4(d) Rule Limit 6
Evaluation and Recommended Determination

Title of RMP: Joint Hatchery and Genetic Management Plans for Snohomish River Basin Early Winter Steelhead

RMP Submitted by: Washington Department of Fish and Wildlife and the Tulalip Tribes

ESU/DPSs: Puget Sound Chinook Salmon ESU
Puget Sound Steelhead DPS

4(d) Rule Limit: ESA 4(d) Rule Limit 6

NMFS Tracking Number: WCR-2015-3441

1 BACKGROUND

NOAA's National Marine Fisheries Service (NMFS) issued a final Endangered Species Act (ESA) 4(d) Rule adopting regulations necessary and advisable to conserve Puget Sound Chinook salmon (50 CFR 223.203(b); 70 FR 37160, June 28, 2005). The 4(d) protective regulations adopted for the two salmon evolutionary significant units (ESU) were subsequently applied to the Puget Sound steelhead distinct population segment (DPS) in a separate final rule (73 FR 55451, June 25, 2008) (both rules are referred to in this document as "the Rule"). Under limit 6 of the Rule, ESA section 9 take prohibitions for these listed salmonid species do not apply to hatchery activities that are undertaken in compliance with a resource management plan (RMP) developed jointly by the Tribes and the State of Washington that is consistent with the 4(d) Rule criteria. The Washington Department of Fish and Wildlife (WDFW) and the Tulalip Tribes as co-managers of the fisheries resource under *United States v. Washington* (1974) (hereafter referred to as "the co-managers"), have provided NMFS with two Hatchery and Genetic Management Plans (HGMP) for hatchery programs and associated monitoring and evaluation actions in the Snohomish River watershed that will adversely affect ESA-listed Puget Sound Chinook salmon and Puget Sound steelhead (Scott 2014; 2015). The HGMPs provide the framework through which the Washington State and Tribal jurisdictions can jointly 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. For the purposes of the proposed recommendation, NMFS considers the two joint HGMPs, submitted for consideration under limit 6, to be an RMP.

2 PROPOSED ACTION

The two HGMPs submitted to NMFS for consideration under limit 6 are designed to support recreational and tribal fishing only, and they are not intended to supplement natural steelhead spawning. They involve activities, including the production and release of hatchery-produced smolts, the collection of these hatchery fish upon their return from the ocean as adults for hatchery broodstock, and associated monitoring and evaluation actions that have the potential to affect Puget Sound Chinook salmon and Puget Sound steelhead listed as threatened species under the ESA. The Hood Canal summer-run chum salmon ESU is also listed as a threatened species under the ESA but it does not encompass the Snohomish River watershed where the HGMPs would be implemented, or include any populations of the species within the watershed (Sands et al. 2009). The Snohomish River basin action area is far-removed geographically from areas where summer-run chum salmon are present, and no effects on summer chum salmon associated with implementation of the EWS programs are likely or expected (NMFS 2002). Applications for ESA authorizations under the section 4(d) Rule, limit 6, must provide the necessary information described in 50 CFR part 222.308. The HGMPs were reviewed upon their final submittal in updated form, and NMFS determined that they were sufficient for NMFS to proceed in its evaluation of effects of the plans on ESA-listed Puget Sound Chinook salmon and Puget Sound steelhead (Jones 2014).

The hatchery programs, as described in the HGMPs, mitigate for impacts on tribal and recreational fishing caused by past and on-going human developmental activities in the Snohomish River watershed, and from climate change. They provide hatchery fish to: (1) meet regional recreational fisheries objectives for the citizens of Washington State, and (2) meet tribal fishery harvest allocations that are guaranteed through treaties, as affirmed in *United States v. Washington* (1974). The two proposed hatchery programs would use only hatchery fish for broodstock. These fish are "early winter" (Chambers Creek hatchery-lineage) steelhead (henceforth "EWS") (WDFW 2014a; 2014b) (Table 1) that are not included as part of the ESA-listed Puget Sound steelhead Distinct Population Segment (DPS) (71 FR 20802, April 14, 2014; Jones 2015).

The proposed hatchery programs would also include monitoring of program performance and effects in the Snohomish River watershed, while applying measures that would minimize risks of adverse genetic, demographic, or ecological effects on ESA-listed fish and other natural populations. If determined to be in compliance with limit 6 of the 4(d) Rule, the EWS hatchery programs would operate in conjunction with on-going habitat restoration and harvest management actions, implemented consistent with the objectives of the salmon recovery plans for Puget Sound and the individual watersheds (SSPS 2005; SSPS 2007; NMFS 2015b) until natural-origin salmonid populations, that would sustain fisheries, are restored.

Table 1. Proposed hatchery programs for Snohomish River basin hatchery early winter steelhead.

Hatchery Program	Operator
Wallace/Reiter Early Winter Steelhead Hatchery Program (WDFW 2014a) 1	WDFW
Tokul Creek Winter Steelhead Hatchery Program (WDFW 2014b)	WDFW

All EWS hatchery program actions and associated monitoring and evaluation activities proposed by the co-managers for the Snohomish River watershed are included in the HGMPs. Actions proposed in the HGMPs, including descriptions of the facilities where the majority of actions occur, are summarized below.

2.1 Wallace/Reiter Early Winter Steelhead Hatchery Program

Actions and effects for the Wallace/Reiter EWS hatchery program would occur in the Skykomish River and its tributaries, extending from the upper-most reaches accessible to migrating steelhead and salmon in the watershed, downstream to the river mouth, and including the Snohomish River estuary. This area includes Wallace River Hatchery, Reiter Ponds Hatchery, Wallace River, Austin Creek, the portions of the Skykomish River and the Snohomish River through which steelhead smolts produced by the programs would emigrate seaward after release and return as adults, and the estuary through which emigrating hatchery smolts would exit freshwater or enter the Snohomish River basin as adults. The affected area includes all freshwater and estuary areas used by the extant populations of ESA-listed Chinook salmon and steelhead originating from the Snohomish River basin.

The proposed Wallace/Reiter EWS hatchery program would operate from Reiter Ponds Hatchery, located on Austin Creek, a tributary to the mainstem Skykomish River at river mile (RM) 46.0 (continues as the Snohomish River at RM 20.5); and Wallace River Hatchery, located at RM 4.0 on the Wallace River, tributary to the Skykomish River at RM 35.7 (continues as the Snohomish River at RM 20.5) (Figure 1) (WDFW 2014a). Adult broodstock collection and spawning, and juvenile fish rearing and smolt release would occur at Reiter Ponds Hatchery and Wallace River Hatchery. Up to 300 EWS adult steelhead would be collected each year to sustain production of up to 167,600 smolts at the two hatcheries (Unsworth 2016). Up to 140,000 EWS smolts would be released at Reiter Ponds, and up to 27,600 smolts would be released from Wallace River Hatchery (E. Kinne, WDFW, pers. comm., February 1, 2016) no earlier than April 15th each year into the Skykomish River and Wallace River, respectively.

Surface water is withdrawn for use at Wallace River Hatchery from the Wallace River and an adjacent tributary (May Creek). Austin and Hogarty Creeks supply surface water for the Reiter Ponds program. Hatchery effluent produced by the two facilities is released into the Wallace River, and the mainstem Skykomish River, respectively. Effects on downstream aquatic life from effluent

1 The co-managers subsequently modified this plan as an outcome of consultation discussions with NMFS by reducing the annual smolt release number from the level proposed in the 2014 HGMP through submittal of a modified plan on February 23, 2016 (Unsworth 2016).

discharge are regulated and monitored through Federal National Pollutant Discharge Elimination System (NPDES) permits issued to each facility. Hatchery effluent at Wallace River Hatchery is passed through a pollution abatement pond to settle out any uneaten food and fish waste before being discharged into receiving waters (WDFW 2014a).

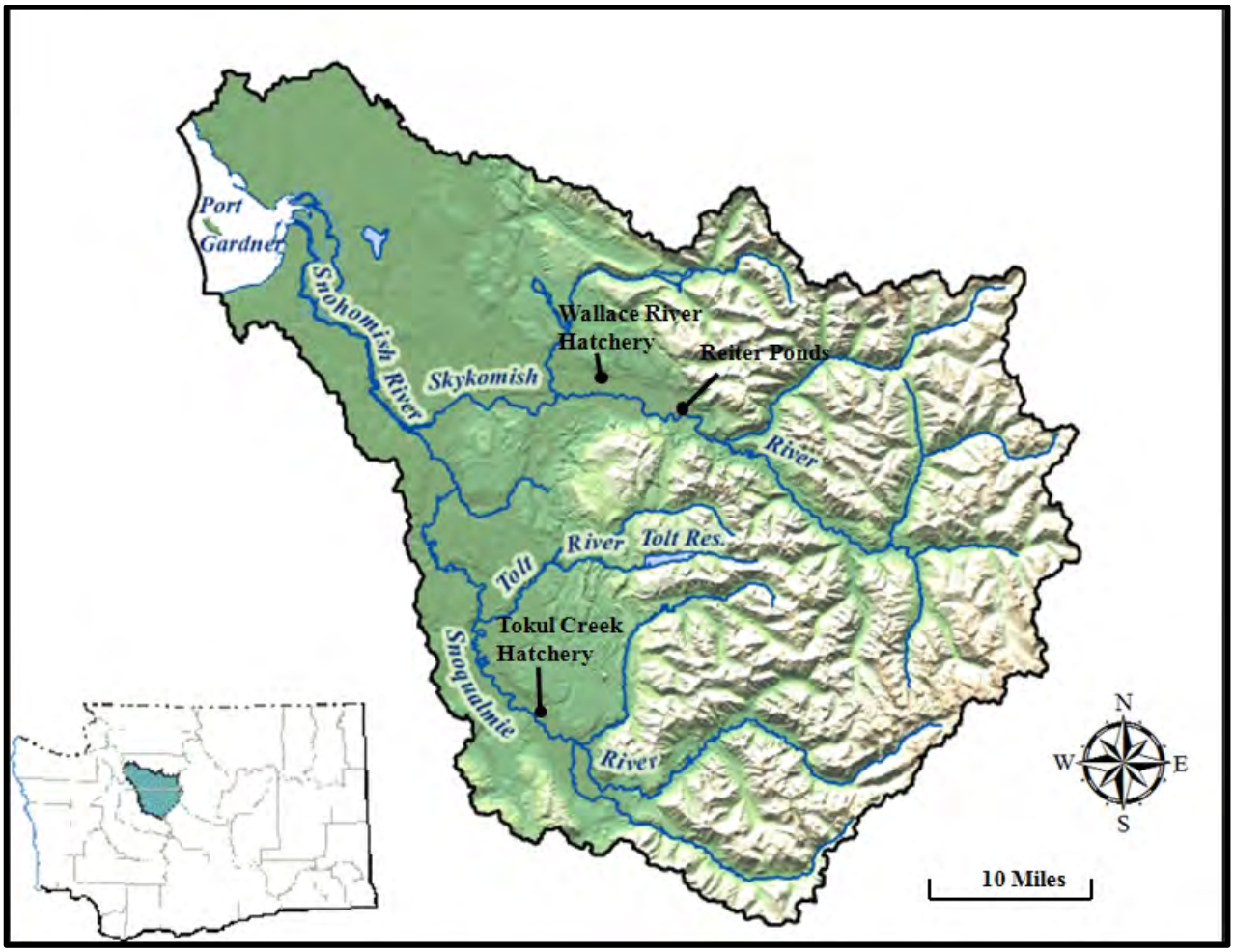

Figure 1. Action area for the proposed continued operation of Snohomish River basin EWS hatchery programs for fisheries harvest augmentation purposes. Map includes locations of all WDFW EWS hatchery facilities in the basin.

