing the supply of early winter steelhead available to Southern Resident killer whales as prey. Alternative 3 would have a negligible positive effect, similar to Alternative 2, but less pronounced.	Same as Alternative 2.

Table 16. Summary of environmental consequences by resource and alternative (continued).

Resource	Alternative 1 (No Action – termination)	Alternative 2[1] (Proposed Action)	Alternative 3[1] (Reduced Production)	Alternative 4[1] (Native Broodstock)
Socioeconomics	Because early winter steelhead hatchery production would be terminated, non-tribal and tribal fishing opportunities would be reduced and there would be a loss of personal income and jobs compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would have low to moderate positive socioeconomic effects from hatchery operations and fishing activities (non-tribal and tribal), compared to Alternative 1.	Same as Alternative 2, except that the socioeconomic effects from hatchery operations and fishing (non-tribal and tribal) would decrease.	Same as Alternative 2.
Environmental Justice	Because early winter steelhead hatchery production would be terminated, reduced fishing opportunities would negatively impact all communities of concern, and affected Native American tribes, compared to existing conditions.	The hatchery programs would continue to operate at existing levels, and would provide low positive effects from fishing opportunities for all communities of concern, and moderate positive effects for Native American tribes, compared to Alternative 1.	Same as Alternative 2, except that fishing opportunities for all communities of concern, and for Native American tribes, would decrease.	Same as Alternative 2.

[1] Potential differences between the no action and the action alternatives would be due to differences in hatchery production levels and program type under the action alternatives.

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Chapter 5

5 CUMULATIVE EFFECTS

5.1 Introduction

The National Environmental Policy Act defines cumulative effects as "the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such other actions" (40 CFR 1508.7). Council on Environmental Quality (CEQ) guidelines recognize that it is not practical to analyze the cumulative effects of an action from every conceivable perspective, but rather, the intent is to focus on those effects that are truly meaningful. In other words, if several separate actions have been taken or are intended to be taken within the same geographic area, all of the relevant actions together (cumulatively) need to be reviewed, to determine whether the actions *together* could have a significant impact on the human environment. Past, present, and reasonably foreseeable future actions include those that are Federal and non-Federal. For this EIS analysis, they also include those that are hatchery-related (e.g., hatchery production levels) and non-hatchery related (e.g., human development).

The cumulative effects of a Proposed Action can be represented as an equation:

Proposed Action + Past Actions + Present Actions + Reasonably Foreseeable Future Actions = Cumulative Effects

The CEQ provides an 11-step process for cumulative effects analyses that is woven into the larger NEPA process and into documents supporting a Federal action (CEQ 1997) (Table 17). Other subsections of this EIS are relevant as support for this cumulative effects analysis.

Chapter 3, Affected Environment, describes the existing conditions (or baseline, for the purposes of this chapter) for each resource and reflects the effects of past actions and present condition. Chapter 4, Environmental Consequences, evaluates the direct and indirect effects of the alternatives on each resource's baseline conditions. This chapter considers the cumulative effects of each alternative in the context of past actions, present conditions, and reasonably foreseeable future actions and conditions.

Table 17. CEQ cumulative effects analysis process and documentation within this EIS.

		Steps in the Process	Location within this EIS
Scoping	1	Identify the significant cumulative effects issues associated with the proposed action and define the assessment goals	Subsections 1.2, 1.3, 1.6, and 5.5
	2	Establish the geographic scope for the analysis	Subsections 1.4 and 5.1.1
	3	Establish the time frame for the analysis	Subsection 5.1.1
	4	Identify other actions affecting the resources, ecosystems, and human communities of concern	Subsection 5.4
Describing the Affected Environment	5	Characterize the resources, ecosystems, and human communities identified in scoping in terms of their response to change and capacity to withstand stresses	Chapter 3
	6	Characterize the stresses affecting these resources, ecosystems, and human communities and relations to regulatory thresholds	
	7	Define a baseline condition for the resources, ecosystems and human communities	
Determining the Environmental Consequences	8	Identify the important cause-and-effect relationships between human activities and resources, ecosystems, and human communities	Chapter 3 and Subsections 5.2 to 5.5
	9	Determine the magnitude and significance of cumulative effects	Subsection 5.6
	10	Modify or add alternatives to avoid, minimize, or mitigate significant cumulative effects	Chapter 2
	11	Monitor the cumulative impacts of the selected alternatives and apply adaptive management	Alternative 2 (Proposed Action) includes monitoring and adaptive management as described in HGMPs

5.1.1 Geographic and Temporal Scales

The cumulative effects analysis area includes the project area described in Subsection 1.4, Project and Analysis Areas, and additionally includes the entire United States and Canadian portions of the Strait of Juan de Fuca, Strait of Georgia, and all connecting channels and adjoining waters, all of which encompasses an area collectively known as the Salish Sea. The area is also commonly referred to as the Georgia Basin, Strait of Juan de Fuca, and Puget Sound ecosystem. This cumulative effects area was determined based on the geography, topography, waterways, and natural interactions that occur among the ecosystems present in Puget Sound. Biological resources and human populations within the Salish Sea cumulative effects area share a common airshed, common watershed, and common flyway. The developed area has a population of approximately 7 million people with some population projections to 9.4 million by 2025 (Environment Canada-EPA 2008).

The temporal scope of past and present actions for the affected resources encompasses actions that occurred prior to and after Puget Sound salmon and steelhead species became listed under the ESA. This is also the temporal context within which affected resources are described in Chapter 3, Affected Environment, whereby existing conditions are a result of prior and ongoing actions in the EIS project area.

5.1.2 Chapter Organization

Provided below are known past, present, and future actions from a regional context that have occurred, are occurring, or are reasonably likely to occur within the cumulative effects analysis area. Subsection 5.2, Past Actions, summarizes past actions that affected the cumulative effects analysis area; Subsection 5.3, Present Conditions, describes current overall trends for the area; and Subsection 5.4, Future Actions and Conditions, describes climate change effects, development, habitat restoration, hatchery production, and fisheries activities and objectives supported by agencies and other non-governmental organizations to restore habitat in the cumulative effects analysis area. Finally, Subsection 5.5, Cumulative Effects by Resource, describes how these past, present, and future actions affect each resource evaluated in this EIS, and specifically focuses on the effects of alternatives, when possible.

5.2 Past Actions

Humans occupied the shores and islands of the Salish Sea for at least the past 8,000 years (Stein 2000). Before Europeans arrived in the Salish Sea ecosystem, most human inhabitants were hunter-gatherers. They relied on sea life for food, animals for food and warm clothing, and trees for building materials. Indigenous peoples were known to use the waterways of the Salish Sea as trading routes. Fire was used to modify the environment, to clear areas to aid hunting, to promote berry production, and to support the growth of grasses for making nets, baskets, and blankets (Barsh 2003).

In the 1800s, with the arrival of the first Europeans, trapping and logging were initiated on a large scale, which changed the landscape. Washington State became one of the top five producers of timber, and salmon harvest increased by over 2,000 percent compared to harvest before European arrival. As natural resource extraction and the number of people in the area increased, the quality of the Salish Sea ecosystem declined. Most of the old-growth forest was harvested, and much forestland was converted to human-dominated uses, such as agriculture and urban development. The quantity and availability of tidal marsh and other freshwater estuarine ecosystem types declined, floodplains were altered, rivers and streams were channelized, substantial dams were constructed in some river basins, estuaries were filled, shorelines were hardened and/or modified, water and air quality declined, pollution and marine traffic increased, and habitat was lost (British Columbia Ministry of Water, Land, and Air Protection [BCMWLAP] 2002; Puget Sound Partnership [PSP] 2012). Additionally, hydropower development in the cumulative effects analysis area increased in the early decades of the 20^{th} century, which altered stream courses, backfilled large tracts of land, and prevented fish spawning. As a result, the number of marine-related species at risk in the Salish Sea ecosystem increased, as did the presence of non-native invasive species (Quinn 2010).

Salmon and steelhead have been propagated in hatcheries in Puget Sound since the late 1800s (PSTT and WDFW 2004). The purpose of early hatchery programs was to support recreational and commercial fisheries as compensation for declining natural-origin fish populations due to overexploitation. Over time, fish produced in hatcheries in the Puget Sound area gradually began to be used as mitigation for the negative effects of human development on natural-origin salmon and steelhead survival and productivity.

In the 1970s, the legal framework of *United States* v. *Washington* (1974) was established that became the primary driver for defining fish production and harvest objectives in Puget Sound (PSTT and WDFW 2004). In general, risks to natural-origin salmon and steelhead (e.g., competition and predation in freshwater and marine water, genetics) from hatchery programs, and associated benefits for fisheries increased as production levels increased (Subsection 2.0, General Effects (Risks and Benefits) of Hatchery Programs to Salmon and Steelhead, of Appendix B, Hatchery Effects and Evaluation Methods for Fish, in the PS Hatcheries DEIS [NMFS 2014a]).

The Pacific Salmon Treaty between Canada and the United States was finalized March 17, 1985 (Pacific Salmon Commission 1985), and has provided a framework for the involved parties to manage salmon stocks either originating from one country and intercepted by the other, or affecting the management or the biology of the stocks of the other country. The objective of the original treaty and subsequently negotiated agreements (annexes) is to constrain harvest on both sides of the United States-Canada border and to rebuild depressed salmon stocks. The role of the Pacific Salmon Commission is to oversee implementation of the treaty and to negotiate periodic revisions of the annex fishing regimes. Although the emphasis of the work of the Pacific Salmon Commission under the Pacific Salmon Treaty is salmon, it is charged with taking into account the conservation of steelhead trout while fulfilling its other functions.

5.3 Present Conditions

As described in Subsection 5.2, Past Actions, substantial changes have occurred to land uses and the marine environment in the Salish Sea cumulative effects analysis area, but the area remains one of the most ecologically diverse in North America, containing a wide range of species and habitats that span international boundaries (EPA 2011). The topography of the area creates highly variable local-scale climates and, in combination with diverse soil types, results in a wide variety of environmental conditions. This variety is important because it supports a diversity of fish species and life histories as described in Subsection 3.2, Salmon and Steelhead, and Subsection 3.3, Other Fish Species. For example, the diversity (genetic and behavioral) represented by variation in Chinook salmon and steelhead life histories helps both species adapt to short- and long-term changes in their environment over time (McElhany et al. 2000).

The Center for Biological Diversity (2005) identified 7,000 species of organisms that occur in Puget Sound, and the area is considered one of the most productive areas for salmon along the Pacific Coast (Lombard 2006). However, the World Wildlife Fund (2012) considers the remaining natural habitats in the Salish Sea area to be threatened from ongoing urbanization, agricultural practices, fire suppression, introduction of noxious weeds, flood control efforts, operation of hydroelectric dams, and logging. For example, these human-induced factors (e.g., habitat modifications, water quality degradation, presence of dams and fish barriers, and other factors) have affected overall abundance, productivity, diversity, and distribution of salmon and steelhead in Puget Sound. In addition, aquaculture (farming of fish, shellfish, and aquatic plants in fresh and marine water for direct harvest), which is practiced in Washington and British Columbia, has grown over time and has the potential to affect other aquatic organisms.

The legal framework of *United States* v. *Washington* (1974) continues to be the primary driver for defining fish production and harvest objectives in Puget Sound. The current Pacific Salmon Treaty agreement (or annex) governs Chinook salmon and several other species from 2009 through 2018.

Salmon and steelhead hatchery facilities and practices have become more sophisticated and efficient over time as new technologies have been applied. For example, although the general risks to natural-origin salmon and steelhead (e.g., competition and predation in freshwater and marine water, genetics) from hatchery programs and associated benefits for fisheries as described Subsection 5.2, Past Actions, are ongoing, risks are being reduced from development of contemporary policies that hatchery operators are implementing for hatchery improvements (HSRG 2014). For example, to reduce or limit the risks of gene flow from hatchery stocks to native fish, hatchery operators are developing more appropriate hatchery broodstocks, limiting the extent to which hatchery-origin fish can be transferred from one basin to another, marking hatchery-origin fish for harvest management and stock assessment purposes, and actively managing unintended natural spawning and straying by hatchery-origin fish. Hatchery managers are also making improvements in fish disease management and improving their understanding of and approaches to reducing ecological impacts (Kostow 2012). Hatcheries are now also used in some circumstances for conservation and recovery purposes by using locally adapted native broodstocks, while simultaneously providing for some harvest benefits (Subsection 3.2, Fish, in the PS Hatcheries DEIS (NMFS 2014a). Notwithstanding these beneficial changes, hatcheries continue to affect salmon in the Salish Sea through genetic introgression, competition, predation and disease.

Altogether, the stressors described above under present conditions (e.g., human development and habitat degradation, hatchery practices, and fisheries) are expected to continue under future actions and conditions as described below.

5.4 Future Actions and Conditions

Reasonably foreseeable future actions include climate change, human development, planned restoration activities, hatchery production, and fisheries. Many plans, regulations, and laws are in place, as well as agreements between the United States and Canada, to minimize effects of development and to restore habitat function. However, it is unclear if these plans, regulations, and laws will be successful in meeting their environmental goals and objectives. In addition, it is not possible to predict the magnitude of effects from future development and habitat restoration with certainty for several reasons: (1) the activities may not have yet been formally proposed, (2) mitigation measures specific to future actions may not have been identified for many proposed projects, and (3) there is uncertainty whether mitigation measures for these actions will be fully implemented. However, when combined with climate change, a general trend in expected cumulative effects can be estimated for each resource as described in Subsection 5.5, Cumulative Effects by Resource.

Because of the large geographic scope of this analysis, it is not feasible to conduct a detailed assessment of all project-level activities that have occurred, are occurring, or are planned in the future for the cumulative effects analysis area. Rather, this cumulative effects analysis qualitatively assesses the overall trends in cumulative effects considering past, present, and reasonably foreseeable future actions, and describes how the alternatives contribute to those trends.

5.4.1 Climate Change

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

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

- Higher ocean temperatures (high certainty)
- Intensified upwelling (moderate certainty)
- Delayed spring transition (moderate certainty)
- Increased ocean acidity (high certainty)

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

For the Pacific Northwest portion of the United States, Hamlet (2011) notes that climate changes will have multiple effects. Expected effects include:

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

The most heavily affected ecosystems and human activities along the Pacific coast are likely to be near areas having high human population densities, and the continental shelves off Oregon and Washington (Halpern et al. 2009).

Several studies note that similar changes are expected to occur in British Columbia. For example, climate change effects in Georgia Strait are expected to include warming of marine waters (Littell et al. 2009) and fresh waters (Perry 2009), and changes in river flow patterns from snow-melt-dominated conditions to rainfall-dominated conditions. Examples of the effects of climate change on human populations include loss of agricultural land because of inundation by rising sea levels, increases in storm intensity duration and frequency, salinization of municipal water intakes, and increases in the risk of tidal flat erosion and dike breaching and flooding (Natural Resources Canada [NRC] 2014).

5.4.2 Development

Future human population growth in the Seattle and Vancouver areas, and the areas between them, is expected to continue over the next 15 years. For example, the number of people in the Vancouver area is expected to grow by over 35,000 residents per year (Metro Vancouver 2013), and in the Puget Sound area by 40,000 per year (Puget Sound Regional Council 2013). This growth will result in increased demand for housing, transportation, food, water, energy, and commerce. These needs will result in changes to existing land uses because of increases in residential and commercial development and roads, increases in impervious surfaces, conversions of private agricultural and forested lands to developed uses, increases in use of non-native species and increased potential for invasive species, and redevelopment and infill of existing developed lands. The need to provide food and supplies to a growing human population in the cumulative effects analysis area will result in increases in shipping, increases in withdrawals of fresh water to meet increasing food and resource requirements, and increases in energy demands. Although the rate of urban sprawl has been decreasing in comparison to previous increases in the late 1900s (Puget Sound Regional Council 2012), development will continue to affect the natural resources in the cumulative effects analysis area.