Source: Modified from WDFW Score data, accessed July 17, 2015- https://fortress.wa.gov/dfw/score/score/maps/map_details.jsp?geocode=wria&geoarea=WRIA07_Snohomish.

Assessment of hatchery program performance (e.g., smolt to adult survival rate and fishery contribution level monitoring) and effects on natural-origin fish would be the primary objectives of monitoring and evaluation actions implemented through the proposed program. All hatchery-origin fish would be marked and/or tagged prior to their release into the natural environment to

allow for positive identification and assessment of smolt-to-adult survival rates and to determine the origin of adult returns. Mass marking would also allow for differentiation of hatchery- from natural-origin adult fish escaping to the Skykomish River and its tributaries, and identification of steelhead by origin during the juvenile fish emigration periods. An adult steelhead monitoring program (spawning ground surveys) would be conducted annually to document abundance and spatial structure of steelhead escaping to natural spawning areas and to the hatcheries in the action area basins (WDFW 2014a). Within the Skykomish River system, genetic (DNA) samples will be collected annually and analyzed to determine the number of natural-origin hybrid and hatchery-ancestry fish (Anderson et al. 2014a). Within the Pilchuck River system, genetic (DNA) sampling of adult fish will be conducted on a rotating basis every three years (Anderson et al. 2014a). The effects of juvenile salmonid sampling occurring outside of the hatchery locations have already been analyzed and authorized under the ESA (NMFS 2009, NMFS 2015a). WDFW and the Tulalip Tribes propose to monitor interactions between juvenile hatchery- and natural-origin salmonids in freshwater and marine areas within the action area to evaluate and manage the programs. Juvenile outmigrant trapping by Tulalip Tribes using a rotary screw trap on the Skykomish River will provide information on the co-occurrence, out-migration timing, relative abundances, and relative sizes of hatchery-origin fish, ESA-listed natural-origin Chinook salmon and steelhead, and of natural-origin coho, chum, and pink salmon. Results from the juvenile outmigrant trapping programs described in the HGMPs (Section 11) will be reported as required (NMFS 2009; NMFS 2015a).

2.2 Tokul Creek Winter Steelhead Hatchery Program

Actions and effects for the Tokul Creek Winter Steelhead Hatchery Program would occur in the Snoqualmie River and its tributaries, extending from the upper-most reaches accessible to steelhead and salmon in the watershed, downstream to the river mouth, and including the Snohomish River estuary. This area includes Tokul Creek Hatchery, Tokul Creek, the portions of the Snoqualmie River and the Snohomish River through which steelhead smolts produced by the program would emigrate seaward after release and return as adults, and the estuary through which emigrating hatchery smolts would exit freshwater or enter the Snohomish River basin as adults. The affected area includes all freshwater and estuary areas used by the extant populations of ESA-listed Chinook salmon and steelhead originating from the Snohomish River basin.

The proposed Tokul Creek EWS Hatchery Program is located at RM 0.5 on Tokul Creek, tributary to the Snoqualmie River at RM 39.6 (the Snoqualmie River enters the mainstem Snohomish River at RM 20.5) (Figure 1; Williams et al. 1975; WDFW 2014b). Broodstock collection, spawning, rearing, and release occur at Tokul Creek Hatchery. Up to 100 EWS adults would be collected each year to sustain the program. Up to 74,000 EWS smolts would be released no earlier than April 15th each year into Tokul Creek.

Surface water is withdrawn from Tokul Creek and an unnamed spring to rear steelhead at the facility. Tokul Creek Hatchery may also use groundwater withdrawn from a well to augment surface water sources for fish rearing in the event of an emergency. Hatchery effluent is released into Tokul Creek. Effects on downstream aquatic life from effluent discharge are regulated and monitored through a NPDES permit issued to the facility.

Assessment of hatchery program performance and effects on natural-origin fish would be the primary objectives of monitoring and evaluation actions implemented through the proposed program. All hatchery-origin fish would be marked and/or tagged prior to their release into the natural environment to allow for positive identification and assessment of smolt-to-adult survival rates and to determine the origin of adult returns. Mass marking would also allow for differentiation of hatchery- from natural-origin adult fish escaping to the Snoqualmie River and its tributaries, and identification of steelhead by origin during the juvenile fish emigration periods. An adult steelhead monitoring program (spawning ground surveys) would be conducted annually to document abundance, spatial structure, and spawn timing of steelhead escaping to natural spawning areas and the hatcheries in the action area basins (WDFW 2014b). Within the Snoqualmie River system, genetic (DNA) samples will be collected annually and analyzed to estimate the number of natural-origin hybrid and hatchery-ancestry fish (Anderson et al. 2014a). The effects of juvenile salmonid sampling occurring outside of the hatchery locations have already been analyzed and authorized under the ESA (NMFS 2009, NMFS 2015a). WDFW and the Tulalip Tribes propose to monitor interactions between juvenile hatchery- and natural-origin salmonids in freshwater and marine areas within the action area to evaluate and manage the programs. Juvenile outmigrant trapping by the Tulalip Tribes using a rotary screw trap on the Snoqualmie River would provide information on the co-occurrence, out-migration timing, relative abundances, and relative sizes of hatchery-origin fish, ESA-listed natural-origin Chinook salmon and steelhead, and of natural-origin coho, chum, and pink salmon. Results from the juvenile outmigrant trapping programs described in the HGMPs (Section 11) will be reported as required in the separate NMFS authorizations for the programs (NMFS 2009; NMFS 2015a).

3 EVALUATION

The final 4(d) Rule for salmon and steelhead states that the prohibitions of paragraph (a) of the rule (50 CFR 223.203(a)) do not apply to actions taken in compliance with a RMP jointly developed by the States of Washington, Oregon, and/or Idaho and the Tribes, provided that elements of the rule are met, including the following:

- The Secretary of Commerce (Secretary) has determined pursuant to 50 CFR 223.209(b) [the Tribal 4(d) Rule] and the government-to-government processes therein that implementing and enforcing the joint tribal/state plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs and DPSs.

- In making that determination for a joint plan, the Secretary has taken comment on how any HGMP addresses the criteria in §223.203(b)(5).

As per the Tribal 4(d) Rule, NMFS consulted with the Tulalip Tribes and the WDFW during the development of the two HGMPs through government-to-government and technical work group meetings. These occasions presented the opportunity to provide technical assistance, to exchange information and discuss what would be needed to conserve the ESA-listed species, and to be

consistent with legally enforceable tribal rights and with the Secretary's trust responsibilities to the treaty tribes.

The following discussion evaluates whether the submitted plans address the criteria in section 223.203(b)(5) of the 4(d) Rule for salmon and steelhead.

3.1 Limit 5 Criteria and RMP Evaluation

3.1.1 5(i)(A) The HGMP has clearly stated goals, performance objectives, and performance indicators that indicate the purpose of the program, its intended results, and measurements of its performance in meeting those results.

Goals, performance objectives (standards), and performance indicators for the three EWS hatchery programs are clearly described in sections 1.7, 1.9, and 1.10, respectively of each HGMP (WDFW 2014a; 2014b).

The goals of the programs are: (1) meeting regional non-Indian recreational fisheries objectives, and (2) supporting values associated with Treaty-reserved fishing rights to meet Tulalip tribal commercial, ceremonial, and subsistence needs. The programs would mitigate for losses to fisheries from lost natural-origin fish production by producing hatchery-origin winter steelhead to provide commercial, ceremonial and subsistence fisheries by the Tulalip Tribes, and recreational harvest for Washington state citizens.

The HGMPs were designed to be consistent with salmon recovery, harvest management, and habitat management strategies and actions specified in the watershed recovery plans and the salmon recovery strategies for the Snohomish River basin (SSPS 2005).

As indicated in section 3.0 of each HGMP, the HGMPs would be implemented to comply with: general Washington State harvest goals to provide fishing opportunities consistent with WDFW's mandate for restoration and recovery of natural origin indigenous salmonid runs; the Pacific Salmon Treaty, the Puget Sound Salmon Management Plan, WDFW's Statewide Steelhead Management Plan (WDFW 2008); annual fisheries management plans; the annual equilibrium broodstock documents agreed through *United States v. Washington* (1974), and other state, federal, and international legal obligations.

WDFW's Statewide Steelhead Management Plan (WDFW 2008) sets forth comprehensive approaches for each region, including Puget Sound, for preserving and restoring natural steelhead populations, and minimizing negative effects, including those associated with hatchery programs. Among the measures included in the plan are designation of wild steelhead management zones where no hatchery production of the species would occur, and creation of gene-banking programs where hatchery, harvest and habitat management measures would be implemented to preserve and restore unique steelhead populations and habitats. Specifically, as part of the plan's policies, steelhead hatchery programs would be implemented to: "promote achievement of the plan's natural steelhead production policy and provide fishery-related benefits by implementing artificial

production programs as a component of a comprehensive habitat, hydro, harvest, and hatchery strategy, and by assuring artificial production programs meet the following characteristics:

- Conservation Hatchery Programs. Artificial programs implemented with a conservation objective shall have a net aggregate benefit to the diversity, spatial structure, productivity, and abundance of the target wild stock.
- Harvest Hatchery Programs. Artificial production programs implemented to enhance harvest opportunities shall provide fishery benefits while allowing watershed-specific goals for the diversity, spatial structure, productivity, and abundance of wild stocks to be met (WDFW 2008)."

Program-specific performance standards derived from the Northwest Power and Conservation Council (NPCC) Artificial Production Review (APR) (NPPC 2001), and performance indicators that would be used to gauge compliance with each of the standards, are described in sections 1.9 and 1.10 of each HGMP (WDFW 2014a; 2014b). The standards and indicators included in the HGMPs address the benefits and risks specifically relating to EWS steelhead production in Puget Sound, and in the watersheds where fish from the two programs would be released. Responsive monitoring and evaluation actions that would be implemented to collect information relevant to each indicator are also described in that section. Separate performance standards, indicators, and monitoring and evaluation actions are presented to track achievement of hatchery program performance relative to objectives, and monitor program effects on affected fish populations. Actions included in the HGMPs are designed to determine: program consistency with proposed hatchery actions and intended results (e.g. juvenile fish release and adult return levels); measurement of the program's success or failure in attaining results; and, effects of the program on natural-origin fish populations in the Snohomish River basin.

3.1.2 5(i)(B) The HGMP utilizes the concepts of viable and critical salmonid population thresholds, consistent with the concepts contained in the technical document entitled "Viable Salmonid Populations."

HGMPs proposed for consideration under the 4(d) Rule must use the concepts of viable and critical thresholds as defined in the NMFS Viable Salmonid Population (VSP) document (McElhany et al. 2000). Application of these VSP concepts is needed to assess the take of ESA-listed salmonids and to avoid jeopardizing any ESA-listed ESU or DPS.

The two HGMPs adequately address this criterion. In Section 2 of each HGMP, effects of the hatchery program(s) on ESA-listed salmon and steelhead are evaluated at the major population group (MPG) and DPS scales. The HGMPs establish that in the course of mitigating for losses to tribal and non-tribal fishers, the hatchery programs take ESA-listed salmon and steelhead within the watersheds where they occur. The term "take" means to harass, harm, pursue, hunt, shoot, would, kill, trap, capture, or collect, or to attempt to engage in any such conduct (ESA section 3(C)(18). So that take is verified and adequately limited, such that the hatchery programs do not jeopardize any ESA-listed ESU or DPS, a series of very specific standards and indicators are

included in each HGMP (Table 1.8.1 and Section 1.10, List of "Performance Indicators", designated by "benefits" and "risks").

Compliance with performance standards and monitoring of indicators related to effects of the programs on ESA-listed salmon and steelhead within each basin would gauge achievement of these goals during the on-station operation of the programs and throughout the juvenile emigration and adult return timeframes. See section 3.1.1, 5(i)(D) below, for specific information on the proposed measures and protocols to be implemented to minimize effects on listed natural-origin salmon and steelhead.

The HGMPs also provide information related to the status of ESA-listed salmon and steelhead populations in the Snohomish River basin. The plans describe the viability goals (where developed) for the individual listed populations, as well as the recovery goals for each of the ESUs or DPSs that encompass the affected populations.

Puget Sound ESA-listed anadromous salmonid ESUs and DPSs in the action area:

Puget Sound Chinook (*Oncorhynchus tshawytscha*): Listed as *Threatened* on March 24, 1999 (64 FR 14308); *Threatened* status reaffirmed on June 28, 2005 (70 FR 37160); reaffirmed *Threatened* by the five-year status review report, completed August 15, 2011 (76 FR 50448). The ESU includes all naturally-spawned populations of Chinook salmon from rivers and streams flowing into Puget Sound including the Strait of Juan de Fuca from the Elwha River, eastward, including rivers and streams flowing into Hood Canal, South Sound, North Sound and the Strait of Georgia in Washington State (NWFSC 2015). The Puget Sound Chinook salmon ESU is composed of 31 historically quasi-independent populations, of which 22 are believed to be extant, as well as fish propagated by twenty-seven artificial propagation programs (NMFS 2013 78 FR 38270). The Puget Sound Chinook salmon populations are aggregated into five biogeographic regions based on shared genetic, environmental, and life history characteristics - Strait of Juan de Fuca; Hood Canal; Central/South Sound; Whidbey Basin; and Georgia Strait (Ruckelshaus et al. 2006). Of the 10 independent Chinook salmon populations identified within the Whidbey Basin biogeographic region, the Snohomish River basin action area supports two natural populations - Skykomish and Snoqualmie.

Puget Sound steelhead *(Oncorhynchus mykis*s): Listed as *Threatened* under the ESA on May 11, 2007 (72 FR 26722); reaffirmed *Threatened* by five-year status review report, completed August 15, 2011 (76 FR 50448). The DPS includes all naturally-spawned anadromous winter-run and summer-run *O. mykiss* (steelhead) populations, below natural migration barriers in the river basins of the Strait of Juan de Fuca, Puget Sound, and Hood Canal, Washington. This DPS is bounded to the west by the Elwha River (inclusive) and to the north by the Nooksack River and Dakota Creek (inclusive) (Ford et al. 2011). Puget Sound steelhead natural populations are aggregated into three extant MPGs (major population groupings) - North Cascades, Central and South Sound, and Hood Canal and Strait of Juan de Fuca - containing a total of 32 "Demographically Independent Populations" (DIPs) based on shared genetic, environmental, and life history characteristics (Myers et al. 2015). DIPs can include summer steelhead only, winter

steelhead only, or a combination of summer and winter run timing (i.e., summer/winter). The ESA-listed DPS also includes steelhead from six artificial propagation programs: Green River Natural; White River Winter Steelhead Supplementation; Hood Canal Steelhead Supplementation Off-station Projects in the Dewatto, Skokomish, and Duckabush Rivers; and the Lower Elwha Fish Hatchery Wild Steelhead Recovery program (NMFS 2013 78 FR 38270). Within the portion of the North Cascades MPG encompassed in the action area, there are five steelhead DIPs: Snohomish/Skykomish River Winter-Run Steelhead; Pilchuck River Winter-Run Steelhead; North Fork Skykomish River Summer-Run Steelhead; Snoqualmie River Winter-Run Steelhead; and Tolt River Summer-Run Steelhead.

Below is a summary of the current information relating to viability for each of the ESA-listed salmon and steelhead populations that would be affected by the continued operation of the two EWS hatchery programs. The two EWS HGMPs were designed in consideration of the best available scientific information for viability goals. Goals for the viability of the Snohomish River watershed salmon and steelhead natural populations were established by the state and tribal co-managers and incorporated in planning and guiding the proposed implementation of the watersheds EWS hatchery programs (WDFW 2014a). The viability goals for steelhead will be updated upon the availability of an ESA Recovery Plan for the Puget Sound Steelhead DPS. For the interim period, the viability goals available to us will be used as reference points for monitoring the status of salmon and steelhead natural populations during implementation of the hatchery programs. The goals will also be used as reference points to gauge achievement of program performance and risk reduction objectives specified in the HGMPs, and for determining the need for adjustment of the hatchery actions. General descriptions of how the proposed hatchery programs for EWS would be implemented are provided in Section 3.1.4 and 3.1.5 of this document.

3.1.2.1 Snohomish River Basin Chinook salmon

Section 2.2.2 of each EWS HGMP describes the status of the two ESA-listed Chinook salmon populations present in the action area relative to “critical” and “viable” population thresholds.

The Skykomish and Snoqualmie Chinook salmon natural populations are two of 22 natural populations of Chinook salmon in the region delineated by NMFS as part of the Puget Sound Chinook salmon ESU (Ruckelshaus et al. 2006). The two populations in the Snohomish River basin are grouped with eight other populations within the Whidbey Basin biogeographic region for Puget Sound Chinook salmon ESU recovery planning purposes (SSPS 2005; NMFS 2007). Under NMFS recovery and delisting criteria for the Chinook salmon ESU, two or more natural populations within the biogeographic region need to be recovered to a low extinction risk status for the ESU to be considered recovered and delisted (NMFS 2007). Hatchery-origin Chinook salmon produced through the Wallace River Hatchery and Tulalip Hatchery programs are included with the natural-origin component of the Skykomish Chinook salmon population as part of the ESU (64 FR 14308, March 24, 1999; 70 FR 37160, June 28, 2005; 71 FR 20802, April 14, 2014). Hatchery fish with a level of genetic divergence relative to the local natural population(s)

that is no more than what occurs within the ESU are considered part of the ESU. The Snoqualmie Chinook population has no associated hatchery-origin component.

Both Snohomish River basin natural populations are ocean-type Chinook salmon with juveniles emigrating seaward in March through June. A significant proportion of adult Chinook salmon in each Chinook salmon population in the Snohomish basin, averaging 24% and 22% for the Skykomish and Snoqualmie populations, respectively from 1996-2011(Mike Crewson and Pete Verhey, Tulalip Tribes and WDFW unpublished escapement data 2014), is comprised of a yearling freshwater life history type ("stream type"). Adults return primarily as four year old fish although both populations exhibit a relatively strong age-5 component. For the period 2005 through 2013, age-5 Chinook salmon made up 20- and 17-percent of the natural-origin spawners in the Skykomish and Snoqualmie populations, respectively (Rawson and Crewson 2014).

Adult summer Chinook salmon return to the Skykomish River watershed beginning in May and extending through July (PSIT and WDFW 2010a). The Skykomish River natural population has a late-summer/early-fall spawn timing with Chinook salmon spawning in the Snohomish River mainstem, the mainstem of the Skykomish, Pilchuck, Wallace, and Sultan rivers; Woods, Elwell, Olney, Proctor, and Bridal Veil creeks; and the North and South Forks of the Skykomish River (WDFW spawning ground database). The Snoqualmie River Chinook salmon population is considered a fall-run stock, migrating into the Snohomish River basin from August through October. Spawning occurs later than in the Skykomish (PSIT and WDFW 2010a), generally in the fall months (mid/late-September through early-November) (WDFW spawning ground database). Snoqualmie Chinook salmon spawn in the Snoqualmie River and its larger tributaries, including the Tolt and Raging rivers, and Tokul Creek (PSIT and WDFW 2010a).

For recovery planning purposes, goals for the four viability parameters—abundance, diversity, spatial structure, and productivity—have been developed for each natural Chinook salmon population in Puget Sound, including Skykomish and Snoqualmie (Table 2) (SSPS 2005; WDFW 2014a).

Snohomish River Basin Chinook Salmon Abundance - Abundance of Snohomish River basin Chinook salmon is a fraction of historical levels (SSPS 2005). The historical equilibrium abundance levels for the Skykomish and Snoqualmie natural populations are 39,000 fish and 25,000 fish, respectively (Ruckelshaus et al. 2002). The most recent estimates of escapement and percent hatchery contribution for the Snohomish Basin populations are summarized in Table 3.

The 1997-2014 average escapement of natural-origin Chinook salmon for the Skykomish population is 2,156 fish, or 5.5-percent of the estimated historical abundance for the population. The average natural-origin fish escapement for the same period for the Snoqualmie population is 1,355 fish, which is 5.4- percent of the population's estimated historical abundance. Naturally-produced Chinook salmon comprise a majority of natural spawners, averaging 74.5 percent for the basin in recent years (2006-2014). The 1997-2014 average hatchery-origin fraction of the naturally spawning Skykomish Chinook salmon population is 35.7%, and 18.6% for the Snoqualmie population. The average contribution of hatchery-origin fish to Skykomish River

Table 2. Minimum viability spawning abundance, abundance at equilibrium or replacement, and spawning abundance and productivity at maximum sustainable yield for a recovered state for the Skykomish and Snoqualmie Chinook populations and for the entire Puget Sound Chinook salmon ESU.

Population - Region	**TRT Minimum Viability Abundance** [c]	**Status Under Properly Functioning Conditions (PFC)**			**NMFS Escapement Thresholds**	
		Equilibrium Abundance [d]	Spawners at MSY	Productivity at MSY	Critical [a]	Rebuilding [b]
Skykomish	17,000	39,000	8,700	3.4	1,650	3,500
Snoqualmie	17,000	25,000	5,500	3.6	400	1,250
ESU	261,300	307,500	70,948	3.2	261,300	261,300

Source: (Ford et al. 2011; WDFW 2014a).

[a] Critical natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000).

[b] Rebuilding natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000).

[c] The TRT minimum viability abundance was the equilibrium abundance or 17,000, whichever was less.

[d] Historic equilibrium abundance" is the estimated maximum (upper level) number of naturally spawning Chinook salmon under properly functioning habitat conditions.