To help protect environmental resources in the cumulative effects analysis area from potential future development effects, both the United States and Canada have Federal environmental protection agencies and Federal laws, regulations, and policies that are designed to conserve each nation's air, water, and land resources. Regulatory processes involve agency review, approval, and permitting of development actions. Regulatory examples include the ESA in the United States and the Species at Risk Act in Canada. Other examples include the Navigable Waters regulations of the Clean Water Act in the United States, and the Navigable Waters Protection Act in Canada. In the United States, aquaculture facilities (such as enclosed facilities for raising and selling fish, shellfish [including geoducks], and aquatic plants) are regulated by Washington State. In Canada, aquaculture facilities are regulated by British Columbia Department of Fisheries, and Fisheries and Oceans Canada. These environmental laws will continue to require agency review and approval of proposed activities.

In addition to Federal laws and processes, state and provincial laws, regulations, and guidelines will help decrease the effects of future commercial, industrial, and residential development on natural ecosystems. In Washington State, various habitat conservation plans (HCPs) have been implemented, such as the Washington Department of Natural Resources (DNR) Forest Practices HCP (DNR 2005), and other HCPs are in development (e.g., DNR Aquatic Lands HCP and WDFW Wildlife Areas HCP). These plans will provide long-term, landscape-based protection of federally listed and non-listed species considered at risk of extinction in Washington's private and state forested lands. Other state laws, regulations, and guidance include the Washington State Environmental Policy Act, and its Endangered, Threatened, and Sensitive Species Act as described in Subsection 1.7.10, Washington State Endangered, Threatened, and Sensitive Species Act. A law unique to the State of Washington is the Growth Management Act (Chapter 36.70A Revised Code of Washington), which requires local land use planning and development of regulations, including identification and protection of critical areas from future development.

Although the Province of British Columbia does not have comparable growth management laws and regulations for future development, the province reviews and approves future development primarily through its Environmental Assessment Act (which is separate from the Federal Canadian Environmental Assessment Act) and other laws and regulations (such as the Environment and Land Use Act, Environmental Management Act, Forest Act, Water Act, Water Protection Act, Wildlife Act, Fisheries Act, Shorelines Management Act, and Fish Protection Act). These provincial and state regulations will continue to help decrease habitat fragmentation, avoid residential development and urban sprawl in sensitive habitat and ecosystems, and decrease contamination to air, lands, and waterways.

In Washington, local land use laws, regulations, and policies will also help protect the natural environment from future development effects. For example, the Puget Sound Regional Council (PSRC) developed Vision 2040 to identify goals that support preservation and restoration of the natural environment ongoing with development through multicounty policies that address environmental stewardship (PSRC 2009). Vision 2040 is a growth management, environmental, economic, and transportation strategy for central Puget Sound. These objectives also include preserving open space, focusing on sustainable development, and planning for a comprehensive green space strategy. Other local policies and initiatives by counties and municipalities include designation of areas best suited for future development, such as local sensitive areas acts and shoreline protection acts.

In lower British Columbia, local zoning and development laws will help to protect open space from future development. The Greater Vancouver Regional District designates Green Zones to protect natural land assets (Greater Vancouver Regional District 2005). In addition, the Fraser River Estuary Management Plan was developed by a partnership of agencies and serves as a policy guide for municipalities and other agencies with jurisdiction or interest in the Fraser River estuary (Fraser River Estuary Management Program 2012). In ecologically sensitive areas, this plan is focused on protecting critical fish and wildlife functions. In addition, municipalities in British Columbia have community plans with policies and guidelines related to land use, development, services, amenities, and infrastructure related to future development (NRC 2014). The plans identify environmentally sensitive areas where future development is limited to protect environmental attributes.

In summary, in the Washington and British Columbia portions of the cumulative effects analysis area, Federal, state, and local laws, regulations, and policies will be applied with the intent to better enforce environmental protection for proposed future project developments. These laws, regulations, and policies include processes for public input, agency reviews, mitigation measures, permitting, and monitoring. The intent of these processes is to help ensure that development projects will occur in a manner that protects sensitive natural resources. The environmental goals and objectives of these processes are aimed at protecting ecosystems from activities that are regulated; however, not all activities are regulated to the same extent (e.g., large developments tend to be regulated more than smaller developments). Further, it is unlikely that all environmental goals and objectives will be successfully met by such processes. Unregulated or minimally regulated activities may lead to cumulative effects on sensitive natural resources over time. Thus, although Federal, state, and local laws, regulations, policies, and guidelines are in place to protect environmental resources from future development effects, there will continue to be some cumulative environmental degradation in the future from development, albeit likely to a lesser extent than has occurred historically when environmental regulatory protections did not exist or were not comprehensive and collaborative.

5.4.3 Habitat Restoration

To counterbalance the human-induced changes that will affect biodiversity in the cumulative effects analysis area (Subsection 5.4.2, Development), future funding for environmental restoration efforts will continue to help create a healthy environment and sustainable ecosystem (PSRC 2009; BCMWLAP 2002). United States Federal agencies and organizations are expected to continue to support habitat protection and restoration initiatives/processes in Puget Sound, including projects such as the Puget Sound Nearshore Ecosystem Restoration Project (Puget Sound Nearshore Ecosystem Restoration Partnership 2013), which is a partnership between the U.S. Army Corps of Engineers and WDFW for the purpose of identifying ecosystem degradation, formulating solutions, and recommending actions and projects to help restore Puget Sound. The Puget Sound Partnership (formerly the Shared Strategy for Puget Sound) is a collaborative initiative that will continue efforts to recover the Puget Sound ecosystem (including listed salmon, steelhead, and other species) with the support of NMFS, USFWS, Washington State, Puget Sound tribes, local governments, and key non-government organizations. In addition, implementation of salmon recovery plans in Puget Sound (72 Fed. Reg. 2493, January 19, 2007, for Chinook salmon, and 72 Fed. Reg. 29121, May 24, 2007, for Hood Canal summer-run chum salmon), will continue to recover salmon and steelhead and the habitats on which they depend in Puget Sound (Subsection 1.7.12, Recovery Plans for Puget Sound Salmon and Steelhead). It is expected that NMFS will continue to provide funding for habitat restoration initiatives through the Pacific Coastal Salmon Recovery Fund (NMFS 2011a). However, based on a recent review of the implementation of the Puget

Sound Chinook salmon recovery plan (NMFS 2011b), habitat continues to decline and habitat protection tools currently in place continue to need improvement.

Federal Canadian funding for habitat restoration includes several ongoing and expected future funded programs supported by Environment Canada. These projects regularly provide annual funding for habitat restoration and include:

- B.C. Hydro Bridge Coastal Fish and Wildlife Restoration Program (designed to fund projects to restore fish and wildlife populations and habitats in watersheds impacted by hydroelectric generation facilities)
- Habitat Conservation Trust Fund (includes funds for habitat enhancement and restoration)
- Public Conservation Assistance Fund (with objectives similar to the Habitat Conservation Trust Fund)
- EcoAction Community Funding Program (with several objectives that include habitat enhancement and rehabilitation)

It is expected that Washington State will continue to support habitat restoration through actions similar to recent support efforts. In addition to cooperative partnerships with Federal agencies as described above, Ecology (2012b) reserves funding for cleanups of toxics in Puget Sound. Although receiving substantial Federal support, the Puget Sound Partnership is a state agency that was created to lead the recovery of the Puget Sound ecosystem (PSP 2010). The agency created, and is overseeing implementation of, a roadmap to a healthy Puget Sound. Objectives include prioritizing cleanup and improvement projects; coordinating Federal, state, local, tribal, and private resources; and ensuring that all agencies and funding partners are working cooperatively. Washington State also created the Salmon Recovery Funding Board, which administers Federal and Washington State funds to protect and restore salmon and steelhead habitat. Priorities for recovering the Puget Sound ecosystem include reducing land development pressure on ecologically important and sensitive areas, protecting and restoring floodplain function, and protecting and recovering salmon and freshwater resources (PSP 2012). In marine and freshwater areas, development will continue to be encouraged away from ecologically important and sensitive nearshore areas and estuaries, and efforts will be made to reduce sources of pollution into Puget Sound (including stormwater runoff). Approaches will be used to help preserve the natural functions of the ecosystem and support sustainable economic growth. Local community efforts, such as smaller community habitat restoration and protection efforts, will help protect sensitive areas in Puget Sound.

In British Columbia, the provincial Watershed Restoration Program under Forest Renewal British Columbia will continue to restore the productive capacity of fisheries, and forest and aquatic resources that have been impacted by past forest practices. The Watershed Restoration Program hastens the recovery of degraded environmental resources in logged watersheds by identifying the needs for proposed restoration projects and by designing and implementing restoration that re-establishes conditions more similar to those found in watersheds that are not degraded. Other provincial and local habitat restoration initiatives will be continued, including the Salmon Habitat Restoration Program, which has historically been supported by the Canadian Federal government, but is now supported by the provincial and local governments.

In summary, a variety of Federal, state, provincial, and local programs will help restore degraded habitat conditions in the cumulative effects analysis area. Collectively, these programs will help to counterbalance habitat degradation and long-term detrimental cumulative impacts to natural resources in the cumulative effects analysis area, which have previously contributed to Federal and state listings of fish and wildlife species (Subsection 3.2, Salmon and Steelhead; Subsection 3.3, Other Fish Species; and Subsection 3.4, Wildlife – Southern Resident Killer Whale).

5.4.4 Hatchery Production

It is likely that the type and extent of salmon and steelhead hatchery programs and the numbers of fish released in the analysis area will change over time. These changes are likely to reduce effects to natural-origin salmon and steelhead such as genetic effects, competition and predation risks that are described in Subsection 3.2.2.1, General Effects of Puget Sound Salmon and Steelhead Hatchery Programs, especially for those species that are listed under the ESA. For example, effects to natural-origin salmon and steelhead would be 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. Where needed, reductions in effects on listed salmon and steelhead may occur through changes such as refinement of times and locations of fish releases to reduce risks of competition and predation; management of overlap in hatchery-origin and natural-origin spawners to meet gene flow objectives; decreased use of isolated hatchery programs; increased use of integrated hatchery programs for conservation purposes; when available, incorporation of new research results and improved best management practices for hatchery operations; decreased production levels; or termination of programs. Similar changes would be expected for non-listed species as well, motivated by the desire to avoid species from becoming listed. For steelhead, under WDFW’s Statewide Steelhead Management Plan (WDFW 2008), Wild Steelhead Management Zones (or wild stock gene banks) are in the process of being identified and implemented in at least three Puget Sound watersheds to promote the recovery of steelhead populations (see http://wdfw.wa.gov/conservation/fisheries/steelhead/gene_bank/). In those watersheds, to protect natural-origin steelhead from the effects of steelhead hatchery programs, releases of hatchery-origin steelhead would not occur.

5.4.5 Fisheries

It is likely that the salmon and steelhead fisheries in the analysis area will change over time. These changes are likely to reduce effects to natural-origin salmon and steelhead listed under the ESA. For example, effects to natural-origin salmon and steelhead would be expected to decrease over time to the extent that fisheries management programs continue to be reviewed and approved by NMFS under the ESA, as evidenced by the beneficial changes to programs that have thus far undergone ESA review. 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 effects on listed salmon and steelhead may occur through changes in areas or timing of fisheries, or changes in types of harvest methods used.

5.5 Cumulative Effects by Resource

Provided below is an analysis of the cumulative effects of climate change, development, habitat restoration, hatchery production, and fisheries under the alternatives and for each resource analyzed in this EIS. The resources for which cumulative effects are described are: water quantity and quality, salmon and steelhead, other fish species, wildlife – Southern Resident killer whale, socioeconomics, and environmental justice.

5.5.1 Water Quantity and Quality

Subsection 3.1, Water Quantity, describes the baseline conditions of water quantity. Water quality information for the analysis area is described in Subsection 3.6.1, Water Quality, in the PS Hatcheries DEIS (NMFS 2014a). These conditions are the result of many years of climate change, development, and habitat restoration, and operation of hatchery programs. The effects of the alternatives on water quantity are described in Subsection 4.1, Water Quantity. As described in Subsection 1.6, Scoping and Relevant Issues, and consistent with Subsection 4.6.3, Water Quality, in the PS Hatcheries DEIS (NMFS 2014a), and draft environmental assessments for salmon hatchery programs in the Dungeness River (80 Fed. Reg. 15985, March 26, 2015), effects of hatchery programs on water quality would be expected to be negligible. Future actions in the overall cumulative effects analysis area are described in Subsection 5.4, Future Actions and Conditions. This subsection considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on water quantity and water quality.

Successful operation of hatcheries depends on a constant supply of high-quality surface, spring, or groundwater that, after use in hatchery facilities, is discharged to adjacent receiving environments. Climate change and development are expected to affecting water quality by increasing water temperatures and affect water quantity by changing seasonality and magnitude of river flows. Although existing regulations are intended to help protect water quality and quantity from effects related to future development, the effectiveness of these regulations over time is likely to vary. Future habitat restoration would likely improve water quality and quantity (such as helping to decrease water temperatures through shading, decrease sedimentation, decrease water diversions, and protect aquifers and recharge areas). As discussed in Subsection 5.4.4, Hatchery Production, changes in hatchery programs may occur over time. Changes in types of hatchery programs over time are unlikely to improve water quality and quantity, because water use would be similar regardless of program type. However, reductions in hatchery production or terminations of programs could improve water quality and quantity to the extent that less water is used in hatchery operations. Fisheries on salmon and steelhead would not be expected to affect water quality or quantity. Overall, cumulative effects of climate change, development, and hatchery production on water quality and quantity are more likely to reduce water quantity than is described in Subsection 4.1, Water Quantity. These negative effects may be offset to some extent by habitat restoration and potential decreases in hatchery production; however, these actions may not fully, or even partially, mitigate for the greater impacts of climate change and development on water quality and quantity, although this is the goal of many of the restoration programs.

In summary, cumulative effects from climate change, development, habitat restoration, and hatchery production would likely impact water quality (particularly water temperature changes) and water quantity (increased demand on limited water supplies) in the analysis area more than that described in Subsection 4.1, Water Quantity, and as described in Subsection 4.6.3, Water Quality, in the PS Hatcheries DEIS (NMFS 2014a) under all alternatives. None of the alternatives would affect the overall trend in cumulative effects on water quantity and quality.

5.5.2 Salmon and Steelhead

Subsection 3.2, Salmon and Steelhead, describes baseline conditions for salmon and steelhead. These conditions are the result of many years of climate change, development, habitat restoration, hatchery production, and fisheries. The expected direct and indirect effects of the alternatives on salmon and steelhead are described in Subsection 4.2, Salmon and Steelhead. Future actions are described in Subsection 5.4, Future Actions and Conditions. This subsection describes cumulative effects on salmon and steelhead that may occur as a result of implementing any of the alternatives at the same time as other future actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on salmon and steelhead.

Salmon and steelhead abundance naturally alternates between high and low levels on large temporal and spatial patterns that may last centuries and on more complex ecological scales than can be easily observed (Rogers et al. 2013). Current run sizes of salmon and steelhead in the cumulative effects analysis area are about 36 percent of historical run sizes in British Columbia, and are about 8 percent of historical run sizes in Puget Sound (Lackey et al. 2006). Thus, cumulative effects on salmon and steelhead may be greater than the direct and indirect effects of each alternative as analyzed in Subsection 4.2, Salmon and Steelhead, under all alternatives. This subsection provides brief overviews of the effects of climate changes, development, habitat restoration, hatchery production, and fisheries on salmon and steelhead.