Chinook salmon natural spawning in the last nine recent years (2006-2014; 27.8%) has decreased by nearly half from the level 15 years ago (1997-2001 avg. = 49.9%). The hatchery-origin fraction of all the naturally spawning Chinook salmon in the Snoqualmie River has largely remained consistent over the last 17 years. A moderate increase was observed in recent years (20.4 percent from 2005-2014) relative to the 1997-2001 average of 15.6 percent (Tulalip 2012; Tulalip Tribes, unpublished data 2014). This increase can be attributed to lower numbers of natural-origin spawners in recent years; as the actual number of hatchery-origin spawners declined by 5.9 percent for the period 2005-2014 relative to the 1997-2001 period.

Snohomish River Basin Chinook Salmon Productivity - Productivity trends for the Skykomish and Snoqualmie natural populations, as measured by recruit per spawner and spawner to spawner rates, are declining (Table 4). Productivity for the two Chinook salmon populations, as gauged by estimated recruit per spawner levels by brood year, has decreased relative to observed since 1999, when the Puget Sound Chinook salmon ESU was listed. Positive trends in productivity were observed for both populations during the early 2000s, as measured by recruit per spawner rates derived using annual age distributions and annual average age distributions (Table 4). The recent brood year (2000-2006) average recruit per spawner estimates are above the replacement level for the Skykomish and Snoqualmie populations. However, spawner return rates for both populations are well below replacement levels for the most recent brood year for which data are available.

Table 3. Summary of Skykomish and Snoqualmie populations natural escapement, natural-origin escapement, and percent of natural escapement composed of hatchery-origin spawners (pHOS) for return years 1997-2014 (where estimates are available).

Return Year	Skykomish Natural Escapement	Skykomish Natural-Origin Escapement	Skykomish Percent Hatchery-Origin	Snoqualmie Natural Escapement	Snoqualmie Natural-Origin Escapement	Snoqualmie Percent Hatchery-Origin
1997	2,161	1,540	28.7%	1,917	1,796	6.3%
1998	4,415	1,495	66.1%	1,891	1,361	28.0%
1999	3,446	1,401	59.3%	1,345	1,040	22.7%
2000	4,668	1,775	62.0%	1,427	1,248	12.5%
2001	4,577	3,054	33.3%	3,589	3,284	8.5%
2002	4,327	NA	NA	2,896	NA	NA
2003	3,472	NA	NA	1,975	NA	NA
2004	7,614	NA	NA	2,988	NA	NA
2005	3,201	NA	NA	1,279	968	24.3%
2006	5,573	4,642	16.7%	2,615	2,161	17.4%
2007	2,648	1,510	43.0%	1,334	1,174	12.0%
2008	5,813	4,780	17.8%	2,560	2,190	14.5%
2009	1,414	1,146	19.0%	895	649	27.5%
2010	2,511	1,836	26.9%	1,788	1,585	11.3%
2011	1,176	876	25.5%	702	479	31.8%
2012	3,738	2,462	34.1%	1,379	898	34.9%
2013	2,355	1,860	21.0%	889	770	13.4%
2014	3,063	1,654	46.0%	839	698	16.8%
Average	**3,689**	**2,156**	**35.7%**	**1,795**	**1,355**	**18.6%**
1997-2001 pHOS			49.9%			15.6%
2006-2014 pHOS			27.8%			19.5%

Source Tulalip 2012; Mike Crewson and Pete Verhey, Tulalip Tribes and WDFW unpublished escapement data 2016).

Snohomish River Basin Chinook Salmon Diversity - Indices of diversity for the Puget Sound Chinook salmon ESU have not been developed at the population level (Ford et al. 2011). Life history diversity of the Snohomish River basin Chinook salmon natural populations has been reduced by anthropogenic activities over the last century (Haring 2002, citing J. Houghton and M. Chamblin), and is further threatened by on-going development in the watershed. Lost and degraded estuarine habitat has impaired the fry migrant components of the Skykomish and Snoqualmie populations, which need a properly functioning, braided lower river and brackish water environment to grow to a viable smolt size. Fry migrants represent a particularly important component of the life history diversity for both populations. The Chinook salmon populations in the Snohomish River basin have been particularly affected by habitat loss in the estuary. The quantity and quality of salmon rearing habitat available to the two populations in the estuary is a small fraction of pre-development conditions (Snohomish County 2013). Historically, the Snohomish River estuary included a rich complex of tidal channels and productive marshes. Under current conditions, only one-sixth of the historic tidal marsh area downstream of the head

Table 4. Recent productivity estimates for Skykomish and Snoqualmie Chinook salmon populations (source: Rawson and Crewson 2014).

Brood Year (BY)	Skykomish Population Recruits per Natural Spawner (based on observed annual average age distribution)	Skykomish Population Recruits per Natural Spawner (based on observed annual age distribution)	Snoqualmie Population Recruits per Natural Spawner (based on observed annual average age distribution)	Snoqualmie Population Recruits per Natural Spawner (based on observed annual age distribution)
1995	0.79	0.54	3.09	2.09
1996	0.67	0.63	2.02	2.06
1997	1.71	2.33	1.59	2.24
Missing Data				
2000	1.76	2.09	2.49	2.80
2001	1.39	0.83	0.67	0.42
2002	1.57	1.38	1.04	1.27
2003	1.29	0.70	1.16	0.66
2004	0.81	1.11	0.93	1.17
2005	0.79	0.94	1.11	1.32
2006	0.41	0.28	0.61	0.53
1995-1997 Average	**1.05**	**1.17**	**2.23**	**2.13**
2000-2006 Average	**1.15**	**1.05**	**1.14**	**1.17**

of Ebey Slough remains intact and accessible to salmonids (Snohomish County 2013). The current lack of critical estuarine tidal marsh habitat is considered a limiting factor for Chinook salmon recovery (SBSRP 2005). These conditions compromise prospects for restoration of Chinook salmon natural population viability, because ocean-type Chinook salmon stocks are extremely dependent on a properly functioning estuary due to their predominantly fry migrant life history.

Snohomish River Basin Chinook Salmon Spatial Structure - Indices of spatial structure have not been developed at the population level (Ford et al. 2011). The spatial structure for the Skykomish and Snoqualmie river natural populations has been adversely affected by habitat loss and degradation. Bank protection and diking of the river and major tributaries have disconnected the river channels from their floodplains, leading to loss of accessible river areas and habitat complexity for rearing and migrating Chinook salmon (Snohomish Basin Salmonid Recovery Technical Committee [SBSRTC] 1999). Lack of adequate in-channel large woody debris relative to historic conditions has decreased the amount of rearing and refuge areas for juvenile Chinook salmon (SBSRTC 1999). Chinook salmon habitat has been further reduced by loss of wetlands through draining and land conversion for human use (SBSRTC 1999). Road construction,

commercial and residential construction, and bank hardening for flood control have also impaired Chinook salmon habitat use and access and population spatial structure. Artificial barriers scattered through the Basin, including dams, tide gates, water diversions, culverts, and pumping stations) prevent juvenile Chinook from reaching rearing habitat to the further detriment of population spatial structure (SBSRF 2005). Since the 1950s, the spawning distribution of the Skykomish River Chinook salmon population appears to have shifted upstream. Since that time, a much larger proportion of fish spawn higher in the drainage, between Sultan and the North and South Forks of the Skykomish River, than in previous decades (SBSRTC 1999).

3.1.2.2 Snohomish River Basin Steelhead

Section 2.2.2 of each EWS HGMP describes the status (if known) of the ESA-listed steelhead natural populations present in the action area relative to "critical" and "viable" population thresholds.

Puget Sound steelhead population viability goals and criteria, where available (e.g., Myers et al. 2015; Hard et al. 2015), were incorporated by WDFW and the Tulalip Tribes in planning and guiding the proposed implementation of the EWS hatchery programs (WDFW 2014a; 2014b). The viability goals are used as reference points for identifying the status of ESA-listed steelhead natural populations during implementation of the hatchery programs. The goals would be used as reference points to gauge achievement of program performance and risk reduction objectives specified in the HGMPs, and for determining the need for adjustment of the hatchery actions. General descriptions of how the EWS hatchery programs would be implemented are provided in Sections 3.1.4 and 3.1.5 of this document.

The Snohomish River basin includes five steelhead DIPs: Snohomish/Skykomish River winter-run; Pilchuck River winter-run; Snoqualmie River winter-run; Tolt River summer-run; and North Fork Skykomish River summer-run (Myers et al. 2015). The DPS viability criteria developed by NMFS (Hard et al. 2015), require that at least 40 percent of the steelhead natural populations within each MPG achieve viability (restored to a low extinction risk), as well as at least 40 percent of each major life history type (e.g., summer-run and winter-run) historically present within each MPG achieve viability. There are no hatchery-origin steelhead produced in basin hatcheries that are included as part of the listed DPS (71 FR 20802, April 14, 2014). The TRT-derived interim DIP natural-origin fish abundance goals for viable populations for the three winter-run populations are 10,695 for the Snohomish/Skykomish River population, 2,597 for the Pilchuck River winter-run population; and 8,370 for the Snoqualmie River winter-run. The TRT viable abundance goals for the two summer populations are 250 fish for the Tolt River population and 331 fish for the North Fork Skykomish River population (Table 5).

Winter-run steelhead in the Snohomish River basin enter freshwater as adults between mid-October and May (PSIT and WDFW 2010b; Myers et al. 2015). Spawning occurs from mid-March through mid-June, with peak spawning in April. Most winter-run steelhead return to spawn as four year-old (57%), and five year-old fish (42%) (Myers et al. 2015 citing WDFW and WWTIT 1994). Juvenile out-migrant trapping data indicate that natural-origin Snohomish River

Table 5. Interim DIP abundance goals for natural populations of steelhead in Puget Sound, based on a four-year average. Abundance goals for summer-run fish *(italics*) are still under review. QET, quasi extinction threshold; SAS, smolt to adult survival. Minimum abundance = 100 (Low Abundance), 250 (Viable).

Population Basin				**Quasi Extinction Threshold**	**Low Abundance**	**Viable**	**Capacity**
Population	**Area Km^2**	**Mean Elevation (m)**	**Total Stream Length (m)**		**1% SAS**	**5% SAS**	**20% SAS**
Snohomish/ Skykomish River	1,595	420	1,021,690	73	2,139	10,695	42,779
Pilchuck River	356	253	242,383	34	519	2,597	10,386
Snoqualmie River	1,615	620	1,134,038	58	1,674	8,370	33,479
Tolt River	182	784	117,732	*25*	*100 (32)*	*250*	*1,325*
NF Skykomish River	156	1,195	117,602	*25*	*100 (66)*	*331*	*641*
Puget DPS Total				1,462	30,449	153,194	613,662

Source: Hard et al. 2015 (as cited in WDFW 2014b).

basin steelhead juveniles emigrate seaward in April and May as smolts predominantly as two-year old fish (84%) (Myers et al. 2015 citing WDFW and WWTIT 1994). Three year old smolts are a lesser seaward emigration component for the species (15% of the total smolt production).

Adult summer steelhead return to the watershed between late-May and mid-October (PSIT and WDFW 2010b; Myers et al. 2015), and predominately as four year olds. Myers et al. (2015) (this and following) reported that summer-run steelhead in the Tolt River spawn from January through May, with two peak spawning periods; one in February and the other in mid-April. Non-native stock (Skamania) hatchery-origin, summer-run steelhead produced by WDFW's Reiter Ponds program spawn from late -December through April. The spawn timing of Skamania lineage hatchery stock is believed to overlap with naturally-spawning native summer-run steelhead in the region, but the overlap may be diminished because of current broodstock collection procedures that have retained the earliest returning fish for spawning. However, recent genetic analyses conducted by WDFW indicate that introgression by Skamania-linage steelhead is substantial in at least two putative steelhead populations in the watershed (K. Warheit, WDFW, pers. comm., February, 2014). Summer-run steelhead are thought to exhibit the same predominantly 2-year smolt emigration life history strategy as natural-origin winter-run steelhead.

Snohomish Steelhead Abundance -
Available data since 2000 indicate that steelhead natural-origin fish abundance in the basin is stable at low levels for three natural populations, declining for one (Snoqualmie/Skykomish River), and largely unknown for another (North Fork Skykomish River) (Table 6). All populations are well below abundance levels that the watershed could support, assuming properly functioning habitat conditions. Intrinsic potential (IP) production estimates based on basin size indicate the Snohomish River basin could support a total winter-run steelhead abundance for the three DIPs of approximately 43,322 fish (assumes a 10% SAS; Myers et al. 2015). Myers et al. (2015) estimated IP-based adult productivity capacity ranges from 21,389 to 42,779 adults for the Snohomish/Skykomish River winter-run steelhead DIP; 5,193 to 10,386 adults for the Pilchuck River DIP; and 16,740 to 33,479 adults for the Snoqualmie River DIP (Table 6). By comparison, the recent year (2000-2015) combined geometric mean escapement for the three winter-run populations in the Snohomish River basin is 3,066 natural-origin fish (WDFW escapement database), or 7.1% of the combined IP production capacity for the basin. Winter-run steelhead escapements have declined significantly since the mid-1990s (Scott and Gill 2008a; 2008b; Ford 2011; Hard et al. 2015). The TRT-derived interim DIP abundance goals for viable populations for the three winter-run populations are 10,695 natural-origin fish for the Snohomish/Skykomish River population, 2,597 for the Pilchuck River winter-run population; and 8,370 for the Snoqualmie River winter-run (Hard et al. 2015). The co-managers' upper management threshold for winter-run steelhead, reflecting the estimated escapement level that would optimally utilize available spawning and rearing habitat based on recent productivity and habitat conditions, is 6,500 fish (or 15% of the combined low- IP production capacity for the basin).

Snohomish Steelhead Productivity - The 5-year geometric mean abundance for the Snohomish/Skykomish natural population was 3,084 natural-spawners from 2005 through 2009 and only 930 from 2010 through 2014 (see Table 7; indicating an overall decline of -70% (from Table 59 *in* NWFSC 2015). Hard et al. (2015) estimated that the probability that the population would decline to a QET of 73 steelhead was low (about 40% within 100 years) based on a mean population growth rate of -0.005 (λ=0.995). The 5-year geometric mean abundance for the Pilchuck population was 597 natural-origin spawners from 2005 through 2009 and 614 from 2010 through 2014; indicating an overall increase of +3% (from Table 59 *in* NWFSC 2015). Hard et al. (2015) estimated that the probability that the population would decline to a QET of 34 steelhead was low (about 40% within 100 years) based on a mean population growth rate of -0.006 (λ=0.994). The 5-year geometric mean abundance for the Snoqualmie population was 1,249 natural-spawners from 2005 through 2009 and only 680 from 2010 through 2014; indicating an overall decline of -46% (from Table 59 *in* NWFSC 2015). Hard et al. (2015) estimated that the probability that the population would decline to a QET of 73 steelhead was high (nearly 70% within 100 years) based on a mean population growth rate of -0.027 (λ=0.973)

The combined intrinsic potential for the two summer-run steelhead DIPs in the basin is 984 fish (assumes a 10% SAS; Myers et al. 2015). The IP capacity ranges for each summer-run steelhead DIP are 321 to 641 adults in the Tolt River DIP and 663 to 1,325 adults in the North Fork Skykomish River (Myers et al. 2015). For Tolt River summer-run steelhead (the only summer-run population in the basin for which redd count data are available), escapements have declined

Table 6. Snohomish River basin natural-origin steelhead annual escapement estimates for three winter-run DIPS and two summer-run DIPs.

Year	Winter Steelhead			Summer Steelhead	
	Snoqualmie River	Pilchuck River	Snohomish/ Skykomish River	Tolt River	N.F. Skykomish
	674	590	1,588	185	
2001	1,395	462	1,265	167	NA
2002	789	279	1,166	115	NA
2003	988	696	1,915	198	NA
2004	1,510	1,518	3,116	42	NA
2005	1,060	604	2,746	68	NA
2006	1,832	580	2,854	112	NA
2007	964	976	NA	50	NA
2008	404	646	NA	52	NA
2009	428	342	NA	86	NA
2010	662	294	732	116	82
2011	664	552	1,150	68	14
2012	792	848	876	122	22
2013	614	1,036	1,008	126	NA
2014	**822**	**676**	**1,188**	**124**	**NA**
2015	**966**	**1,008**	**940**	**53**	**72**
Average	**910**	**694**	**1,578**	**105**	**NA**

Source: Mike Crewson and Pete Verhey, Tulalip Tribes and WDFW unpublished escapement data 2015. 2015 data are preliminary estimates.

since the late 1990s. The recent year (2000-2015) average Tolt River summer-run steelhead escapement is 105 fish (WDFW Score Database). The TRT viable abundance goals for the two summer populations are 250 fish for the Tolt River population and 331 fish for the North Fork Skykomish River population (Hard et al. 2015). The 5-year geometric mean abundance for the Tolt population was 73 natural-origin spawners from 2005 through 2009 and 105 from 2010 through 2014; indicating an overall increase of +44% (from Table 59 *in* NWFSC 2015). Hard et al. (2015) estimated that the probability that the population would decline to a QET of 25 steelhead was high (about 80% within 100 years) based on a mean population growth rate of -0.013 (λ=0.987)

Snohomish Steelhead Diversity - Data are not available to evaluate changes in the diversity of steelhead in the Snohomish River basin. However, it is likely that the degradation and loss of habitat in the watershed and past harvest practices have disproportionately affected the earliest returning fish, and thus, reduced the diversity of the natural populations relative to historical levels. It is also likely that genetic diversity for the native winter-run populations has been adversely affected by releases of non-native Chambers Creek steelhead from basin hatcheries, in watershed areas where spawn timings for natural and hatchery-origin fish have over-lapped.

Table 7. Naturally spawning steelhead (natural-origin and hatchery-origin steelhead combined) abundances and trends for DIPs within the North Cascades MPG for which information is available. Populations within the action area are bolded. Note WR=winter-run, SUR=summer run, and SWR=summer/winter run population.

Population (Run Timing)	2005-2009 Geometric Mean Escapement (Spawners)[1]	2010-2014 Geometric Mean Escapement (Spawners)[1]	Percent Change[1]
Nooksack R WR	**NA**	**1,834**	**NA**
Pilchuck R WR	597	614	3%
Samish R WR	534	846	58%
Skagit R SWR[2]	4,767	5,123	7%
Snohomish/Skykomish WR	3,084[3]	930	-70%
Snoqualmie R. WR	1,249	680	-46%
Stillaguamish R. WR[4]	327	392	20%
Tolt River SUR	73	105	44%

1 Source: NWFSC 2015
2 Skagit data includes four DIPs: Skagit, Nookachamps, Baker, and Sauk.
3 Does not include return years 2007-2009 which were among the lowest abundance for Snohomish Basin populations.
4 Only includes the estimated number of naturally spawning steelhead in the North Fork Stillaguamish River index segments.

Although not part of the EWS hatchery programs under review, continued releases of Skamania lineage summer steelhead through a past and on-going program at WDFW's Reiter Ponds facility has led to interbreeding with native steelhead populations in the Snohomish River basin. There is also evidence of hatchery EWS interbreeding at low levels with natural fish from the three winter-run populations in the basin (Warheit 2014).

Snohomish Steelhead Spatial Structure - Human developmental activities in the Snohomish River basin have adversely affected steelhead population spatial structure. Scott and Gill (2008) reported that the current distribution of winter-run steelhead in the basin over 432 miles is reduced from the pre-development maximum distribution of 562. Similarly, the distribution of summer-run steelhead had been reduced from an historic maximum distribution of 570 miles to a current distribution of 431 miles.

Because the two HGMPs, considered here as an RMP, apply VSP criteria that are incorporated as standards and indicators for program effects, and into the monitoring objectives, the actions are consistent with this 4(d) rule criterion.

3.1.3 5(i)(C) Taking into account health, abundances, and trends in the donor population, broodstock collection programs reflect appropriate priorities.

Broodstock collection actions proposed for the Snoqualmie/Skykomish and Tokul Creek Hatchery EWS programs reflect appropriate priorities to safeguard ESA-listed fish populations.

No natural-origin ESA-listed fish are collected as broodstock for spawning and propagation. All broodstock collected each year for spawning would be EWS, produced by the WDFW hatcheries and localized to the individual hatchery release sites. EWS in the Snohomish River basin are not listed under the ESA and are not part of the Puget Sound steelhead DPS.

The HGMPs describe measures that would be applied to safeguard the health and abundance of ESA-listed Chinook salmon and steelhead in the Snohomish River and its tributaries that may be affected incidentally by broodstock collection activities associated with the proposed hatchery actions.

3.1.4 5(i)(D) The HGMP includes protocols to address fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management.

The HGMPs for the two EWS programs include detailed descriptions of protocols and operational elements related to this criterion. This criterion is primarily focused on the adequacy of HGMPs for programs that rear ESA-listed fish, and the need to operate such programs in a manner that adequately safeguards listed fish while under propagation. The proposed isolated hatchery EWS programs do not include spawning, rearing, or acclimation and release of ESA-listed steelhead. Additionally, because EWS are not part of the listed Puget Sound steelhead DPS, the catastrophic risk management component of this criterion, which is focused on the risk to ESA-listed fish while under propagation, is not included in the HGMPs. "Best management practice" (BMP) measures applied to safeguard non-listed EWS under propagation are included in the HGMPs. Below are the EWS hatchery effects elements identified in this criterion that are germane to listed Chinook salmon and steelhead populations, and for which the proposed HGMPs therefore identify protocols or BMPs designed to address potential incidental effects. These elements are: fish health, broodstock collection, release of juveniles, and deposition of hatchery adults.

Fish Health

BMPs addressing fish health, including fish health maintenance and hatchery sanitation procedures applied during broodstock collection, mating, fish incubation, rearing, and release, are detailed in the performance standard and indicator, adult management, and fish rearing and release sections of each HGMP. Fish health monitoring and evaluation measures are also described in those HGMP sections.