The effects of climate change on salmon and steelhead are described in general in ISAB (2007), and would vary among species and among species' life history stages. Effects of climate change may affect virtually every species and life history type of salmon and steelhead in the cumulative effects analysis area (Glick et al. 2007; Mantua et al. 2009). Cumulative effects from climate change, particularly changes in streamflow and water temperatures, would likely impact hatchery-origin and natural-origin salmon and steelhead life stages in various ways as described below and shown in Table 18. Under all alternatives, impacts to salmon and steelhead from climate change are expected to be similar, because climate change would impact fish habitat under each alternative in the same manner.

Previous and new developments (such as residential, commercial, transportation, and energy development); accidental discharges of oil, gas, and other hazardous materials; and the potential for landowner and developer noncompliance with regulations continue to affect aquatic habitat used by salmon and steelhead (Puget Sound Action Team 2007). Although regulatory changes for increased environmental protection (such as local critical areas ordinances), 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 quality, and contribute to salmon and steelhead mortality. These developments result in environmental effects such as land conversion, sedimentation, impervious surface water runoff to streams, changes in stream flow because of increased consumptive uses, shoreline armoring effects, channelization in lower river areas, barriers to fish passage, and other types of environmental changes that would continue to affect hatchery-origin and natural-origin salmon and steelhead (Quinn 2010).

Table 18. 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 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: ISAB (2007), Glick et al. (2007), Beamish et al. (2009), and Beechie et al. (2013).

The primary cause of these continuing development changes is the continued increase in human population in the cumulative effects analysis area (Subsection 5.4.2, Development), which also leads to fisheries management challenges associated with overfishing (Puget Sound Action Team 2007). Development would more likely affect species that reside in lower river areas (such as floodplains and estuaries) most directly because that is where development tends to be concentrated. Effects from development are expected to affect salmon and steelhead similarly under all alternatives because preferred development sites would not change by alternative scenario.

Restoration of habitat in the cumulative effects analysis area will improve salmon and steelhead habitat in general under all alternatives, with particular benefits to freshwater and estuarine environments considered to be important for the survival and reproduction of fish. As a result, habitat restoration would be expected to improve fish survival in local areas (Puget Sound Action Team 2007). However, habitat restoration alone will not substantially increase survival and abundance of salmon and steelhead. In addition, habitat restoration is dependent on continued funding, which is difficult to predict when economic recessions occur or governments experience deficits. Benefits from habitat restoration are expected to affect salmon and steelhead survival similarly under all alternatives.

The potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify, but are expected to occur in localized areas where the activities occur. These actions may not fully mitigate for the impacts of climate change and development on fish and wildlife and their associated habitats. However, climate change and development will continue to occur over time and affect aquatic habitat, while habitat restoration (which is dependent on funding and is localized in areas where agencies and stakeholders' habitat restoration actions occur) is less certain under all alternatives.

In addition to hatchery production of salmon and steelhead in Puget Sound (described in Subsection 3.2, Salmon and Steelhead), hatchery production and salmon aquaculture also occur in the Canadian portion of the cumulative effects analysis area. The Canadian Salmonid Enhancement Program uses hatcheries, along with other strategies, to conserve and rebuild populations of natural-origin salmon and to provide fishing opportunities for Canadians (MacKinlay et al. 2004). In 2002, these hatcheries raised 173 million salmon, steelhead, and trout (Chinook salmon, 30 percent; chum salmon, 42 percent; coho salmon, 11 percent; pink salmon, 10 percent; sockeye salmon, 7 percent; steelhead, less than 1 percent; and cutthroat trout, less than 1 percent). Total time in hatcheries for these fish is 10 months or less with subsequent release into freshwater or marine environments. Releases are from 18 major hatcheries, 21 community hatcheries, and 16 public involvement or educational hatcheries. Releases in 2009 were 300 million fish. The majority of the 2009 fish released were sockeye salmon (about half the fish released) followed by chum salmon, Chinook salmon, pink salmon, coho salmon, steelhead, and cutthroat trout (Sandher et al. 2010). Aquaculture operations also occur in British Columbia where salmon are raised in marine pens to adulthood with subsequent seafood processing and no fish releases into the freshwater or marine environment. These aquaculture operations raise almost exclusively Atlantic salmon.

The effects to natural-origin salmon and steelhead from future releases from salmon and steelhead hatcheries are expected to decrease over time, especially for listed species as hatchery programs are reviewed and approved under the ESA (Subsection 5.4.4, Hatchery Production). For example, reduction of genetic risks (Subsection 3.2.3.1, Genetic Risks; Appendix B, Genetic effects analysis of early winter steelhead programs proposed for the Nooksack, Stillaguamish, Dungeness, Skykomish, and Snoqualmie River basins of Washington; Subsection 2.1.3, Genetics, in Appendix B of the PS Hatcheries DEIS [NMFS 2014a]) may occur through changes such as increased use of integrated hatchery programs, application of new research results that lead to improved best management practices, and reductions in production levels. Over time, these changes would also be expected to reduce the ecological risks of competition and predation. In general, continued hatchery releases within the Salish Sea, along with other observed environmental trends as described in the following subsections, would affect continued long-term viability of natural-origin salmon and steelhead.

In summary, to the extent aquatic habitat will continue to degrade over time under all alternatives, the abundance and productivity of natural-origin salmon and steelhead populations may be reduced. Hatchery-origin salmon and steelhead may be similarly affected. In addition, effects to abundance and productivity of natural-origin salmon and steelhead from changes in hatchery production and fisheries would be expected to continue but may decrease over time. Although none of the alternatives would affect the overall trend in cumulative effects on salmon and steelhead, Alternative 1 and Alternative 4 could help mitigate negative effects on steelhead. That is, because under Alternative 1 hatchery programs would be terminated, and under Alternative 4 the type of program would change to use of a local, native broodstock (unlike under Alternative 2 and Alternative 3). These hatchery programs could be used to reduce the extinction risk of natural-origin populations resulting from cumulative effects such as habitat degradation in the Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins.

5.5.3 Other Fish Species

Subsection 3.3, Other Fish Species, describes the baseline conditions of fish species other than salmon and steelhead. These conditions are the result of many years of climate change, development, habitat restoration, hatchery production, and fisheries. The effects of the alternatives on other fish species are described in Subsection 4.3, Other Fish Species. Future actions in the overall cumulative effects analysis area are described in Subsection 5.4, Future Actions and Conditions. This subsection considers effects that may occur as a result of the alternatives being implemented at the same time as other anticipated future actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on fish species other than salmon and steelhead.

Other fish species that have a relationship to salmon and steelhead include bull trout, rainbow trout, coastal cutthroat trout, sturgeon and lamprey, forage fish, groundfish, and resident freshwater fish (Subsection 3.3, Other Fish Species). Similar to salmon and steelhead species, these fish species require and use a diversity of habitats. However, similar to effects described above for salmon and steelhead, these other fish species, including bull trout may also be affected by climate change and development because of the overall potential for loss or degradation of aquatic habitat or the inability to adapt to warmer water temperatures. In addition, climate change and development may attract non-native aquatic plants that may, over time, out-compete native aquatic plants that provide important habitat to native fish (Patrick et al. 2012).

As discussed in Subsection 5.4.3, 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.

As discussed in Subsection 5.4.4, Hatchery Production, changes in hatchery programs over time may affect other fish species that have a relationship to salmon and steelhead, including bull trout. For example, reductions in hatchery production or terminations of hatchery programs may decrease the prey base available for other fish species (like bull trout) that use salmon and steelhead as a food source.

In summary, cumulative effects from climate change, development, habitat restoration, and hatchery production on other fish species, including bull trout, would likely result in a decrease in the abundance of those fish species in the analysis area. Cumulative effects on fish species that compete, prey on, or are prey items for salmon and steelhead may be greater than described under Subsection 4.3, Other Fish Species. None of the alternatives would affect the overall trend in cumulative effects on other fish species, including bull trout, because the range of production levels under the alternatives (e.g., from 0 to 620,000 early winter steelhead hatchery-origin smolts) would be a small fraction of the total salmon and steelhead in the analysis area that these other fish species could compete with, prey on, or be prey items for.

5.5.4 Wildlife – Southern Resident Killer Whale

Subsection 3.4, Wildlife – Southern Resident Killer Whale, describes the baseline conditions of wildlife (Southern Resident killer whale). These conditions represent the effects of many years of climate change, development, habitat restoration, and hatchery production. The effects of the alternatives on wildlife in Puget Sound are described in Subsection 4.4, Wildlife – Southern Resident Killer Whale. Future actions for the overall cumulative effects analysis area are described in Subsection 5.4, Future Actions and Conditions. This subsection considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on wildlife.

As described in Subsection 5.5.2, Salmon and Steelhead, climate change and development in the cumulative effects analysis area may reduce the abundance and productivity of natural-origin salmon and steelhead populations. Hatchery-origin salmon and steelhead may be similarly affected. Consequently, the total number of salmon and steelhead available as prey to wildlife may be lower than that considered in Subsection 4.4, Wildlife – Southern Resident Killer Whale. As described in Subsection 3.4, Wildlife – Southern Resident Killer Whale, effects would be greatest on wildlife species that have a relationship with salmon and steelhead, including Southern Resident killer whales. Other species with a relationship to salmon and steelhead include common merganser, bald eagle, and Caspian terns (PS Hatcheries DEIS [NMFS 2014a]). Cumulative effects to Southern Resident killer whales may include changes in distribution in response to changes in the abundance and distribution of their food supply, decreases in abundance, and decreases in reproductive success compared to that described in Subsection 4.4, Wildlife – Southern Resident Killer Whale. Effects to other wildlife species that have a relationship with salmon and steelhead may also occur depending on how their overall aquatic prey base (which includes salmon and steelhead) would also be affected by climate change, development, habitat restoration, and fisheries.

The potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify. These actions may not fully, or even partially, mitigate for the effects of climate change and development on salmon and steelhead abundances.

As discussed in Subsection 5.4.4, Hatchery Production, and Subsection 5.4.5, Fisheries, changes in hatchery programs and fisheries, respectively, may occur over time. These changes may affect wildlife species that have a relationship to salmon and steelhead. For example, reductions in hatchery production or terminations of hatchery programs may decrease the prey base available for wildlife species (Southern Resident killer whales) that use salmon and steelhead as a food source.

In summary, it is likely that cumulative effects from climate change, development, habitat restoration, hatchery production, and fisheries, would affect those wildlife species that have a relationship with salmon and steelhead (including Southern Resident killer whales), and may impact other wildlife based on whether their overall food supply would decrease or otherwise change in some way (e.g., distribution, composition) as a result of climate change, development, habitat restoration, hatchery production, and fisheries. However, none of the alternatives would affect the overall trend in cumulative effects on wildlife because the range of production levels under the alternatives (e.g., from 0 to 620,000 early winter hatchery-origin steelhead smolts) would be a small fraction of the total number of prey items for wildlife in the analysis area.

5.5.5 Socioeconomics

Subsection 3.5, Socioeconomics, describes the baseline conditions for socioeconomics. These conditions represent the effects of many years of climate change, development, habitat restoration, and hatchery production. The expected effects of the alternatives on socioeconomics are described in Subsection 4.5, Socioeconomics. Future actions are described in Subsection 5.4, Future Actions and Conditions. This subsection considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on socioeconomic resources.

Although unquantifiable, climate change and development actions, changes in hatchery production and fisheries may reduce the number of salmon and steelhead available for harvest over time as described in Subsection 5.5.2, Salmon and Steelhead. This, in turn, may reduce angler expenditure and economic revenue relative to conditions considered in Subsection 4.5, Socioeconomics. Likewise, it may reduce the number of steelhead available to tribal members as a food source and may increase tribal reliance on other consumer goods or increase travel costs to participate in other fisheries.

The potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify. These actions may not fully mitigate for the impacts of climate change and development.

As discussed in Subsection 5.4.4, Hatchery Production, and Subsection 5.4.5, Fisheries, changes in hatchery programs and fisheries may occur over time. Changes in hatchery programs may affect the socioeconomic effects from hatchery production of salmon and steelhead. For example, reductions in hatchery production or terminations of hatchery programs may decrease the number of fish available for harvest, decrease associated angler expenditures and revenues generated from fishing, and reduce the number of steelhead available to tribal members.

In summary, it is likely that cumulative effects from climate change, development, and hatchery production would decrease the number of fish available for harvest and reduce angler expenditure and economic revenue relative to conditions considered in Subsection 4.5, Socioeconomics. However, none of the alternatives would affect the overall trend in cumulative effects on socioeconomics because the range of production levels under the alternatives (e.g., from 0 to 620,000 early winter hatchery-origin steelhead smolts) would result in a small fraction of the total harvestable salmon and steelhead in the analysis area, and, therefore, comprise a small fraction of the overall economic benefits derived from salmon and steelhead harvest in the analysis area

5.5.6 Environmental Justice

Subsection 3.6, Environmental Justice, describes environmental justice communities in the analysis area. Subsection 3.6, Environmental Justice, also describes methods for identifying environmental justice user groups and communities of concern. Environmental justice user groups and communities of concern within the cumulative effects analysis area include Indian tribes that fish for salmon and steelhead and low income or minority communities. The expected effects of the alternatives on environmental justice are described in Subsection 4.6, Environmental Justice. Future actions are described in Subsection 5.4, Future Actions and Conditions. This subsection considers potential effects that may occur as a result of implementing any one of the alternatives at the same time as other anticipated actions. This subsection discusses the incremental impacts of the alternatives in addition to past, present, and reasonably foreseeable future actions (i.e., cumulative effects) on environmental justice user groups and communities of concern.

Climate change and development actions, and changes in hatchery production and fisheries, may reduce the number of salmon and steelhead available for harvest over time as described in Subsection 5.5.2, Salmon and Steelhead. This, in turn, may reduce fishing opportunity in the analysis area relative to conditions considered in Subsection 4.6, Environmental Justice.

The potential benefits of habitat restoration actions within the cumulative effects analysis area are difficult to quantify. These actions may not fully mitigate for the impacts of climate change and development on the abundance of fish that would be available for commercial or recreational harvest.

As discussed in Subsection 5.4.4, Hatchery Production, and Subsection 5.4.5, Fisheries, changes in hatchery programs and fisheries may occur over time. Changes in hatchery programs may affect the number of salmon and steelhead available for harvest by environmental justice communities.

In summary, it is likely that cumulative effects from climate change, development, and hatchery production would decrease the number of fish available for harvest relative to conditions considered in Subsection 4.6, Environmental Justice. However, none of the alternatives would affect the overall trend in cumulative effects on environmental justice because the range of production levels under the alternatives (e.g., from 0 to 620,000 steelhead smolts) would result in a small fraction of the total harvestable salmon and steelhead in the analysis area available to environmental justice communities.

5.6 Summary of Effects

Table 19 summarizes the combined effects of past, present, and reasonably foreseeable actions, other than the Proposed Action and alternatives (summarized above), affecting the environmental resources reviewed in this EIS, affected by climate change, human development, habitat restoration, and hatchery production.

Table 20 summarizes the conclusions made above on the impacts of past, present, and reasonably foreseeable actions when combined with the impacts of the Proposed Action. Definitions for effects terms are the same as described in Subsection 3, Affected Environment, and Subsection 4, Environmental Consequences. The relative magnitude and direction of impacts is described using the following terms:

Undetectable: The impact would not be detectable.