The Snohomish River basin EWS hatchery programs would be operated in compliance with "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" protocols (WDFW and NWIFC 1998). The co-manager policy delineates Fish Health Management Zones and defines inter and intra-zone transfer policies and guidelines for eggs and fish that are designed to limit the spread of fish disease pathogens between and within watersheds (WDFW and NWIFC 1998). The programs would also comply with standard fish health diagnosis, maintenance and hatchery sanitation practices referenced in the policy (as per Pacific Northwest Fish Health Protection Committee (PNFHPC) (1989) and AFS (1994) guidelines) to reduce the

risks of fish disease pathogen amplification and transfer within the hatchery and to fish in the natural environment. Fish health specialists and pathologists from the WDFW Fish Health Section would provide fish health management support and diagnostic fish health services for EWS propagated through the two HGMPs (WDFW 2014a; 2014b).

BMPs for monitoring the health of fish in hatcheries specified in the co-managers' fish health policy (WDFW and NWIFC 1998) help reduce the likelihood of fish disease pathogen amplification and transmission from hatchery salmonids to naturally produced fish. When implemented, these BMPs would help contain any fish disease outbreaks in the hatcheries, minimizing the risk that diseased fish would be released from the hatcheries, reducing the risks of fish disease pathogen transfer and amplification to natural-origin fish (NMFS 2012).

Broodstock Collection

Sections 6 and 7 of the HGMPs describe BMPs for broodstock selection and collection, carrying forth steelhead production goals and objectives for the hatchery programs, and addressing adult fish capture, transport, holding, and handling practices.

Steelhead collected for use as hatchery broodstock are adult early winter-run, hatchery-origin fish returning to Wallace River Hatchery, Reiter Ponds Hatchery, and Tokul Creek Hatchery. None of the adult fish collected for use as broodstock are part of the Puget Sound Steelhead DPS. All EWS collected for broodstock are from the extant, non-listed, early winter hatchery steelhead stock propagated at each hatchery facility. The proposed WDFW hatchery programs function to produce EWS adults for harvest in tribal and recreational fisheries. All broodstock voluntarily enter hatchery traps during December through January, with peak EWS entry and spawning in January. The traps used to collect broodstock are operated until April 15 as a measure to ensure that any later-returning EWS adults are captured and removed from basin waters.

Due to their earlier (July through September) return and spawn timing, Chinook salmon adults are not typically present when EWS trapping occurs at the hatcheries, and incidental captures are therefore unlikely. Natural winter-run steelhead populations in the Snohomish River watershed enter freshwater as adults between mid-October and May (Myers et al. 2015). The peak spawn timing for natural origin winter steelhead is from late-April through early May (Hoffmann 2014). Adult summer steelhead return to the watershed between late-May and mid-October (Myers et al. 2015), and predominately as four year olds. Myers et al. (2015) reported that summer-run steelhead in the Tolt River spawn from January through May, with two peak spawning periods; one in February and the other in mid-April. Due to the low level of return and spawn timing overlap between EWS and natural winter-run and summer-run steelhead, the potential exists for natural steelhead to be encountered in the traps used to collect broodstock at Wallace River Hatchery and Tokul Creek Hatchery. The trapping facility at Reiter Ponds is positioned on the hatchery outlet to the Skykomish River, with little or no incentive for natural-origin fish to voluntarily enter the trap (WDFW 2004a). Austin and Hogarty Creeks, which supply surface water for the Reiter Ponds program, are not used by natural steelhead, and incidental encounters during broodstock collection at the site are unlikely.

The Wallace River Hatchery EWS broodstock collection facilities are located on May Creek and Wallace River (WDFW 2014a). No natural origin steelhead have been observed during EWS broodstock collection at Wallace River Hatchery over the past 12 years (WDFW 2014a). The Tokul Creek Hatchery trap is located at the hatchery outlet, which coupled with the hatchery location on a small tributary stream, provides minimal attraction for natural-origin steelhead, with little incentive to enter the Tokul Creek Trap. (WDFW 2014b). No natural origin steelhead have been observed in the hatchery trap for the last 12 years (WDFW 2014b). Any natural origin steelhead or bull trout encountered during the EWS broodstock collection period at the two hatcheries would be immediately released unharmed back into the natural environment (WDFW 2014b).

For the above reasons, although stray natural-origin steelhead adults may be incidentally trapped during the EWS broodstock collection period, encounters with ESA-listed Puget Sound steelhead at the broodstock collection locations are unsubstantial, and measures are applied to minimize effects of any natural steelhead encountered.

Release of Juveniles

BMPs for hatchery EWS rearing and release are described in sections 9 and 10 of the HGMPs. Rearing and release practices proposed for implementation would help ensure that juvenile fish produced by the two programs are released as healthy seawater-ready smolts that emigrate downstream rapidly after release, leading to minimal interactions with any co-occurring natural-origin fish, and high hatchery smolt to adult return survival rates.

Effects of ecological interactions between newly released EWS and natural-origin salmon and steelhead in the action area are described in Section 2.0 of the HGMPs. Reducing adverse ecological effects on natural-origin salmon and steelhead from the release of juvenile EWS is an important objective, as indicated in the justification statements for both plans (Section 1.8). Post-release interactions of concern include competition between hatchery-origin EWS and natural-origin salmon and steelhead for food and space, and EWS smolt predation on natural-origin fish. Section 10.11 of the HGMPs describes the specific BMPs proposed to minimize the effects of EWS smolt competition and predation in Snohomish River basin freshwater areas downstream of the hatchery release sites and in the estuary. These BMPs also are designed to promote high juvenile hatchery fish to adult return survival rates consistent with meeting harvest augmentation objectives for the proposed programs. These measures are: 1) reductions in the number of hatchery fish that would be released at each hatchery location relative to recent past levels; 2) elimination of off-station smolt releases to reduce the number of areas that may be affected by hatchery EWS smolt interactions with natural juveniles; 3) elimination of fry and sub-yearling releases, and mandatory rearing and release of only yearling smolts in migratory condition, promoting rapid out-migration that minimizes the time spent in the river, thereby minimizing or eliminating interactions with rearing and migrating natural-origin salmonids; 4) use of volitional release practices to foster rapid seaward migration and limit residualism and freshwater interactions with ESA-listed Chinook salmon and steelhead juveniles, bull trout and other naturally-produced salmonids; 5) mass-marking all EWS smolt release groups to allow

monitoring of hatchery and natural fish interactions and selective removal of EWS upon return as adults; 6) release of steelhead smolts no earlier than April 15th, to allow listed juvenile Chinook salmon and steelhead to emigrate out of the system, and/or provide time for additional natural-origin fish growth to reduce the risk of EWS smolt predation; and, 7) continuation of monitoring, research and reporting of EWS smolt migration performance behavior, and interactions with natural origin fish to assess and adjust, if necessary, hatchery production and release strategies to further minimize effects on natural origin fish.

Adult Management and the Disposition of Hatchery Adults

Protocols for the disposition of adult hatchery EWS are described in section 7.5 of the HGMPs. Weirs and traps at the hatcheries would remain open for the entire EWS adult migration and spawning period (November through March). This measure would be implemented to maximize removal of EWS, and thus minimize the number of hatchery-origin fish that escape to spawn naturally. Fish collected above broodstock needs (surplus) would be removed from the system (culled), and there would no longer be any recycling of adult EWS trapped at the hatcheries back into the natural environment. Recycling of escaping EWS from the hatcheries that were surplus to broodstock collection needs back into the rivers was applied in the past to make the fish available for harvest in recreational fisheries. If available, food-grade surplus fish may be donated to charitable organizations and local tribes for ceremonial and subsistence purposes. Non-food-grade carcasses would be distributed in local streams for nutrient enhancement purposes, if approved by WDFW Fish Health Program staff.

3.1.5 5(i)(E) The HGMP evaluates, minimizes, and accounts for the propagation programs' genetic and ecological effects on natural populations, including disease transfer, competition, predation, and genetic introgression caused by straying of hatchery fish.

The two Snohomish River basin EWS HGMPs provide thorough evaluations, based on best available scientific information, of genetic and ecological effects on listed steelhead and Chinook salmon in section 2.0. Additionally, each HGMP includes risk minimization measures that would be applied for each specific program action (in Sections 6-10) to reduce the likelihood for substantial adverse effects on listed fish species from disease transfer, competition, predation, and interbreeding. Following is a summary of the likely Snohomish River basin EWS hatchery program genetic and ecological effects on listed natural fish populations evaluated and accounted for in the plans, as well as risk minimization measures proposed in the HGMPs to address any effects.

Genetic Effects

Steelhead do not interbreed with Chinook salmon so there would be no genetic effects on ESA-listed Chinook salmon populations in the Snohomish River basin associated with EWS HGMP implementation. However, adult EWS returning to the hatchery release sites in the Skykomish and Snoqualmie river watersheds, unless harvested or removed by some other means, are likely to

spawn naturally with natural steelhead populations in the Snohomish River, and thus affect, genetically, the next generation of natural-origin fish. The magnitude of any effects would be dependent on the level of gene flow between hatchery and natural-origin fish, and on the risk level given the affected natural population's viability status, in particular diversity, productivity, and abundance. Genetic effects to natural steelhead populations that may result from implementation of the Wallace/Reiter and Tokul Creek Hatchery EWS HGMPs are: loss of within-population diversity, outbreeding effects, and hatchery-influenced selection ("domestication") (NMFS 2012).

The subject HGMPs use best available scientific information to identify and propose a suite of practices that are expected to result in low genetic effects. Information that is particularly crucial to an analysis of genetic effects is the fact pattern and circumstances that are unique to each HGMP including the geology, hydrology, and the quality and quantity of habitat for fish and the VSP status or condition of each natural population likely to be affected by the HGMP. Other examples are the location and operational considerations unique to every hatchery facility and the behavior of the fish themselves. To the extent this information is available, it is included in the HGMPs.

Loss of Within-Population Diversity

Loss of within-population genetic diversity (variability) is defined as the reduction in quantity, variety and combinations of alleles in a population (Busack and Currens 1995). Quantity is defined as the proportion of an allele in the population and variety is the number of different kinds of alleles in the population. Genetic diversity within a population can change from random genetic drift and from inbreeding. Random genetic drift occurs because the progeny of one generation represents a sample of the quantity and variety of alleles in the parent population. Since the next generation is not an exact copy of the parent generation, rare alleles can be lost, especially in small populations where a rare allele is less likely to be represented in the next generation (Busack and Currens 1995).

The hatchery programs under consideration produce steelhead that are not included as part of the ESA-listed Puget Sound steelhead DPS (Jones 2011). Adult fish produced are not intended to spawn naturally, however some still do, nor are they suitable to contribute to the viability of any Puget Sound steelhead population as part of an integrated recovery effort. Only EWS adults produced by the programs (identified by early return timing and early spawn timing, and presence of an adipose fin clip mark) will be used as broodstock, and no natural-origin steelhead will be collected and spawned.