Negligible: The impact would be at the lower levels of detection, and could be either positive or negative.

Low: The impact would be slight, but detectable, and could be either positive or negative.

Moderate: The impact would be readily apparent, and could be either positive or negative.

High: The impact would be greatly positive or severely negative.

Table 19. Summary of effects of past, present, and reasonably foreseeable future actions on the affected resources evaluated in this EIS.

Affected Resource	Past Actions	Present Actions	Reasonable Foreseeable Future Actions	Past, Present, and Reasonably Foreseeable Future Actions
Water Quantity	Negligible to low negative due to water withdrawals from human development	Negligible to low negative	Low negative	Low negative
Salmon and Steelhead	Moderate to high negative due to human development, past fishery, hatcheries, and habitat management practices	Mixed (negligible to moderate negative, to low positive) due to ESA compliance and improved fishery, hatcheries, habitat management practices, and habitat restoration, depending on population	Mixed (moderate negative to low positive), depending on population	Mixed (moderate negative to low positive), depending on population
Other Fish Species	Mixed (negligible to low negative, to negligible positive) depending on species, due to human development, past fishery, hatcheries, and habitat management practices	Mixed (negligible negative to negligible positive) depending on species	Negligible to low negative depending on species	Negligible to low negative depending on species
Wildlife – Southern Resident Killer Whale	Mixed (negligible to low negative, to low positive) due to habitat degradation and hatchery-origin salmon and steelhead as a food source	Low positive due to ESA compliance	Negligible to low positive	Low positive
Socioeconomics	Moderate positive from benefits to recreational fisheries and tribal fisheries, although some have been reduced in recent years as numbers of fish available to harvest have declined	Low positive due to declines in harvest opportunities	Low positive	Low positive
Environmental Justice	Low to moderate negative due to reductions in fish available for use by communities of concern and populations of concern such as treaty Indian tribes	Low negative to low positive	Negligible negative	Low negative

Table 20. Summary of the cumulative effects of the Proposed Action.

Affected Resource	Baseline	Past, Present, and Reasonably Foreseeable Future Actions	Proposed Action	Cumulative Effects of the Proposed Action
Water Quantity	Mixed (negligible negative to negligible positive)	Low negative	Negligible negative	None
Salmon and Steelhead	Mixed (negligible to moderate negative, to low positive) due to ESA compliance and improved fishery, hatchery, habitat management practices, and habitat restoration, depending on population	Mixed (moderate negative to low positive), depending on population	Negligible negative	None
Other Fish Species	Mixed (negligible negative to negligible positive) depending on species	Negligible to low negative depending on species	Mixed (negligible negative to negligible positive) depending on species	None
Wildlife – Southern Resident Killer Whale	Low positive due to ESA compliance	Low positive	Negligible positive	None
Socioeconomics	Moderate positive	Low positive	Moderate positive	None
Environmental Justice	Low negative to low positive	Low negative	Negligible positive	None

Chapter 6

6 REFERENCES

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Chapter 7

7 DISTRIBUTION LIST

Federal and State Agencies

Council of Environmental Quality
Department of Fisheries and Oceans, Government of Canada
NMFS Northwest Fisheries Science Center
U.S. Army Corps of Engineers, (Seattle District)
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U.S. Environmental Protection Agency, Region 10
U.S. Fish and Wildlife Service, Portland Oregon Office
U.S. Fish and Wildlife Service, Western Washington Office
Washington Governor's Salmon Recovery Office
Washington Department of Fish and Wildlife, Olympia Office
Puget Sound Partnership

Elected Officials

Washington Governor's Office
U.S. Representatives, Washington State
U.S. Senators, Washington State

Utilities

Puget Sound Energy
Seattle City Light
Tacoma Public Utilities

Puget Sound and Olympic Peninsula Native American Tribes

Jamestown S'Klallam Tribe
Lower Elwha Klallam Tribe
Lummi Indian Nation
Makah Indian Tribe
Muckleshoot Indian Tribe
Nisqually Indian Tribe

Nooksack Indian Tribe
Port Gamble S'Klallam Tribe
Puyallup Tribe
Sauk-Suiattle Indian Tribe
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Skagit System Cooperative
Snoqualmie Tribe
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Swinomish Indian Tribal Community
Tulalip Tribes
Upper Skagit Tribe

Councils and Commissions

Columbia River Inter-tribal Fish Commission
Hood Canal Coordinating Council
Northwest Indian Fisheries Commission
Northwest Power and Conservation Council
Pacific Fishery Management Council
Pacific Salmon Commission
Pacific States Marine Fisheries Commission
Point No Point Treaty Council

Organizations and Associations

American Rivers
Building Industry Association of Washington
Center for Biological Diversity
Coastal Conservation Association, Washington
Earth Justice
Fishing Vessel Owner's Association
Long Live the Kings
Marine Conservation Biology Institute
Native Fish Society
Northwest Sportfishing Industry Association
NW Energy Coalition
Ocean Conservancy
Pacific Biodiversity Institute
Pacific Coast Federation of Fishermen's Associations
Pacific Rivers Council
People for Puget Sound

Puget Sound Anglers
Seattle Audubon Society
Sierra Club
Steelhead Trout Club of Washington
The Conservation Angler
The Mountaineers
Trout Unlimited
Washington Association of Realtors
Washington Environmental Council
Washington State Council of the Federation of Fly Fishers
Washington State Farm Bureau
Wild Fish Conservancy
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Wild Steelhead Coalition

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Olympia Timberland Library
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Washington State Library
Whatcom County Library

Individuals

(An extensive distribution list of individuals were notified by email that contained an electronic link to the EIS.)

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Chapter 8

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Agencies and Individuals Consulted for Development of the EIS

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- NMFS Sustainable Fisheries Division (Rob Jones on hatchery production and salmon and steelhead, Craig Busack on genetics, James Dixon on socioeconomics)

- NMFS Protected Resources Division (Lynne Barre and Teresa Mongillo on Southern Resident killer whales)
- NWIFC (Chris James on hatchery plans)
- WDFW (Jim Scott, Kelly Cunningham, and Brian Missildine on hatchery production; Teresa Scott and Beata Dymowska on water quantity; Robert Leland and Eric Kraig on steelhead harvest)

During development of the EIS, NMFS also consulted with the following tribes, organizations, and individuals:

- Jamestown S'Klallam Tribe (Scott Chitwood on tribal resources)
- Lummi Nation (Alan Chapman, Randy Kinley, and Merle Jefferson on tribal resources)
- Muckleshoot Indian Tribe (Isabel Tinoco on tribal resources)
- Nooksack Indian Tribe (Ned Currance on tribal resources)
- Sauk-Suiattle Indian Tribe (Janice Mabee on tribal resources)
- Skagit System Cooperative (Lorraine Loomis on tribal resources)
- Stillaguamish Tribe (Jason Griffith and Kate Konoski on tribal resources)
- Tulalip Tribes (Terry Williams and Mike Crewson on tribal resources)
- Upper Skagit Tribe (Jennifer Washington on tribal resources)

Chapter 9

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Appendix A

Puget Sound Salmon and Steelhead Hatchery Programs and Facilities

1 # Table A-1. Chinook 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]	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	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** (September 2014)	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/ May	2,000,000	Lummi Bay Hatchery	Lummi Bay (1.0 million) and Bertrand Creek, tributary to the Nooksack River at RM 1.5 (1.0 million)
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	4,000,000	Samish Hatchery	Samish River RM 10.5
Chinook	Georgia Strait	San Juan Islands (Orcas)	Glenwood Springs Hatchery (January 2013)	Green R. lineage (out-of-ESU)	Summer/ Fall	Isolated harvest	Harvest augmentation	Long Live The Kings	Subyearling/ July	550,000	Glenwood Springs Hatchery	Eastsound, Orcas Island (One HGMP)

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	Skagit	**Marblemount spring Chinook** (2015-pending)	Cascade	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** (2015-pending)	Upper Skagit	Summer	Integrated research	Indicactor 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** (draft September 2015)	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** (draft September 2015)	SF Stillaguamish	Fall	Integrated recovery	Conservation	Stillaguamish Tribe	Subyearling/ May	200,000	Harvey Creek Hatchery	Brenner Hatchery, SF Stillaguamish River RM 31.0
Chinook	Whidbey Basin	Snohomish	Bernie Kai-Kai Gobin Salmon Hatchery, Tulalip spring Chinook (March 2004)	Cascade	Spring	Isolated harvest	Harvest augmentation	Tulalip Tribes	Yearling/ March	40,000	Bernie Kai-Kai Gobin Salmon Hatchery	Tulalip Bay, Port Susan
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

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	**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	Websters Rearing Ponds
									Subyearling/ May	1,600,000	Grovers Creek Hatchery/Gorst Creek Rearing Ponds	Gorst Creek Rearing Pond

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	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 ~~fingerling~~ 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

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

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)
												Twenty-eight Mile Creek.
Chinook	Central/ South Sound	Carr Inlet/South Sound	**Minter Creek/ Hupp Springs Hatchery White River spring Chinook** (2015-pending)	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 (May 2013)	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
									Yearlings/ March-April	120,000	Hupp Springs Hatchery	Hupp Springs Hatchery on Minter Creek RM 3.0, tributary to Carr Inlet, South Puget Sound
Chinook	Central/ South Sound	Chambers Creek, South Puget Sound	Chambers Creek fall Chinook (May 2015)	Green R. lineage (out-of-ESU)	Fall	Isolated harvest	Harvest augmentation	WDFW	Subyearling/ ~~April~~ May	450,000	Garrison Springs Hatchery	Chambers Creek Fishway Trap RM 0.5
									Subyearling/ May	400,000	Chambers Creek Hatchery	Chambers Creek Fishway Trap RM 0.5
Chinook	Central/ South Sound	Nisqually	**Nisqually Fish Hatchery at Clear Creek/Kalama Creek Salmon Hatchery (**September 2014**)**	Nisqually	Fall	Isolated harvest	Harvest augmentation	Nisqually Tribe	Subyearling/ May-June	3,500,000	Clear Creek Hatchery	Clear Creek, tributary to Nisqually River at RM 6.3

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)
										600,000	Kalama Creek Hatchery	Kalama Creek, tributary to Nisqually River at RM 9.2
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

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)
												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

Table A-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	Skagit	**Baker River: Steelhead Reservoir Passage Research (**August 2015**)**	Skagit River	Winter	Integrated research	Research	Upper Skagit Indian Tribe	Yearling/ May	11,000	Marblemount Hatchery	Baker Lake
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 (July 2014)	Chambers Ck lineage (out-of-DPS)	Winter	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April-May	185,000	Reiter Ponds	Reiter Pond at Skykomish River RM 46
									Yearling/ April-May	71,000	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 (draft June 2015)	Skamania Hatchery-lineage (out-of-DPS)	Summer	Isolated harvest	Harvest augmentation	WDFW	Yearling/ April	30,000	Soos Creek Hatchery	Soos Creek RM 0.8, tributary to the Green River at RM 33.5
									Yearling/ April	20,000	Icy Creek Pond	Icy Creek, tributary to the Green River at RM 48.3
Steelhead	Northern Cascades	Green	**Green River Native Winter (late) Steelhead** (July 2014)	Green River	Winter	Integrated recovery	Conservation	WDFW	Yearling/ May	18,000	Icy Creek Pond	Icy Creek, tributary to the Green River RM 48.3

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/ May	15,000	Flaming Geyser (Pond)	Flaming Geyser Park, Crystal Creek, tributary to the Green River at RM 44.3
									Yearling/ May	17,000	Palmer Ponds	Palmer Ponds, Green River RM 56.1
									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 (**September 2006**)**	White River	Winter	Integrated recovery	Conservation	Puyallup Indian Tribe and Muckleshoot Indian Tribe w/ WDFW	Yearling/ May	35,000	Diru Creek Hatchery and White River Hatchery	White River RM 24.3, which is tributary to the Puyallup River at RM 10.1

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	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	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 A-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 (August 2015)	Nooksack	Normal-timed	Isolated harvest	Harvest augmentation	Lummi Indian Nation	Yearling/ May-June	2,000,000	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 (August 2015)	Nooksack	Normal-timed	Isolated harvest	Harvest augmentation	Lummi Indian Nation	Yearling/ April-May	2,000,000	Lummi Bay Hatchery	Lummi Bay, north Puget Sound
Coho	Whidbey Basin	Skagit	Skagit Coho Program (Draft August 2015)	Skagit (Cascade) River	Normal-timed	Isolated harvest	Harvest augmentation	WDFW	Yearling/ June	250,000	Marblemount Hatchery	Cascade River Rm 1.0, tributary to the Skagit River at RM 78.5
Coho	Whidbey Basin	Skagit	Baker River Coho (Draft August 2015)	Skagit (Baker)	Normal-timed	Integrated Harvest	Harvest augmentation	WDFW	Fry/ May-June	160,000	Baker Lake Sulphur Cr Facility	Baker Lake, behind Upper Baker Dam, Baker River RM 9.1
									Yearling/ May-June	5,000	Baker Lake Sulphur Cr Facility	Baker Lake, behind Upper Baker Dam, Baker River RM 9.1
									Yearling/ May-June	55,000	Baker Lake Sulphur Cr Facility	Stress Relief Ponds on Baker River RM 0.7 (Baker River Fish Trap), tributary to Skagit River at RM 56.5
									Yearling/ May-June	5,000	Baker Lake Sulphur Cr Facility	Lake Shannon, behind Lower Baker Dam, Baker River RM 8.9
Coho	Whidbey Basin	Stillaguamish	Stillaguamish Coho Program (March 2004)	Stillaguamish	Normal-timed	Integrated harvest/recovery	Harvest augmentation/conservation	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

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	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.
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
						Integrated Harvest		WDFW	Yearling/ May	600,000	Soos Creek Hatchery	Soos Creek RM 0.8, tributary to the Green River at RM 33.5
Coho	Central/South Sound	Green	Soos Creek Coho Program (July 2014)	Green	Normal-timed	Isolated harvest	Harvest augmentation	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

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	Green	Keta Creek Complex (December 2014)	Green	Normal-timed	Integrated Harvest	Harvest augmentation	Muckleshoot Indian Tribe	Yearling/ May	500,000	Crisp Creek Ponds	Crisp Creek RM 1.1 Green R. tributary at RM 40.1
										500,000	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 (June 2013)	Puyallup (Voights Creek Hatchery)	Normal-timed	Integrated harvest	Harvest augmentation	WDFW	Yearling/ April,May	780,000	Voights Creek Hatchery	Voights Creek RM 0.5, tributary to Carbon River at RM 4.0, trib to Puyallup River at RM 17.8
Coho	Central/South Sound	Puyallup	Puyallup Acclimation Sites (March 2003)	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

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)
									Yearling/ May	100,000	Voights Creek Hatchery/ Puyallup Tribal Hatchery	Rushingwater Acclimation Pond, RM 0.5 on Rushingwater Creek, trib to Mowich River at RM 1.1
Coho	Central/South Sound	Carr Inlet	Minter Creek Coho (January 2013)	Minter Creek	Normal-timed	Isolated 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
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	Nisqually	Clear Creek Hatchery Fall Coho (April 2003)	Central/South Sound mix	Normal-timed	Isolated harvest	Harvest augmentation	Nisqually Tribe	Yearling/ April	?	Clear Creek Hatchery	Clear Creek, tributary to Nisqually River at RM 6.3
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 Tribes and WDFW	Yearling/ May-June	1,800,000	South Sound net-pens,	Peale Passage, deep South Puget Sound
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, tribuary to Skokomish River at RM 4.1
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 AdamsHatchery, 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

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 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.

Table A-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 Strait of Georgia	Nooksack	Whatcom Creek Pink Program (January 2013)	Nooksack (localized to release site)	Normal	Isolated harvest	Education/ Harvest augmentation	Bellingham Technical College/ WDFW	Fed fry/ April	500,000	Whatcom Creek Hatchery	Whatcom Creek RM 0.5, tributary to Bellingham Bay
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/ Apirl	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 A-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 A-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 (May 2013)	Nooksack	Fall	Integrated harvest	Harvest augmentation	Lummi Indian Nation/ WDFW	Fed fry/ April-May	1,000,000	Lummi Bay Complex, 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 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
Chum	Fall-run chum salmon MPGs have not been designated. Chinook salmon MPG is Whidbey Basin	Stillaguamish	Stillaguamish (Harvey Creek) Chum Program (March 2003)	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

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	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	?	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	?	Cowling Creek Hatchery	Cowling Creek, tributary to Miller bay, East Kitsap
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

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. 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
									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
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.

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 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.

APPENDIX B

Genetic effects analysis of early winter steelhead programs proposed for the Nooksack, Stillaguamish, Dungeness, Skykomish, and Snoqualmie River Basins of Washington

Anadromous Production and Inland Fisheries Program
Sustainable Fisheries Division
NMFS West Coast Region
October 13, 2015

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The hatchery programs under consideration in the Nooksack, Stillaguamish, Dungeness, Skokomish, and Snoqualmie Basins are isolated harvest programs that release fish that are not included in the Puget Sound steelhead DPS. Operators will use only early winter steelhead (EWS) produced by the programs (identified by early return timing and presence of an adipose fin clip mark) as broodstock, and no natural-origin steelhead will be collected and spawned. The intent of management of these programs is to have few returning fish in excess of broodstock needs escape to spawn in the wild. Those that do spawn in the wild are expected to have low reproductive success relative to the natural-origin fish because they spawn earlier than natural-origin fish, and thus are presumed to spawn under non-optimal conditions. They may also be less successful than natural-origin fish due to other aspects of domestication. To the extent they do reproduce and contribute to the next generation of natural-origin fish, however, they pose genetic risks to the population. In this section, we analyze the risks posed by this gene flow. NMFS considers three areas of effects caused by gene flow from hatchery-origin fish: within-population diversity, outbreeding effects, and hatchery-influenced selection.

Within-Population Diversity Effects

Risk to within-population diversity is much less of a concern in isolated programs such as those in the Proposed Action than in integrated programs, so we will deal with this risk briefly. Within-population diversity is influenced strongly by the effective size of the population. Effective size depression is generally a concern only if the relative abundance of hatchery-origin fish on the spawning grounds far exceeds that of natural-origin fish, so that a disproportionate share of the progeny come from a small number of hatchery-origin parents (Ryman et al. 1995). We do not expect this to be the case with the five proposed programs. An additional potential concern is that diversity in the natural population could be lowered by gene flow from a hatchery population with a lower background level of diversity. This is not the case with these programs: the background levels of genetic diversity are essentially identical in the hatchery and natural steelhead populations (Warheit 2014a). In general, we expect the risk posed by the Proposed Action to within-population diversity to be negligible.

However, a concern that has been raised in connection with these isolated steelhead programs is that, due to the low expected reproductive success of early winter steelhead spawning in the wild, the reproductive potential of natural-origin fish that spawn with hatchery-origin fish would be reduced or wasted. Reductions in the reproductive output of these natural-origin fish thus reduces the size of the spawning population and therefore the genetically effective size of the population.

Figure B-1 is a generalized schematic of the expected distribution of hatchery-origin and natural-origin spawners over time. Although the difference varies from basin to basin, EWS have an earlier spawn timing than natural PS winter steelhead (Table 3 in Myers et al. 2015).This means there will be a time during the spawning season when hatchery-origin steelhead can only spawn with other hatchery-origin steelhead (Region A), an overlap period when hatchery-origin and natural-origin steelhead can spawn amongst themselves or with each other (Region B), and a period when natural-origin steelhead can spawn only with natural-origin steelhead (Region C). Assuming random mating[1], the expected proportion of different mating types can easily be determined. In this case, since the only matings that are of interest are those that occur in Region B, and of those, only the matings in which natural-origin fish mate with hatchery-origin fish are of interest.

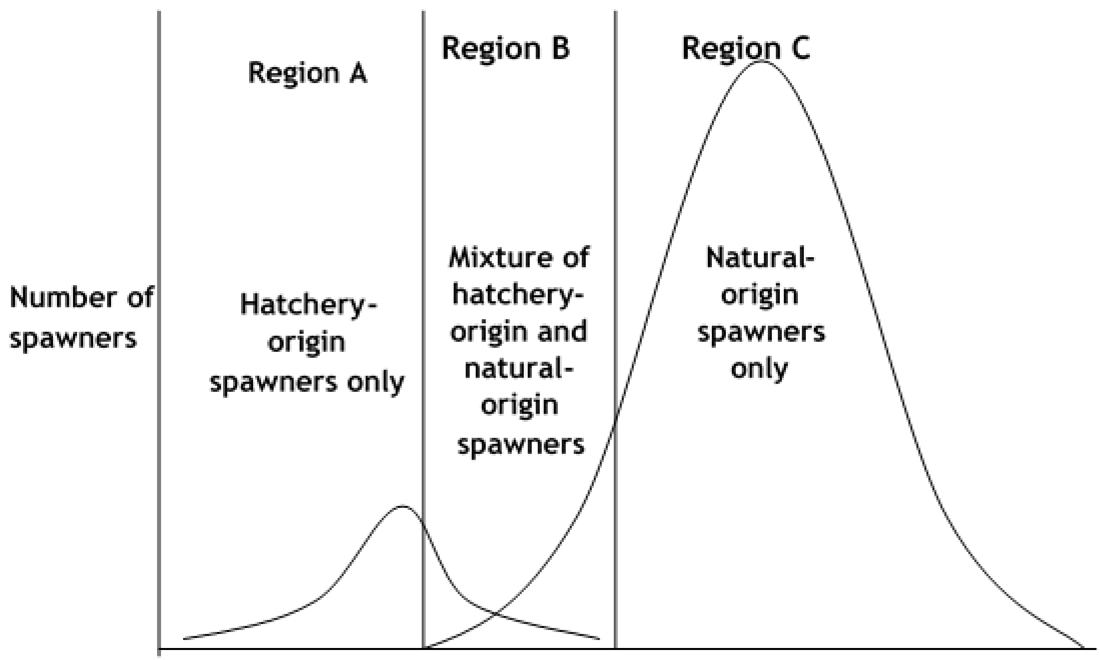

Figure B-1. Schematic of temporal spawning overlap between early winter hatchery steelhead and natural-origin winter steelhead. Shape, sizes and placement of curves is conceptual and is not meant to represent any specific situation (Scott and Gill 2008, Fig. 4-7).

[1] Random mating is assumed in a number of basic population genetic models for mathematical simplicity. The models in this section are based on simple population genetic models, and use the random mating assumption for the same reason. Mating dynamics of steelhead and salmon is in fact non-random. but attempting to include all the deviations from random mating would be a major modelling exercise in itself. We assume that the results of our modelling is robust to the typical deviations from random mating found in nature.

The expected proportion of the natural-origin escapement actually mating with hatchery-origin fish is given by:

$\frac{pHOS*O_N*O_H}{pHOS*O_H+(1-pHOS)*O_N}$ (1), where pHOS is the proportion of natural spawners that are of hatchery origin, and O_N and O_H are the proportions of the natural-origin spawners, and the hatchery-origin spawners, respectively that spawn in region B. Based on extrapolations from spawning ground observations and return times of hatchery fish to the hatcheries (Hoffmann 2014), the proportion of the natural-origin spawners involved in HxN[2] matings is expected to be very low under the Proposed Action, at most 1.4% in the Skykomish (Table B-1). Thus, under the assumption that the reproductive output of a natural-origin fish mating with a hatchery-origin fish is a complete loss, the impact to the population in terms of demographic and effective population size would be less than 2%.

Table B-1. Expected percentage of natural-origin escapement involved in HxN matings for winter steelhead populations affected by the Proposed Action. Table B-2 provides further details on metrics used in calculations. All values are expressed as percentages.

Metric/Data	**Population**				
	Nooksack	**Stillaguamish**	**Dungeness**	**Skykomish**	**Snoqualmie**
O_N	6.21	1.25	0.09	1.96	2.10
O_H	8.38	18.41	32.38	49.45	16.88
Proposed Action pHOS	3.4	5.9	3.4	8.2	16.0
Expected percentage of natural-origin fish mating with hatchery-origin fish	0.3	0.6	0.1	1.4	1.3

[2] The HxN notation is meant to include matings in which a hatchery-origin male mates with a natural-origin female, and vice versa.

All parameters of this model are subject to uncertainty, as will be discussed below. We present a simple evaluation of the effects of this uncertainty Figure B-2, which shows the proportion of natural-origin fish participating in HxN matings as a function of pHOS and overlap. For simplicity, in this analysis we assumed that O_N and O_H were equal, which is a much higher level of overlap than has been observed (Table B-1). Overlap and pHOS must be considerable before the proportion of natural-origin spawners in HxN matings reaches even 1%, and this proportion has a maximum value of pHOS if overlap is complete (equation 1).

A potential shortcoming of this "region" approach to analysis of spawning is that it assumes that all the spawners are returning adults. Resident *O. mykiss* (rainbow trout) and precocious residual hatchery juveniles may also be involved, both of which would not have been counted as part of the escapement. McMillan et al. (2007) noted both types of males participating in mating in the later part of the spawning season in an Olympic Peninsula stream. Residual males accounted for less than 1% of the observed mating attempts, and only late in the season. Measurable reproductive success of non-anadromous male *O. mykiss* was noted in another Olympic Peninsula stream that has no hatchery program (Seamons et al. 2004). The relative abundance of anadromous and non-anadromous O. *mykiss* is not well known in most Puget Sound streams (Myers et al. 2015). Residualism rates for the programs in the Proposed Action are not known. A recent meta-analysis of steelhead programs found an average residualism rate of 5.6%, ranging from 0 to 17% (Hausch and Melnychuk 2012). Genetically, residual males are of no concern unless they are sexually mature. Although historically high rates of precocious maturation have been reported (e.g., Schmidt and House 1979) and groups can be generated with rates as high as 100% (e.g., Sharpe et al. 2010), the rate in WDFW steelhead releases tends to vary from 1 to 5% (Tipping et al. 2003).

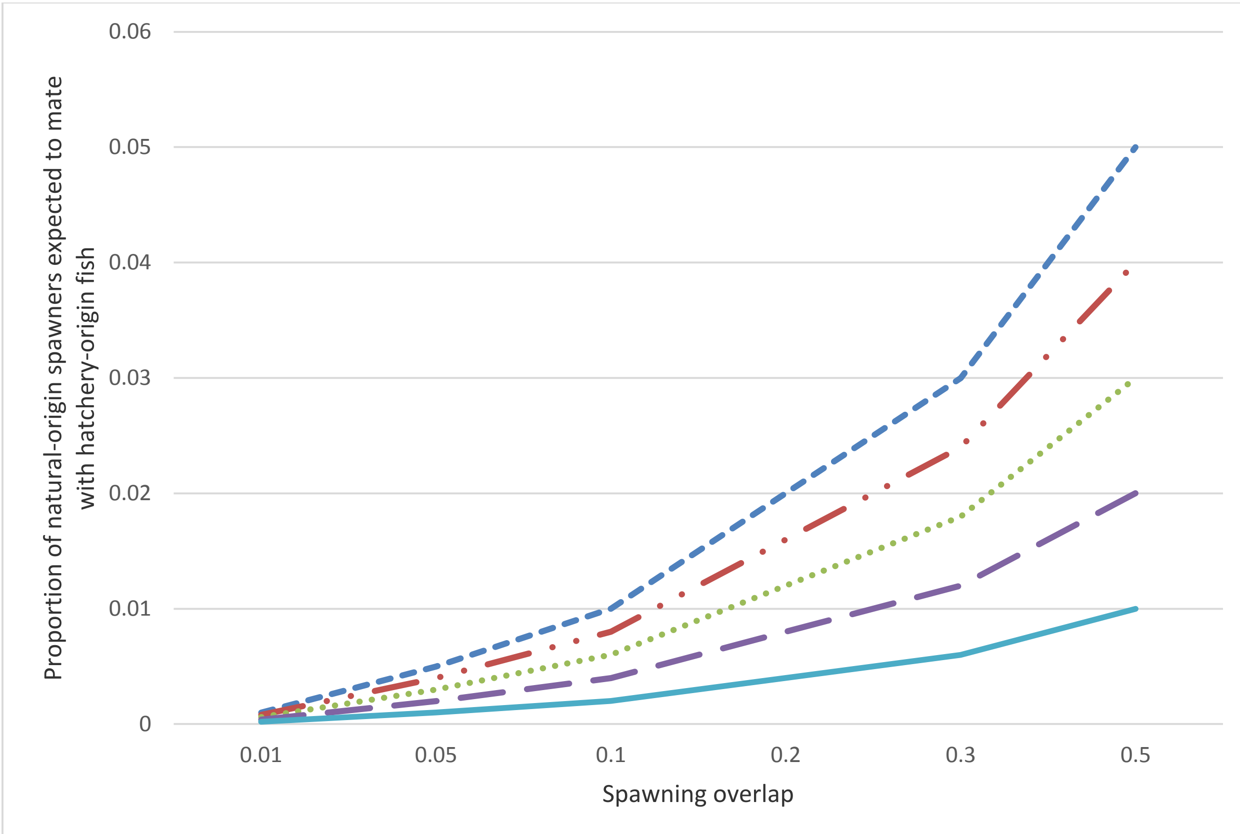

Figure B-2. Proportion of natural-origin fish expected to be involved in HxN matings as a function of pHOS, and proportion of spawners in overlap zone. For simplicity we have assumed that the overlap is the same for natural-origin and hatchery-origin fish; e.g., for the 0.05 level, $O_N = O_H = 0.05$. Isopleths represent pHOS=0.1 (small dashes), 0.08 (dots and dashes), 0.06 (dots), 0.04 (large dashes), and 0.02 (solid).

This additional analysis of possible effective size reduction reinforces our original conclusion, of the Proposed Action having a negligible effect to within-population diversity.

Outbreeding Effects and Hatchery-influenced Selection Effects

Although we conclude that the effects of the Proposed Action on within-population diversity will be negligible, the Proposed Action may pose non-negligible risks to natural steelhead populations through outbreeding effects and hatchery-influenced selection, however. Outbreeding effects are a concern whenever the hatchery-origin and natural-origin fish are from different populations, and this is certainly a case with the early winter hatchery steelhead and the natural populations considered in this Proposed Action. In fact, the early winter steelhead are considered so diverged genetically from natural steelhead that they are not considered part of any steelhead DPS (NMFS 2003). The basis of this is the fact that they have been subjected to so many years of intense artificial selection for early smolting, which has resulted not only in smolting predominantly at one year of age, but also earlier spawning time (Crawford 1979). Of all the salmon and steelhead hatchery populations used on the West Coast, NMFS considers the early winter steelhead population the most altered by artificial selection. NMFS has also voiced concerns about the potential genetic risks of EWS programs (Hard et al. 2007; McMillan et al. 2010).