Risk to the within-population diversity of natural steelhead populations is much more of a concern in integrated programs than in isolated programs such as those in the Proposed Action. However, within-population diversity of the natural steelhead populations may be affected by hatchery-origin fish from the proposed programs spawning with natural-origin steelhead. Within-

population diversity is influenced strongly by the effective size of the population[2]. Population effective size could either increase or decrease from hatchery-origin fish spawning in the wild, depending on the effective number of breeders that produced the hatchery-origin and natural-origin fish, the relative spawning success of the hatchery-origin and natural-origin fish, and the background level of diversity in the natural-origin and hatchery-origin fish. Effective size changes are generally a concern only when the relative abundance of hatchery-origin fish on the spawning grounds far exceeds that of natural-origin fish, which is not expected to be the case for the programs described in the HGMPs under review. As with the genetic risk of outbreeding depression and hatchery-influenced selection (described below), risks posed to within-population diversity of natural populations of steelhead are further mitigated through measures that reduce the number of naturally spawning hatchery-origin fish, in general, and in particularly those fish that would overlap spatially and temporally with natural-origin spawners (See *Risk Minimization of Genetic Effects* below).

Outbreeding Effects and Hatchery-Influenced Selection

Gene flow from EWS hatchery fish could impact natural steelhead populations through outbreeding effects and hatchery-influenced selection. Although the relative contribution of the two types of effects cannot be cleanly determined, the potential effect is the same reduction in fitness of natural populations. The measures applied to reduce both types of risk are also the same, all aimed at minimizing gene flow opportunities.

Outbreeding effects are a concern whenever the hatchery-origin and natural-origin fish are from different populations. This is particularly true with the proposed EWS and the natural steelhead populations in the basins of operation. EWS 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 many years of purposeful and 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).

Hatchery-influenced selection (commonly called “domestication”) results in fitness loss and phenotypic change caused by differences between the hatchery and natural environments (includes intentional selection and relaxation of selection), and sampling “errors” during fish culture (includes advertent or inadvertent selection of traits for fish under propagation). Hatchery-induced selection may lead to changes in quantity, variety, and the combination of alleles between a hatchery population and its source population that are the result of selection in the hatchery environment (Busack and Currens 1995). This hazard is also defined as the selection for traits that favor survival in a hatchery environment and that reduce survival in natural environments NMFS (2012). The concern is that hatchery-induced selection effects will decrease the performance of hatchery fish and their descendants when exposed to natural selection conditions in the wild.

[2] Effective population size is the size of a breeding population adjusted for variation in sex ratio and reproductive success to reflect the rate at which genetic diversity is lost. The maximum genetic diversity which can be maintained by a population is determined by its effective population size as is the rate at which genetic diversity is lost by chance due to random fluctuations in allele frequencies known as genetic drift.

For both effects, risks to natural-origin steelhead populations are controlled by measures that reduce the number of naturally spawning hatchery-origin fish, in general, and, in particular, reduction in the number of those fish that would overlap spatially and temporally with natural-origin spawners. Genetic effect analyses included with the HGMPs, and cited in the body of the plans, indicate that adult EWS produced by the programs, as previously implemented, have contributed and are expected to contribute very few fish to the associated naturally spawning populations in the watersheds where the fish are released (Hoffmann 2014; Warheit 2014). Specifically, for the two proposed programs, the analysis of genetic data indicate that gene flow from EWS to native steelhead populations should be under 2% in all the natural-origin steelhead populations affected by the programs and this is supported by gene flow projections based on demographic parameters. Cumulatively, in compliance with this criterion, findings presented in the HGMPs and accompanying analyses (Hoffmann 2014; Warheit 2014) indicate the proposed EWS programs would not pose substantial hatchery influenced selection and fitness loss effects through gene flow to listed Snohomish River basin steelhead populations to the extent that effects would impair the survival of these populations, or progress towards their recovery for achieving Puget Sound steelhead DPS viability goals (NMFS 2016).

Measures Applied to Minimize Potential Genetic Effects

The HGMPs address genetic effects posed by the continued operation of these programs in Sections 1.10.2, 2.2.3, 6.3, 7.9, and 11.1.1. The plans propose a series of important operational actions to reduce the number of unharvested adult EWS escaping to stray into natural spawning areas and interacting reproductively with natural-origin ESA-listed steelhead in the Snohomish River basin. These actions include:

- A greater than 40% reduction in on-station smolt releases at Tokul Creek Hatchery relative to the recent average level (from 185,000 to 74,000 fish) to reduce the number of adults produced, and associated gene flow risks, to natural-origin steelhead in the Snoqualmie River watershed.
- Cessation of off-station smolt releases, reducing the number of smolt release locations from three to one in the Snoqualmie River watershed, and from five to two in the Skykomish River watershed. These reductions promote homing fidelity to the hatchery rearing sites, where returning adult fish can be removed, reducing the potential for EWS straying to natural steelhead spawning areas.
- Elimination of EWS adult recycling, with removal of all adult fish recruiting to the hatcheries required to prevent straying that potentially resulted from this past practice of returning adult fish to the rivers to increase recreational fishing opportunities.
- Collection of all eggs to sustain each program from broodstock returning to each of the individual hatchery facilities to promote fidelity of adult fish homing to the hatchery location where the fish were propagated.
- Collection of all eggs to sustain each program from hatchery-origin, marked EWS returning to the facilities prior to January 31st, of each year, to promote and maintain temporal separation in the spawn-timing between hatchery EWS and natural origin fish.

- Maintenance of all hatchery traps in open, operating condition through mid-April each year to provide opportunity for all adult hatchery fish to return to the hatchery for removal, thereby reducing the potential number of unharvested, returning EWS remaining in the rivers that may stray to natural steelhead spawning areas.

The HGMPs also describe proposed protocols for minimizing the number and rate of program smolts released that fail to emigrate from the system. These protocols are designed to reduce the risk that the newly released hatchery fish do not emigrate seaward, but instead "residualize" in the rivers. Hatchery steelhead that residualize can compete with and prey on natural-origin steelhead (addressed below, Ecological Effects), but can interbreed with natural listed populations of steelhead if the hatchery fish later mature to spawn as jacks in freshwater. The BMPs described in the Competition and Predation sections below are applied to reduce these affects.

Measuring and Monitoring for Genetic Effects

The HGMPs include monitoring and evaluation actions that would be implemented to account for and monitor genetic effects resulting from the proposed hatchery steelhead programs. Through these actions, the level of gene flow from hatchery EWS into the natural steelhead populations in the Skykomish and Snoqualmie River watersheds would be verified. WDFW would estimate and report gene flow as "proportionate effective hatchery contribution" or PEHC. WDFW has proposed to manage the proposed steelhead programs for isolated harvest purposes, and thereby seek to minimize PEHC to not exceed 2% in each watershed. They propose several methods (Hoffmann 2014; Warheit 2014) to estimate annual gene flow rates, and validate whether gene flow remains under 2%. Collection of data necessary to derive gene flow rates will be accomplished through a significant annual sampling effort to obtain thorough and representative tissue samples for DNA analyses from either juvenile or adult natural-origin steelhead in each of the basins (Anderson et al. 2014a).

Ecological Effects

Best available scientific information for ecological effects generally associated with hatchery programs has been taken into account and the HGMPs include BMPs specific to these EWS hatchery programs to limit affects to ESA-listed species (section 2.0 in WDFW 2014a; 2014b). Based on available information, ecological effects that may be of concern associated with implementation of the two steelhead HGMPs are fish disease pathogen transfer, resource competition, and predation.

Disease

The HGMPs address general threats from disease transfer in section 2.0 of each plan. Fish disease transfer and amplification risk reduction measures are more specifically addressed for broodstock selection and collection actions in sections 6.0 and 7.0; incubation and rearing actions in section 9; and for fish release actions in section 10.0. Within these sections, the plans describe fish disease pathogen issues of concern and actions that would be implemented to minimize risks of fish disease pathogen transfer and amplification. As noted in the plans, all hatchery actions would

be implemented in accordance with the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State (WDFW and NWIFC 1998). Protocols described in the policy and applied through the programs would reduce risks of fish disease to propagated and natural fish populations through regular fish health monitoring and reporting, and application of BMPs to reduce fish health risks. The health of steelhead under propagation would be monitored and managed consistent with fish health policy practices. Under the fish health plan, professional fish pathologists from the WDFW Fish Health Section would visit the hatchery rearing locations monthly, or as needed to perform routine monitoring of adult and juvenile fish, advise hatchery staff on disease findings, and recommend disease treatments when appropriate. All fish monitored for fish health assessment purposes would be sampled consistent with the co-manager policy and procedures referenced in the policy, to minimize the proportion of the total rearing population exposed to handling and non-lethal and lethal sampling. In addition, all WDFW hatchery personnel are trained in standard fish propagation and fish health maintenance methods to help ensure that fish under propagation are adequately protected from catastrophic loss due to poor hatchery practices, adverse water quality conditions, or fish health issues associate with poor water quality or inadequate water quantity.

Competition

Release of hatchery–origin species into ESA-listed species' habitat, or where they may access the habitat of listed species, may harm listed species and therefore constitutes a "take" under the ESA (NMFS 1999). Among the mechanisms of potential harm is competition (Tatara and Berejikian 2012). Competition occurs when the demand for a resource by two or more organisms exceeds the available supply. If the resource in question (e.g., food or space) is present in such abundance that it is not limiting, then competition is not occurring, even if both species are using the same resource. Adverse impacts of competition may result from direct interactions, whereby a hatchery-origin fish interferes with the accessibility to limited resources by naturally produced fish, or through indirect means, as when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific hazards associated with adverse competitive impacts of hatchery salmonids on listed naturally produced salmonids may include food resource competition, competition for juvenile rearing sites, and, to a lesser extent, competition for spawning sites NMFS (2012). For these competition risks between fish origins or fish species to occur, substantial levels of spatial and temporal overlap, and limited resources shared by the fish must exist (Tatara and Berejikian 2012). The relative sizes of juvenile hatchery EWS and natural-origin salmon and steelhead, species and size-determined diet preference differences, and relative densities of EWS and natural-origin fish in migration reaches, would also determine competition risks in freshwater areas where the groups overlap spatially and temporally.

The co-managers have included BMPs in the HGMPs that are designed to avoid or reduce competition in freshwater between fish from natural populations and hatchery EWS:

- All juvenile hatchery steelhead produced by the programs would be released as seawater-ready smolts as a measure to foster rapid emigration seaward. The release of seawater-ready

smolts only is expected to reduce the duration of interaction with any co-occurring natural-origin steelhead and salmon that are at a life stage vulnerable to competition for food or space.