Evaluation of outbreeding effects is very difficult. Under conditions of no selection and no genetic drift, and the best existing management guidance for avoiding out breeding effects remains the conclusion of the 1995 straying workshop (Grant 1997) that gene flow between populations (measured as immigration rates) should be under 5%. The HSRG (2009) generally recommended that for primary populations (those of high conservation concern) affected by isolated hatchery programs that the proportion of natural spawners consisting of hatchery-origin fish (pHOS) not exceed 5%, and more recently (HSRG 2014) have suggested that perhaps this level should be reduced. While not addressing them specifically in their guidelines, the HSRG earlier discussed risks posed by highly diverged hatchery populations such as the early winter steelhead, concluding that "…if non-harvested fish spawn naturally, then these isolated programs can impose significant genetic risks to naturally spawning populations. Indeed, any natural spawning by fish from these broodstocks may be considered unacceptable because of the potential genetic impacts on natural populations" (Appendix B in HSRG 2004). WDFW used the Ford (2002) model to evaluate the hatchery-influenced selection risk of early winter isolated steelhead programs, and concluded they posed less risk than integrated native-stock programs at pHOS levels below 2%, but greater risk at levels above that (Scott and Gill 2008). WDFW's statewide steelhead management plan states that isolated programs will result in average gene flow levels of less than 2% (WDFW 2008).

Some explanation is needed at this point of the relationship between pHOS and gene flow, because the two can easily be confused. Genetic impacts from hatchery programs are caused by gene flow from hatchery fish into the naturally spawning population. In the Ford (2002) model, the analytical and conceptual framework for the HSRG guidelines regarding acceptable pHOS levels assumes that hatchery fish contribute in proportion to their relative abundance on the spawning grounds. Thus, if hatchery-origin fish equal natural-origin fish in reproductive success, pHOS represents the maximum proportionate contribution of hatchery-origin parents to the next generation of natural-origin fish. In the absence of other information, pHOS is an estimate of maximum gene flow on the spawning grounds, and thus is a surrogate for gene flow. Although the EWS-specific modeling by Scott and Gill (2008) used the Ford model, NMFS feels the Ford model may not be a good fit to the situation of EWS spawning in the wild for two reasons. First, highly domesticated steelhead stocks are known to have low fitness in the wild (e.g., Chilcote et al. 1986; Araki et al. 2007), so gene flow is nearly certain to be lower than that predicted by the Ford model. This is the situation that inspired the HSRG (2014) to develop the “effective pHOS” concept. Second, even if it is assumed that the EWS are equal in fitness to the natural-origin fish, the Ford model does not consider the effects on gene flow of partially overlapping spawning distributions, which will decrease the proportion of HxN matings and increase the proportion of HxH matings relative to what it would be with total temporal overlap of hatchery-origin and natural-origin spawners. Focusing attention on gene flow rates rather than pHOS is thus always advisable if feasible, and especially in the case of EWS spawning in the wild, NMFS feels that pHOS levels considerably overestimate gene flow levels.

In discussing gene flow from hatchery programs, it is also important to distinguish the EWS from most other hatchery programs. Although some divergence from natural life history can be expected over time in hatchery programs, the EWS stock represents a situation in which the fish have been subjected to intensive artificial selection over many years for a divergent life history (Crawford 1979). The prospect of gene flow from such highly domesticated stocks seems intuitively risky, as is reflected in the cautionary statement of the HSRG that was cited above. However, studies have only recently begun to compare the relative impact of highly domesticated stocks, such as those considered in this review, and with those that are less domesticated. A modeling effort by Baskett and Waples (2013) demonstrated that the effects of programs using “different” broodstocks could be quite different than those from “similar” programs, and depending on the circumstances, could pose more or less risk. Considering all the guidance, and empirical and theoretical information currently available, NMFS concludes that gene flow from EWS into Puget Sound steelhead populations may not pose significant risk to the Puget Sound steelhead populations, provided the gene flow rate is low, that appropriate metrics are developed to estimate gene flow, that gene flow is estimated with a reasonably high level of certainty, and that adequate monitoring is in place to ensure that gene flow criteria are met.

NMFS considers, based on the present level of empirical and theoretical information currently available on the subject, that the proposed maximum gene flow levels of 2%, into natural Puget Sound steelhead populations of high conservation concern, poses low genetic risk, subject to two criteria. First, that an appropriate gene flow metric is used and second, that the gene flow level is known with a reasonably high level of certainty.

Gene flow from hatchery fish into natural populations is referred to in many NMFS documents and elsewhere as interbreeding or hybridization. This is an oversimplification. In reality, gene flow occurs by two processes: hatchery-origin fish spawning with natural-origin fish and hatchery-origin fish spawning with each other. How well the hatchery-origin fish spawn and how well their progeny survive, determines the rate at which genes from the hatchery population are incorporated into the natural population. The importance of including the progeny of HxH matings as a potential "vector" for gene flow is illustrated by the observation that these fish may have a considerably longer and later spawning season than hatchery-origin fish (Seamons et al. 2012). An appropriate metric for gene flow needs to measure the contributions of both types of matings to the natural population being analyzed. WDFW has developed such a metric based on genetic data, which is called proportionate effective hatchery contribution (*PEHC*) (Warheit 2014a). NMFS has accepted it as an appropriate measure of gene flow for evaluation of these proposed isolated hatchery programs (Jones Jr. 2014). WDFW also has developed an alternative demographic method, hereafter called the Scott-Gill method, for calculating the expected gene flow that is not based on genetic data (Scott and Gill 2008). NMFS also considers the metric generated by the Scott-Gill method, called gene flow by WDFW, an appropriate metric for estimating gene flow, subject to subsequent verification through genetic data.

Below we discuss in detail these two methods for estimating gene flow and results from applying them to data on Puget Sound steelhead. It is important to understand in reading this material that the Warheit and Scott-Gill methods estimate the current rate of gene flow and expected rate of gene flow, respectively, not cumulative gene flow. In other words, the effects analysis is aimed at how much gene flow is occurring or will occur, not how much may have occurred in the past, nor what the cumulative genetic contribution of EWS to the natural steelhead populations has been. Our analysis this assumes that natural-origin fish in either analysis may have some level of hatchery ancestry. In the case of the Scott-Gill method, the natural-origin fish considered in the equation may include the progeny of HxH or HxN matings.

Estimation of gene flow using genetic data

Warheit method

Estimation of PEHC in Puget Sound steelhead is difficult because, in terms of genetic markers that can currently be analyzed on a production scale, the differences between the hatchery-origin fish and natural-origin fish are slight, because of common ancestry and possibly gene flow in the past. WDFW has struggled with this problem for several years, and Dr. Ken Warheit, director of the Molecular Genetics Laboratory at WDFW, has developed a method for estimating PEHC in situations like this. The method is new, still undergoing refinement, and for that reason has received limited peer review[3]. Because of this, the method has been extensively reviewed by NMFS staff, and refined in response to that review.

The Warheit method involves, in part, comparing genotypes of natural-origin and hatchery-origin fish using the Structure program (Pritchard et al. 2000; Pritchard et al. 2010). Structure is one of the most widely used programs for inferring population structure, and has also been used for detecting hybrid individuals, frequently between wild and domestic populations. The WDFW Molecular Genetics Laboratory has many years' experience using the program. Structure makes use of each individual's multilocus genotype to infer population structure (e.g., hatchery versus wild), given an a priori assumed number of groups or populations. The program will probabilistically assign individuals to populations, or if the admixture option is used, will assign a portion of an individual's genome to populations.

Although *Structure* is the basic analytical engine of the Warheit method, the full method is far more complex than a basic *Structure* analysis. Realizing that assignment portions of an individual's genome to populations must involve error if the genetic distance between the populations involved in the admixture is small, Warheit first investigated this assignment uncertainty in a study of genetic effects of early winter steelhead Skagit winter steelhead[4]. He simulated populations of hatchery-origin and natural-origin fish and their hybrids, then applied *Structure* to determine how well the program classified fish of known ancestry (Warheit 2013). He found that depending on the situation, the proportion of hybrid fish could either be seriously over- or underestimated, and concluded that he lacked sufficient power with 15 microsatellite loci to reliably quantify introgression from early winter steelhead into the wild Skagit River winter steelhead populations, or reliably identify pure unmarked hatchery-origin or hatchery-ancestry fish. Warheit's current (2014a) method applies and extends the lessons learned in the Skagit work. The data set consists of genotypes from up to 192 single-nucleotide polymorphism (SNP) loci. Simulation methods were refined to better model the genetic composition of populations. In

[3]Dr. Warheit is currently developing a manuscript for submission to a peer-reviewed journal.[4] We refer to the Skagit report only for presenting the historical development of the method. Any results presented have been superseded by Warheit (2014a) (Warheit, pers comm.)

[4] We refer to the Skagit report only for presenting the historical development of the method. Any results presented have been superseded by Warheit (2014a) (Warheit, pers comm.)

addition, Warheit used a likelihood approach to adjust the *Structure*-based assignment proportions, based on the assignment error from analysis of the simulated populations.

NMFS Northwest Fisheries Science Center (NWFSC) staff reviewed a report provided to us in March 2014 that described the method and the results of its application to several Puget Sound steelhead populations (Warheit 2014d). They commented extensively on many aspects of the document (Hard 2014). Because of these comments and additional discussion with SFD staff, the method was refined and the document extensively revised. WDFW provided NMFS with the new draft (Warheit 2014a) in October 2014, which we submitted to NWFSC for review, along with a document by Warheit (Warheit 2014c) detailing his responses to the earlier review. The NWFSC responded with a new review in January 2015 (Ford 2015).

Briefly, the NWFSC reviewers found Warheit's method to be a reasonable, thoughtful and innovative effort to address genetic introgression from closely related hatchery populations. Importantly, Warheit's approach demonstrated that a naïve application of the *Structure* program would provide misleading results, probably overestimating introgresion. However, they were concerned, as in their previous review, that Warheit's approach may overstate the precision and possibly the accuracy of the estimates. In other words, the confidence intervals may be larger than reported, and point estimates may be biased. They singled out two potential sources of uncertainty. The first was uncertainty associated with sampling, which did not seem to have been taken into account. The second was sensitivity to the many assumptions and choices about model parameters that Warheit used.

These NWFSC comments were expected. The Warheit approach is an innovative complex method that attempts something very difficult, and necessarily involves many assumptions and sources of uncertainty. NMFS staff and Warheit discussed the method and revisions to it extensively during the EIS development process. Confidence intervals were developed, in fact, at the urging of NMFS staff, with the full understanding that they were potentially underestimates. NMFS considers that although sensitivity analysis is necessary, which may spur further refinement of the technique, the Warheit method is not only a reasonable approach to measuring gene flow in this situation, but the best method available.

Application of Warheit method

WDFW has applied the Warheit method to the Nooksack, Stillaguamish, Snohomish/Skykomish, and Snoqualmie steelhead populations, as well as several other Puget Sound steelhead populations, but has not yet applied it to the Dungeness population because of lack of genetic data. Table B-2 reports *PEHC* information provided by WDFW (Warheit 2014a) on these steelhead populations, the estimates of PEHC and sampling details. The HGMPs for the programs present the same information, but numbers vary. Given that Warheit (2014a) was finalized after the HGMPs, we assume the values therein are more up to date and have based analysis on them. Also included in Table B-2 is additional information on confidence intervals provided by Warheit (2014b), specifically the probability that *PEHC* exceeded 2%.

Table B-2. *PEHC* estimates from early winter steelhead hatchery programs and sampling details for the Nooksack, Stillaguamish, Skykomish, and Snoqualmie steelhead populations (Warheit 2014a). No PEHC estimates are available for the Dungeness Basin. All values presented as percentages.

Basin	Listed Population	Sample size and details	*PEHC* and 90% CI	Probability (*PEHC*>0.02)
Nooksack	Nooksack (W)	246 (2009-2013 adults and juveniles)	0 (0-2)	10
	SF Nooksack (S)	66 (2010-2011 adults)	0 (0-2)	13
Stillaguamish	Stillaguamish (W)	86 (2006 smolt trap samples)	0 (0-7)	52
	Deer Cr. (S)	157 (1995+2013 juveniles, few 2012-2013 adults)	0 (0-1)	2
	Canyon Cr. (S)	96 (2013 juveniles)	0 (0-2)	6
Skykomish/ Snohomish	Skykomish (W)	21 (2013 adult)	0 (0-0)	0
	Pilchuck (W)	49 (2012 adult)	1 (0-12)	80
	N.F. Skykomish (S)	145 (2004, 2012, and 2013 juveniles and adults)	1 (1-3)	26
Snoqualmie	Snoqualmie (W)	166 (2010-2013 juveniles and adults)	4 (0-12)	90
	Tolt (S)	74 (2010-2012 juveniles)	1 (0-3)	37

Assuming that sample pooling had no effect on the results, *PEHC* appears to be under 2% in both Nooksack steelhead populations with high confidence. Since the proposed programs are essentially the same size as the existing programs, we expect these values to remain under 2%. It is interesting that the PEHC information is virtually identical for the Nooksack summer and winter steelhead populations, given that the summer steelhead are thought to spawn only in areas inaccessible to winter steelhead (WDFW 2014b). The result may suggest this spatial separation is not absolute, or may reflect an insensitivity in analysis. PEHC estimates for the Stillaguamish summer steelhead populations are also very low, likely because summer and winter steelhead spawning in the Stillaguamish are largely segregated spatially by seasonably impassable cascades.

The point estimate for *PEHC* in Stillaguamish winter steelhead population was also 0%, but the confidence interval ranged to 7%, with a 52% probability that *PEHC* exceeded 2%. Warheit (2014a) noted that the Stillaguamish was the most poorly represented system in his analysis. No true sample of naturally produced Stillaguamish winter steelhead was available, and no samples of the hatchery fish released into the Stillaguamish were used in the analysis. The WDFW analysis was based on sampling outmigrating smolts at a lower basin smolt trap that undoubtedly collects fish from multiple populations, and is many years old now, so may not be a good representation of current gene flow conditions anyway. Thus, both the *PEHC* estimate and confidence interval for Stillaguamish winter steelhead are more uncertain than for other populations.

We have included the sample information in Table B-2 to highlight the fact that Warheit's analysis largely used pooled samples from multiple years, and multiple life stages. Given the difficulties inherent in sampling steelhead, pooling seems reasonable, but it may have implications for *PEHC* estimates. We discuss this in detail in the section below.

Genetic monitoring

A key part of the Proposed Action is a genetic monitoring plan described in Anderson et al. (2014), which is intended to verify that *PEHC* is being maintained at or below stipulated levels. The plan includes sampling in several Puget Sound basins. Table B-3 presents sampling details for the Nooksack, Stillaguamish, Dungeness, Skykomish/Snohomish, and Snoqualmie Basins.

This level of sampling is impressive, especially coupled with sampling efforts elsewhere in Puget Sound. But the plan lacks important details. The plan commits to sampling a maximum specified number of either smolts or adults on a regular basis, but the numbers are the same in all basins, so it appears to that there is no link between sample size and analytical power. In the Dungeness River, for example, is a sample of 100 smolts large enough to generate a *PEHC* estimate of the desired precision and accuracy? It is also unclear, given that the specified sample sizes are maxima, how many samples can actually expected to be collected in a season at the various locations. This would be true even if the traps collected fish from single populations, but most traps can be expected to collect fish from more than one population.

Based on the sample pooling evident in the Warheit report (Warheit 2014a), it seems likely that either analytical demands or sampling difficulties that samples will be pooled. The implications of this procedure are unclear. If PEHC is constant over time, then unweighted pooling seems reasonable in principle. However, PEHC will undoubtedly vary to some degree, possibly necessitating weighting of samples. In addition, sample sizes may vary widely from year to year. Perhaps samples should be weighted based on size. Finally, it makes sense that in a given population, a PEHC estimate based on adults could differ from one based on smolts, simply because the progeny of hatchery-origin are expected to be less fit than the progeny of natural-origin fish and thus some of them may die before they can be sampled as adults. What are then the implications of pooling adult and juvenile samples?

Table B-3. Genetic sampling plans for Nooksack, Stillaguamish, Dungeness, Skykomish/Snohomish, and Snoqualmie steelhead (Anderson et al. 2014).

Basin	Sample site	Life stage	N	Population(s) sampled
Nooksack	Mainstem Nooksack R.	Smolts	≤ 100 annually	Nooksack (W) and (S)
	SF Nooksack R.	Adults	≤ 50 every third year	SF Nooksack (S)
Stillaguamish	Mainstem Stillaguamish R.	Smolts	≤ 100 annually	Stillaguamish (W), Canyon Cr. (S), Deer Cr. (S)
	Deer Cr.	Adults	≤ 50 every third year	Deer Cr. (S)
Dungeness	Mainstem Dungeness R.	Smolts	≤ 100 annually	Dungeness (S/W)
Skykomish / Snohomish	Mainstem Skykomish R.	Smolts	< 100 annually	Skykomish (W) and N.F. Skykomish (S)
	Pilchuck River	Adults	≤ 50 every third year	Pilchuck (W)
Snoqualmie	Mainstem Snoqualmie R.	Smolts	< 100 annually	Snoqualmie (W) and Tolt (S)
	Snoqualmie R.	Adults	≤ 50 annually	Snoqualmie (W)

We also note that there is no directed sampling of the Canyon Creek summer steelhead population. Summer steelhead are at low levels in the Stillaguamish basin, with no available escapement estimates, but intrinsic potential estimates of capacity for Deer Creek may be ten times higher than that for Canyon Creek. Canyon Creek fish can be expected to be sampled at low rates at the smolt trap, but at this point sampling this population effectively seems very difficult. In the monitoring plan WDFW has chosen to sample the Deer Creek population intensively to represent Stillaguamish summer steelhead. This not really a deficiency, but the monitoring plan should deal with this issue in more detail.

Estimation of gene flow using demographic methods

Methodology

The Scott-Gill method is also based on the schematic diagram presented in Figure B-2. The Scott-Gill method assumes random mating, and uses estimates of the proportion of spawners that are of hatchery origin (pHOS[5]), the proportion of hatchery-origin and natural-origin spawners in region B, and the relative reproductive success (RRS) of the HxH and NxH mating types to compute the proportion of the offspring gene pool produced by hatchery-origin fish. Dr. Craig Busack (NMFS) developed the equation in 2006 when he worked at WDFW. Although the value produced by the equation seems to us to be analytically identical to *PEHC*, we will call it *Gene_Flow* to prevent confusion as to which metric we are discussing, and to distinguish the metric from the concept.

Hoffmann (2014) presents Scott-Gill estimates for *Gene_Flow* for several Puget Sound winter steelhead populations, including the Nooksack, Stillaguamish, Skykomish, and Snoqualmie populations, along with details on estimation of parameters. Considerable effort went into population-specific development of the overlap parameters, especially in modeling the timing of natural spawning. Because spawning distributions are not known with precision for either the early winter hatchery or natural steelhead populations in most cases, basin specific information on overlap was bracketed with information from the Tokul Creek hatchery population, the best studied winter steelhead hatchery population, and the natural winter steelhead populations in Snow Creek and Clearwater River. Hoffmann used literature values for the RRS of early winter hatchery steelhead, including a range for HxH matings. The parameter most susceptible to error is pHOS, which was estimated from spawning ground surveys and from hatchery-origin fish returning to the hatchery. The total number of fish returning to the hatchery was assumed to be 70-80% of the escapement. This assumption of 20-30% of the hatchery-origin escapement remaining in the river to spawn was considered to be conservative in comparison to earlier estimates by the HSRG of 10-20% (Hoffmann 2014). The Dungeness population was also

[5] Symbolized by *q* in the equation in WDFW documents.

analyzed but the Scott-Gill method in the HGMP (WDFW 2014a), but using slightly differing assumptions about proportion of hatchery-origin escapement remaining in the river, and RRS.

During the review an algebraic error was discovered in the Scott-Gill equation (Busack 2014), so all previously published *Gene_Flow* values were slightly inaccurate. Table B-4 presents updated *Gene_Flow* values for steelhead populations in the Nooksack, Stillaguamish, Dungeness, Skykomish, Snoqualmie, and Pilchuck Basins computed with the same assumed values about RRS (0.13 for HxH matings and 0.54 for HxN), and pHOS as proportion of hatchery-origin escapement (30%) (Hoffmann 2015a; 2015b). Because these populations are not monitored (WDFW 2014b), and thus no abundance or timing data exists, no analysis was possible for the summer steelhead populations potentially affected by the Proposed Action.

Table B-4. *Gene_Flow* values generated from the Scott-Gill equation for the Nooksack, Stillaguamish, and Dungeness winter steelhead populations (Hoffmann 2015a; 2015b). All values are expressed as percentages. For historical pHOS and *Gene_Flow* , means are reported with maxima in parentheses. Proposed Action pHOS values are back-calculated approximations from the *Gene_Flow* values using the Scott-Gill Equation. All data have had the correction to the equation applied.

Metric/Data	**Population**					
	Nooksack	**Stillaguamish**	**Dungeness**	**Skykomish**	**Snoqualmie**	**Pilchuck**
Escapement years	2009-12	2000-12, except 2006-7	2010-11, 2012-13	2002-2012, except 2007 - 2009	2002-2012	2003-2011, except 2008
O_N	6.21	1.25	0.09	1.96	2.1	1.88
O_H	8.38	18.41	32.38	49.45	16.88	49.45
Historical pHOS	3.0 (3.5)	5.2 (10.8)	2.0 (2.9)	7.2 (24.2)	38.9 (69.7)	12.8 (23.8)
Historical *Gene_Flow*	0.50 (0.58)	0.93 (1.87)	0.30 (0.42)	1.5 (4.65)	9.15 (23.67)	2.51 (4.57)
Proposed Action pHOS	3.4	5.9	3.5	8.2	16.0	0
Proposed Action *Gene_Flow*	0.57	1.05	0.50	1.70	2.93	0

The Scott-Gill results indicate that gene flow into the natural steelhead winter populations in the Nooksack and Stillaguamish Basins, and the summer/winter population in the Dungeness Basin has been and will continue to be (under the Proposed Action) well under 2%. These results agree with the *PEHC* analysis.

The Scott-Gill results for the Skykomish and Snoqualmie indicate higher gene flow levels for the Skykomish and Snoqualmie basins than for the other three basins, with the exception of the Pilchuck, which is expected to experience no gene flow because of a program change that lead to a cessation of off-station EWS smolt releases into the Pilchuck. The *Gene_Flow* estimate for the Snoqualmie exceeds 2%, so we conclude this program poses low to moderate risk rather than low risk. This estimate is consistent with the *PEHC* estimate of 4%.

The Scott-Gill approach offers a look at the mechanics of the gene flow process that makes these estimates more understandable. For the five-year period 2007-2012, post-harvest survival rate for returning hatchery fish in the Stillaguamish River was 0.16% (averaging 216 adults from an average release of 131,840 smolts) (WDFW 2014a). Of the estimated 216 fish returning, 151 would return to the hatchery and 65 fish (30% of the return) would remain on the spawning grounds. The natural spawning escapement averaged 1217 fish, so average pHOS was 5%. Because of temporal segregation only 1.25% of the natural-origin fish and 18.4% of the hatchery-origin fish coincided temporally (15 natural-origin and 12 hatchery-origin fish). The other 1202 natural-origin fish would spawn among themselves, as would the other 53 hatchery-origin fish. Assuming random mating, this would be expected to result in 94.5% NxN matings, 1% NxH matings, and 4.5% HxH matings. Only 11 natural-origin fish (0.9%) would be expected to mate with hatchery-origin fish. Assuming no differences in success of these matings, the initial proportion of the progeny gene pool originating from hatchery-origin fish would be 5.0%. However, because of the expected low RRS of the hatchery-origin fish (e.g., Araki et al. 2008), this percentage would be reduced to 1.1% (assuming RRS of 0.54 for NxH matings and 0.18 for HxH).

This example also illustrates well the chain of logic in using modeled parameter values to generate the *Gene_Flow* values. Whatever error exists in the *Gene_Flow* is predominantly due to parameter uncertainty, rather than error associated with assumed statistical distributions, so no confidence intervals are included with the estimates in Table B-4. Hoffmann (2014) used a sensitivity analysis to evaluate the effects of parameter uncertainty on the Scott-Gill results. This was a general rather than a basin- or population-specific analysis. Average parameter values for overlap, pHOS, and RRS[6] over all the Puget Sound steelhead populations were analyzed in the document to arrive at an average *Gene_Flow*. Each parameter average was then varied individually up and down 50% (Table B-5) to determine the effect on that average *Gene_Flow* estimate (Figure B-2). Based on this analysis, results seem most sensitive to pHOS, but are reasonably sensitive to RRS and overlap values. Although this sensitivity analysis is informative, additional sensitivity analysis needs to be done to improve the level of certainty of the *Gene_Flow* estimates. First, although basing the analysis on average values makes sense in several ways, it should be done on a population specific basis as well, as the situation for a particular population may deviate considerably from average. Second, multiple parameters should be varied simultaneously. We realize that varying combinations of parameters presents a huge number of options, but this can be limited by focusing on those subject to greatest uncertainty or variability. Third, variation should be done on a biologically realistic basis rather than using an arbitrary scale such as 150% and 50%, because some variables are more subject to variability/uncertainty than others. Biological reality may require the dissection of the input parameters into components and investigating their individual variability/uncertainty. An excellent example is pHOS, which is obviously a function of the estimated number of hatchery-origin and natural-origin fish on the spawning grounds. The former is assumed to be a constant proportion of the escapement, calculated from the known number returning to the hatchery, and the latter is based on redd counts and assumptions about the proportion of the run that spawns before redd surveys begin, itself an input parameter to the Scott-Gill equation. Given this, it is unclear that sensitivity analysis based on varying pHOS up and down 50% adequately captures all the uncertainty/variability in pHOS. Possibly the major source of imprecision and bias is in the redd counts, which are well known to be potentially subject to error. Another obvious candidate for closer scrutiny for biological reality is overlap.

The Seamons et al. (2012) study of performance of EWS at Forks Creek, a small tributary of the Willapa River on the Washington coast is frequently cited in discussions of risk from naturally spawning returning EWS, particularly the failure of assumptions about spawning overlap and resulting high proportion of HxN progeny. Given the high visibility for this work, and the obvious potential for applying the conclusions to Puget Sound EWS programs, we consider it important to discuss in detail the potential applications of this research to Puget Sound EWS programs. NMFS requested that WDFW provide supplementary information dealing with this

[6] Hoffmann used two values for the RRS of HxH matings (0.02 and 0.13), so used an average of 0.07 in the sensitivity analysis.

issue (Tynan 2015), and the following discussion is based on WDFW's response (WDFW 2015), which should be consulted for additional detail. In evaluating the Forks Creek study, there are two primary issues: spawning overlap of natural-origin and hatchery-origin fish; and the presence of HxN hybrids resulting from that overlap. In the Seamons et al. (2012) study, the median day of arrival for hatchery-origin adults was early to middle January, and the median day of arrival for natural-origin (unmarked) adults assigned by Seamons et al. (2012) to the wild category was middle to late April. There was no overlap between the hatchery and wild distribution quartiles, and very little overlap between the 95% CIs (Seamons et al. 2012, Fig. 5). Thus, the spawning overlap in Forks Creek does not appear to be different from the values used in the Scott-Gill modelling (Hoffmann 2015a; 2015b). Because there is no evidence for more spawning, the question is - why does the Forks Creek research indicate a considerably larger number of hatchery-wild hybrids than are detected by Warheit in several basins? The most likely explanations are higher pHOS and higher spawner overlap than would be expected in Puget Sound. Unpublished work in WDFW (2015) indicates that pHOS in Forks Creek is 15%, far higher than in most of the streams in the Proposed Action (Table B-4), so more hybrids would be expected than in lower pHOS systems. The spawner overlap argument is based on size of the system and hatchery location. Hatchery fish were therefore likely to be attracted back to Forks Creek, increasing the spatial overlap of spawning. Thus, the degree of hybridization seen in Forks Creek may be more similar to small river systems with similar characteristics, systems which are quite different in size and hatchery location from the three dealt with in this Proposed Action. A final possibility is an upward bias in assignment of fish to the hybrid category.

This discussion of the Seamons et al. (2012) is in no way intended to weaken the argument for empirical verification of key biological parameters used in the Scott-Gill modelling. In fact, by emphasizing the importance of considering program-specific factors, it strengthens the argument.

Table B-4. Input parameter values used in sensitivity analysis of Scott-Gill method applied to Puget Sound steelhead populations (from Table 11 in Hoffmann (2014)).

Input Parameter	Average value over watersheds and cases	Parameter value at a 50% increase	Parameter value at a 50% decrease
O(n)	3.63%	5.44%	1.81%
O(h)	12.19%	18.29%	6.10%
K1	0.07	0.11	0.04
K2	0.54	0.81	0.27
On Station pHOS	5.05%	7.58%	2.53%

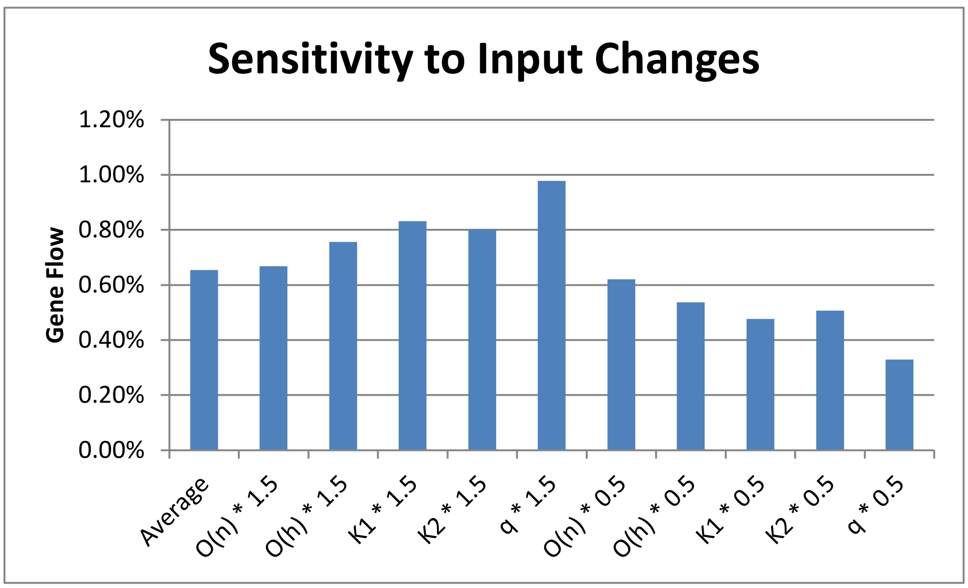

Figure B-2. Gene flow values when varying each Scott-Gill parameter in isolation by a 50% increase and a 50% decrease over the input value averaged over all watersheds and all cases (from Figure 11 in Hoffmann 2014).

Summary

Above we have discussed at length the need for additional work on the Warheit method and associated sampling plans, and the need for a considerably more thorough sensitivity analysis of the input parameters used in the Scott-Gill method. The space devoted to detailing those issues should not overshadow the fact that for these five proposed programs, two credible and independent approaches indicate that gene flow, measured either as *PEHC* or *Gene_Flow* should be under the 2% level in five of six winter steelhead populations affected by the five programs in the Proposed Action (Table B-6). And although there are concerns about the precision of the genetically based results, and concerns about both precision and bias of the demographically based results, we conclude that there would have to have been unreasonably large errors in methods or parameter estimation to have achieved these results if the gene flow was larger than the *PEHC* and *Gene_Flow* estimates. On the basis of this determination, NMFS concludes that the Proposed Action does not pose unacceptable risk through gene flow to Puget Sound steelhead.

However, NMFS also feels that this conclusion must be validated as indicated above by (1) further development of the Warheit method to produce improved confidence intervals, (2) further development of the genetic monitoring plan, and (3) expanded sensitivity analysis of the Scott-Gill method.

Table B-5. Summary of analyses of gene flow from early winter hatchery steelhead into listed Nooksack, Stillaguamish, and Dungeness steelhead populations. (Data from Table B-2 and Table B-4). All values are expressed as percentages.

Basin	**Listed Population**	***PEHC (%)***	***Gene_Flow (%)***
Nooksack	Nooksack (W)	0 (0-2)	0.57
	SF Nooksack (S)	0 (0-2)	-
Stillaguamish	Stillaguamish (W)	0 (0-7)	1.05
	Deer Cr. (S)	0 (0-1)	-
	Canyon Cr. (S)	0 (0-2)	-
Dungeness	Dungeness (S/W)	-	0.50
Snohomish/ Skykomish	Pilchuck (W)	1 (0 - 12)	0
	Skykomish (W)	0 (0 - 0)	1.70
	N.F. Skykomish (S)	1 (1 - 3)	-
Snoqualmie	Snoqualmie (W)	4 (0 - 12)	2.93
	Tolt (S)	1 (0 - 3)	-

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Appendix C

Socioeconomics Methods

Prepared by TCW Economics

October 2015

This Socioeconomics Methods appendix describes the methods and data used to describe baseline conditions in Subsection 3.5, Socioeconomics, and to conduct the analysis of effects on the socioeconomic resource as described in Subsection 4.5, Socioeconomics, of the Puget Sound early winter steelhead (EWS) draft environmental impact statement (DEIS). The analysis of socioeconomic impacts is based on baseline catch conditions associated with five EWS programs that use eight hatchery facilities located in five Puget Sound river basins (Dungeness, Nooksack, Stillaguamish, Skykomish, and Snoqualmie River basins) (Subsection 3.5, Socioeconomics). Note the Skykomish River and Snoqualmie River are major tributaries in the Snohomish River basin. The socioeconomic effects of changes in hatchery operations and in affected recreational fisheries are estimated for each alternative analyzed in the DEIS. Effects of changes in production under the alternatives on tribal commercial and ceremonial and subsistence also are considered qualitatively in Subsection 3.5, Socioeconomics, and Subsection 4.5, Socioeconomics, of the DEIS.

Impact Assessment Methods

Estimates of regional economic impacts derived from assessing hatchery production costs and expected fishing effort associated with EWS caught in recreational fisheries are expressed primarily in terms of personal income accruing to households within local areas (county or multi-county regions). Local personal income is considered a key indicator of economic activity, and is used in economic analysis to evaluate distributional effects on local and regional economies associated with hatchery production. Estimates of local personal income, which the Pacific Fishery Management Council also derives to annually assess the economic effects for its salmon allocation decisions, reflect the wages, profits, and property income associated with expenditures made by sport anglers (and commercial fishers) in their fishing pursuits. For this analysis, the only effects on fisheries that are quantified are those occurring in freshwater recreational fisheries, which are understood to represent the most substantial fisheries affected by the EWS hatchery programs.

In addition to the personal income generated by angler participation in recreational fisheries affected by EWS hatchery production, EWS hatchery facilities operating in the Puget Sound region also affect local and regional economies by providing employment opportunities for those working at the eight hatchery facilities where EWS are produced, and through the procurement of materials and services needed for operation of the hatchery facilities.

The following four analytical steps were followed to conduct the analysis of socioeconomic effects of the five EWS programs that are the subject of this assessment.

Step 1: Compile Hatchery Production and Catch Data for the EWS Hatchery Programs

Hatchery production information for the five EWS hatchery programs was used to generate statistics on the relative contribution of each of the five programs to the total EWS production and estimated adult returns throughout the Puget Sound region. This production information is included in Table C-1. Sport catch data (in numbers of fish caught) for EWS reported by the Washington Department of Fish and Wildlife (WDFW) in its annual Sport Catch Report were compiled (Table C-2) and used to estimate a recent 10-year average catch by river basin.

Table C-1. Summary of EWS releases by river basin, under the DEIS alternatives.

River Basin (County)	Hatchery Facilities	Smolt Release by Alternative			
		1 No Action	2 Proposed Action	3 50 percent Reduction	4 Native Broodstock
Dungeness (Clallam)	Dungeness River Hatchery Hurd Creek Hatchery	0	10,000	5,000	10,000
NF Nooksack (Whatcom)	Kendall Creek Hatchery McKinnon Pond	0	150,000	75,000	150,000
NF Stillaguamish (Snohomish)	Whitehorse Ponds	0	130,000	65,000	130,000
Skykomish (Snohomish)	Wallace Hatchery Reiter Ponds	0	256,000	128,000	256,000
Snoqualmie (King)	Tokul Creek Hatchery	0	74,000	37,000	74,000
Total	8	0	620,000	315,000	620,000

Step 2: Convert Estimates of Baseline Catch to Sport Angler Trips

The catch data compiled in Step 1 required conversion to angler trips so that the hatchery production of adult steelhead would match the regional economic impact (REI) factors (REI per angler trip) used to estimate total personal income. As mentioned above, quantitative estimates of economic values were only derived for sport fisheries because the most substantial effect of the EWS hatchery program are understood to be on recreational fisheries. (The relatively limited effect on tribal commercial fisheries was addressed qualitatively in the impact assessment, primarily due to tribal catch data limitations.) For recreational fisheries, estimated catch was converted to angler trips, considering the influence of catch-and-release fishing as part of angler effort. Then, the REI factors were applied to the estimates of angler effort to calculate personal income effects of total angler effort associated with affected fisheries. (Note that these estimates of REI include the effect on angler effort from both wild and hatchery fish.).

The primary sources of information used for deriving the catch per unit of effort (CPUE) factors for steelhead fishing in the freshwaters of Puget Sound included: 1) state-wide estimates of steelhead sport fishing effort (2,706,340 freshwater steelhead trips, as derived from angler days reported by the U.S. Department of the Interior, Fish and Wildlife, U.S. Department of Census Bureau, 2011 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (personal communication from James Dixon to TCW Economics, September 21, 2015) and 2) estimates of total sport catch of steelhead in statewide freshwaters (152,285 fish, as reported in the WDFW's Catch Record Report for the 2011-12 winter season.

The resulting conversion factor of 17.77 trips per steelhead caught, which is generally consistent with findings by Scott and Gill (2008), was then applied to the 10-year average of winter-run steelhead sport catch (4,412 fish caught; Table C-2) in the affected EWS rivers in the Puget Sound region to estimate the baseline number of sport angler trips (78,400 trips).

Table C-2. Sport harvest estimates of early winter steelhead by Puget Sound river basin.

River Basin[1]	Harvest Year (winter of)										
	2004-05	**2005-06**	**2006-07**	**2007-08**	**2008-09**	**2009-10**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**10-year Average**
Dungeness	24	32	38	21	7	19	26	57	93	100	42
Nooksack	447	238	216	69	49	56	106	59	83	104	143
Stillaguamish	733	625	852	521	116	108	105	282	430	266	404
Skykomish	3600	2045	2595	2453	1019	1114	1563	2439	2106	1604	2226[2]
Snoqualmie	3257	1443	1476	1206	800	900	877	1806	1643	985	1597[2]
										Total	4412

Sources: WDFW final Sport Catch Reports for 2004-05 through 2011-12 (http://wdfw.wa.gov/fishing/harvest/); Preliminary estimates for 2012-13 and 2013-14 from WDFW data (J. Dixon, Pers. Comm. with Eric Kraig, WDFW).

[1] River-basin level harvest estimates include estimated harvest in both the mainstem and tributaries of each river.

[2] Average totals for the Skykomish and Snoqualmie River basins include the reported catch from the lower mainstem Snohomish River (10-year average of 330), proportionally divided and added to each of the Skykomish and Snoqualmie 10-year averages (52 percent to 48 percent, respectively), based on the baseline hatchery program release sizes in each of the river basins.

Step 3: Estimate Regional Economic Impacts (Total Personal Income) of EWS Hatchery Production under Baseline Conditions

Estimates of regional economic impacts, as measured in terms of total personal income, were developed based on consideration of both hatchery operations, and of the effect on recreational fisheries that are supported by the five EWS hatchery programs. For estimating REI of hatchery operations, estimates of annual operating costs and employment for the eight hatchery facilities involved in producing EWS were compiled from information in the HGMPs (WDFW 2014a, WDFW 2014b, WDFW 2014c, WDFW 2014d, WDFW 2014e). (It should be noted that these hatcheries produce species other than EWS so the estimates of annual operating costs [$2.02 million] and employment [19.34 full-time equivalent positions] reflect total hatchery operations, not just for EWS. It was assumed that the EWS programs account for an estimated average of 28 percent of the total annual operating costs of the eight hatchery facilities, or about $561,300, based on the total production at EWS hatchery facilities that is comprised of steelhead (in pounds) (DEIS Table 4).

The estimates of operating costs and jobs were then converted to estimates of total personal income based on factors derived from State of Washington hatchery budget information used in a study for Trout Unlimited of the economic contribution of salmonids to the Southeast Alaska economy (TCW Economics 2011). According to this study, wages and other forms of personal income accounted for 57 percent of total operating costs, and procurement of materials and services required for production accounted for 43 percent of total operating costs. Based on these factors, direct income (i.e., wages and other forms of compensation) generated by the eight hatchery facilities that produce EWS is estimated at $1,114,975. (Note that the percentages used for this analysis were adjusted to 55 percent for wages and other compensation, and 45 percent for procurement.) Of this total, it is estimated that $312,190 (28%) is related to EWS production.

Based on a feasibility study of hatchery improvements at the Leavenworth Hatchery Complex in eastern Washington (McMillan 2015), secondary income effects (i.e., wages generated by the spending of hatchery workers' income and from procurement of materials and services) accounted for 59 percent of the direct income effects, which represents $657,835 ($1,114,975 * 0.59) of direct income associated with production of all species at the eight hatchery facilities. Total income generated by production at the eight hatchery facilities where EWS are produced is therefore estimated at $1,772,810 ($1,114,975 + $657,835). Based on an estimated 28 percent share of hatchery operation costs associated with EWS production, the regional economic effect, as measured in personal income, associated with production of EWS-only would be about $496,400 ($1,772,810 * 0.28).

For analyzing the regional economic effects of the recreational fisheries supported by EWS production at the eight hatchery facilities, an REI factor of $67.30 per trip for steelhead fishing in freshwaters of Puget Sound was applied to the estimated number of angler trips (78,400 trips) under baseline conditions to estimate regional economic impacts (direct and secondary personal income) of the EWS hatchery programs. This REI factor ($67.30 per trip) reflects the estimated regional economic impact per angler trip, as expressed in 2015 dollars and derived for a preliminary socioeconomic study (The Research Group 2009) prepared for the DEIS on the Columbia River Basin Hatchery Operations and Funding of Mitchell Act Hatchery Programs. The REI factor, originally developed in 2007 dollars, was adjusted to 2015 dollars using the state-wide consumer price index for all goods and services. Applying this REI factor to the estimate of baseline number of trips (78,400 trips) resulted in an estimate of about $5.28 million in regional income effects.

Under baseline conditions, total regional income effects from both hatchery operations (including production of all species at EWS hatchery facilities) and from affected EWS recreational fisheries in Puget Sound are estimated at $7.05 million annually. When hatchery production costs of EWS-only are considered, the total personal income effects are estimated at $5.77 million annually.

Step 4: Analyze Effects of Changes in Hatchery Production under the Alternatives on Recreational Fishing Effort and Regional Economic Conditions

For the alternatives analysis in Subsection 4.5, Socioeconomics, the baseline conditions described above were used to characterize the expected regional economic effects and associated effects on fisheries under Alternative 2 (Proposed Action) (Subsection 4.5.2, Proposed Action). The effects of implementing Alternative 1 (No Action) would be to eliminate the marginal economic benefits of the contribution of EWS hatchery production to angler trips and associated regional economic effects described under Alternative 2 (Proposed Action). The baseline conditions described in Subsection 3.5, Socioeconomics, and explained above also would reflect the socioeconomic effects of implementing Alternative 4 (Native Broodstock) because there would be no change in hatchery production under Alternative 4. Note that there could be some additional production costs associated with the transitioning to native broodstock but the potential socioeconomic effect of this would be expected to be minimal.

For analyzing the socioeconomic effects of Alternative 3 (50 percent reduction), the number of steelhead angler trips compared to baseline conditions would be expected to decline. A number of factors were considered to assess the magnitude of this reduction in angler effort, including the relative contribution of EWS hatchery fish to the overall number of catchable adult steelhead fish; angler perceptions of how a potential reduction in the abundance of adult steelhead populations would affect fishing quality; and how the steelhead fisheries on the affected rivers are managed.

Although these and other issues related to potential effects on angler effort from changes in (hatchery) fish abundance are very specific to the affected EWS rivers, the relevant literature does suggest some key conclusions concerning how angler effort could generally be expected to respond to a 50 percent reduction in the number of adults from EWS hatchery programs in the affected Puget Sound rivers.

Based on a review of relevant literature (e.g., Allen and Ahrens 2012; Andrews and Wilen 1988; Hooton 1985; Johnson and Carpenter 1994; Johnson and Adams 1988; Johnson and Adams 1989; Johnston, et al. 2006; Larson and Lew 2013; and Murdock, J. 2001), a key conclusion that can reasonably be drawn is that the relationship between the number of trips taken and the abundance of adult catchable fish is 'inelastic', a term indicating that, in most situations of changes (increases or declines) in the abundance of adult catchable steelhead over time, the percentage change in the number of angler trips would be expected to change by less than that of abundance. In other words, as abundance goes down, the number of angler trips also would be expected to decline but at a more reduced rate of change. Because of the many site-specific factors that affect this behavioral response, primary research, such as conducting surveys of steelhead anglers on the affected rivers, is the only potentially statistically-valid method to estimate this response.

Conducting angler surveys to estimate angler response to an expected 50 percent reduction in the releases of fish from EWS hatchery programs is beyond the scope of this assessment; however, based on a review of the relevant literature and on expert judgment, a reasonable estimate is that angler effort could be expected to decrease at a rate that is about 50 percent of the rate of change in numbers of EWS hatchery fish. Assuming this response, the estimated number of angler trips could be expected to decline by about 19,600 trips (78,400*0.5*0.5). Based on a REI factor of $67.30 per trip, this would result in a personal income reduction of an estimated $1.32 million annually, or 25 percent of the contribution under the baseline condition.

In addition to the regional economic effects related to affected recreational fisheries, a 50 percent reduction in the production from EWS hatchery programs also would affect personal income supported by hatchery operations. Consistent with information described by NMFS (2014), a 50 percent reduction in hatchery production of EWS would not be expected to affect the number of FTE positions at the eight hatchery facilities because these facilities also produce other fish for other hatchery programs (e.g., salmon). However, there would be a reduction in the procurement of materials and services needed. This reduction in procurement would be expected to correspond with the reduction in production of EWS fish, which would translate to an estimated $65,100 in reduced procurement for materials and services related to EWS hatchery programs, relative to baseline conditions.

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