- All smolt release groups will meet the minimum size criteria of 5 to 6 fish per pound (fpp), or 198 to 210 mm fork length (fl) established by Tipping (2001) (as cited in (WDFW 2014a; 2014b)) to ensure the fish are at size that has been demonstrated to promote downstream migration. EWS smolts would be released at a uniform average size closely adhering to the 5 to 6 fpp minimum to reduce the risk of residualism.
- Hatchery- and natural-origin juvenile steelhead and salmon emigration timing and abundance would be monitored each year through operation of tribal juvenile outmigrant trapping programs to evaluate hatchery fish emigration rates, co-occurrence levels with natural-origin fish, and the potential for harmful ecological interactions. Information collected would be used to develop, as needed, alternate hatchery EWS release timings or other mitigation measures that would help avoid or limit interactions that may lead to competition.
- All hatchery-origin steelhead smolts produced by Wallace River Hatchery, Reiter Ponds Hatchery, and Tokul Creek Hatchery would be volitionally released from hatchery rearing ponds to minimize residualization, and associated competition risks to natural fish. The plans provide sufficient information, some of which is based on 30 years of hatchery program implementation and monitoring, supporting the efficacy of volitional release for meeting actively migrating smolt release and residual minimization objectives. As indicated in the HGMPs, WDFW is conducting research on the effects of volitional release practices in Upper Columbia River region. Preliminary results suggest faster downstream migration for volitionally released smolts, and substantially reduced rates of residualism relative to force-released steelhead (Snow et al. 2013). Volitional releases would begin when steelhead display cues of outward physical signs and behaviors reflecting a state of active smoltification, including loss of parr marks, banding of the caudal fin, and increased attraction of the population to pond edges, inflow, and outflow areas. When these conditions were observed after May 1st, rearing pond end-screens would be removed to provide the opportunity for migration-ready steelhead smolts ready to exit downstream. Any EWS smolts that do not exit rearing ponds volitionally would be removed (culled) and planted into landlocked lakes to enhance recreational fishing opportunities.

Predation

Effects on naturally produced salmon and steelhead attributable to direct predation (direct consumption) or indirect predation (increases in predation by other predator species due to enhanced attraction) can result from hatchery salmonid releases (NMFS (2012). Hatchery-origin fish may prey upon juvenile naturally produced salmonids at several stages of their life history. Newly released hatchery EWS smolts have the potential to consume naturally produced fry and fingerlings that are encountered in freshwater during downstream migration. Hatchery smolts that do not emigrate and instead take up stream residence near the point of release (residuals) have the potential to prey on rearing natural-origin juvenile fish over a more prolonged period. In general, naturally produced salmonid populations will be most vulnerable to predation when naturally produced populations are at low abundance and predator abundance is high, in small streams,

where migration distances are long, and when environmental conditions favor high visibility (NMFS (2012).

The level of effects from EWS hatchery smolt predation on natural-origin juvenile fish is dependent upon three factors: 1) the hatchery fish and their potential natural-origin prey must overlap temporally; 2) the hatchery fish and their prey must overlap spatially; and, 3) the prey should be less than 1/3 the length of the predatory fish (NMFS (2012).

The proposed EWS hatchery programs would reduce temporal and spatial overlap and the potential for predation on listed juvenile salmon and steelhead through application of the following measures:

- All juvenile hatchery steelhead produced by the programs would be released as seawater-ready smolts as a measure to foster rapid emigration seaward. The release of seawater-ready smolts only is expected to reduce the duration of interaction with any co-occurring natural-origin steelhead and salmon that are at life stages and sizes vulnerable to predation by EWS smolts of an average individual size of 5 to 6 fpp, or 198 to 210 mm fl.
- All smolt release groups will meet the minimum size criteria of 5 to 6 fpp (198 to 210 mm fl) established by Tipping (2001) (as cited in (WDFW 2014a; 2014b) to ensure the fish are at size that will promote downstream migration. EWS smolts would be released at a uniform size closely adhering to the 5 to 6 fpp minimum to reduce the risk of residualism.
- Hatchery- and natural-origin juvenile steelhead and salmon emigration timing and abundance would be monitored each year through operation of tribal juvenile outmigrant trapping programs to evaluate hatchery fish emigration rates, co-occurrence levels with natural-origin fish, and the potential for harmful ecological interactions. Information collected would be used to develop as needed, alternate hatchery EWS release timings or other mitigation measures that would help avoid or limit interactions and resulting predation effects.
- All hatchery-origin steelhead smolts produced by Wallace River Hatchery, Reiter Ponds Hatchery, and Tokul Creek Hatchery would be volitionally released from hatchery rearing ponds to minimize residualization, and associated predation risks to natural fish. The plans provide sufficient information, some of which is based on 30 years of hatchery program implementation and monitoring, supporting the efficacy of volitional release for meeting actively migrating smolt release and residual minimization objectives. As indicated in the HGMPs, WDFW is conducting research on the effects of volitional release practices in Upper Columbia River region. Preliminary results suggest faster downstream migration for volitionally released smolts, and substantially reduced rates of residualism relative to force-released steelhead (Snow et al. 2013). Volitional releases would begin when steelhead display cues of outward physical signs and behaviors reflecting a state of active smoltification, including loss of parr marks, banding of the caudal fin, and increased attraction of the population to pond edges, inflow, and outflow areas. When these conditions were observed after May 1st, rearing pond end-screens would be removed to provide the opportunity for migration-ready steelhead smolts to exit downstream. Any EWS smolts that do not exit rearing ponds volitionally would be removed (culled) and planted into landlocked lakes to enhance recreational fishing opportunities.

3.1.6 5(i)(F) The HGMP describes interrelationships and interdependencies with fisheries management.

The HGMPs describe the relationship of the proposed actions with fisheries management in section 3.0 of each plan. The HGMPs indicate that all co-manager anadromous salmonid hatchery programs in the Puget Sound region, including the two proposed EWS programs, would operate consistent with the *United States* v. *Washington* (1974) fisheries management framework. This legal framework sets forth required measures for coordinating State and tribal implementation of agreed hatchery programs, defining artificial production objectives, and maintaining treaty-fishing rights through the court-ordered Puget Sound Salmon Management Plan (PSSMP 1985). This fisheries resource co-management process requires that both the State of Washington and the Puget Sound Tribes develop salmon hatchery program goals and objectives, and reach agreement on the function, purpose, and fish production strategies for all Puget Sound hatchery programs.

The NMFS evaluation and authorization for 'take' of ESA-listed steelhead associated with fisheries in the Snohomish River basin occurs through a separate ESA consultation process (for spring 2015 through spring 2016, see NMFS 2015b).

3.1.7 5(i)(G) Adequate artificial propagation facilities exist to properly rear progeny of naturally spawned broodstock, to maintain population health and diversity, and to avoid hatchery-influenced selection and domestication.

This 4(d) Rule, limit 5 criterion was intended to address programs that propagate ESA-listed fish, to ensure that hatchery facilities and practices used for the programs provide adequate safeguards to protect the listed fish while in the hatchery. The two hatchery programs rear steelhead that are not included in the ESA-listed Puget Sound steelhead DPS (71 FR 20802, April 14, 2014; Jones 2015). This criterion therefore does not apply to the proposed hatchery programs.

3.1.8 5(i)(H) Adequate monitoring and evaluation exist to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of the listed ESU.

Adequate monitoring and evaluation actions are proposed in the two HGMPs to evaluate program performance in meeting hatchery plan implementation requirements and objectives, including verification of effects on ESA-listed species (Anderson et al. 2014a). These actions are summarized in Section 1.10, and are further described in Section 11.0 of each HGMP ("Monitoring and Evaluation of Performance Indicators"). Included in HGMP section 1.10 are descriptions of monitoring and evaluation measures that would be implemented to assess hatchery program performance indicators. The Anderson et al. (2014a) report included in the co-manager submittal of the HGMPs for NMFS review describes monitoring and evaluation actions that will be applied to determine gene flow effects of each program on associated natural steelhead populations.

In addition to the monitoring and evaluation actions included in the HGMPs, the WDFW and Puget Sound Tribal staffs engage in annual monitoring activities to assess the status of listed steelhead and Chinook salmon natural populations in the Snohomish River basin action area. These activities have been previously analyzed and authorized under the ESA (NMFS 2009; NMFS 2015a) and include:

- Annual surveys to census steelhead spawning abundance, count redds, and sample carcasses to identify fish origin in natural spawning areas, and adult fish abundance and distribution.
- Annual scale sampling of returning adult fish and fish carcasses for age composition analysis.
- Annual operation of a downstream juvenile outmigrant traps in the mainstem Skykomish and Snoqualmie Rivers that would provide estimates of natural-origin juvenile salmon production levels and sizes for assessment of the natural population survival and productivity. The outmigrant trapping programs would also be used to indicate natural and hatchery-origin salmon and steelhead juvenile emigration timings, rates, and co-occurrence levels.
- Collection of adult steelhead return abundance, timing, sex ratio, mark status, disposition, holding mortality, and fish health condition data at all hatchery facilities to monitor the effects of the programs.
- Implementation of juvenile outmigrant trapping programs and carcass sampling in natural spawning areas that would provide sources of tissue samples for DNA analyses to determine gene flow levels between EWS and associated natural-origin steelhead populations. In the Skykomish River watershed, genetic samples would be collected annually from smolts trapped at the mainstem trap, and analyzed to determine the number of wild, hybrid, and hatchery-ancestry fish. Genetic samples would be collected from adults in the Pilchuck River subbasin on a rotating basis every three years for the same purpose. Annual genetic sampling of smolts and adults collected from the mainstem Snoqualmie River smolts trap, and through hook and line sampling, respectively, would be used to assess gene flow levels for EWS spawning in the Snoqualmie River watershed.

The proposed monitoring and evaluation of hatchery implementation requirements (e.g., annual EWS smolt release levels, individual fish sizes, and release timing), hatchery performance, and the verification of hatchery effects on ESA-listed species, along with annual, natural population status and trends monitoring, will enable the co-managers to detect and evaluate the success of the two EWS programs as well as any deleterious effects on ESA-listed salmon and steelhead.

3.1.9 5(i)(I) The HGMP provides for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that data show are needed.

Consistent with this criterions, the HGMPs provide for regular monitoring and reporting, and responsive adaptive management. Key provisions of the HGMPs include implementation of BMPs, monitoring and evaluation of program performance, and adjustment of the hatchery programs accordingly. Each of the HGMPs identify objectives and actions needed to determine

hatchery program performance in meeting stated EWS production objectives and effects on natural-origin fish populations in the Snohomish River basin (HGMP Section 1.10). In compliance with this 4(d) Rule criterion, the HGMPs promise to apply adaptive management and risk management approaches in their implementation of the EWS hatchery programs.

Under the HGMPs, monitoring data collected on an annual basis and relating to hatchery program performance and effects would be evaluated by WDFW and the Tulalip Tribes to determine whether the two steelhead hatchery programs were meeting their respective objectives and ESA compliance criteria. As identified in Sections 1.10 and 11 of the HGMPs, monitoring and evaluation results would be used to verify whether performance standards addressing program benefits and risks (performance and effects) were met and likely to be met in the foreseeable future. The co-managers indicate in the HGMPs that funding and staff resources would be committed to monitor and evaluate the programs.

The HGMPs include actions to monitor achievement of performance objectives for providing harvest opportunities and compliance with criterion for protecting ESA-listed salmon and steelhead (sections 1.10.2 and 10). The co-managers will report: numbers of hatchery (marked) and natural (unmarked) steelhead returning to the hatcheries, number of broodstock collected, and surplus returns; EWS smolt release information consistent with Equilibrium Broodstock Document requirements (number, location, method and age class); levels of compliance with applicable fish health standards and criteria; effluent discharge water quality and water withdrawal levels compared to permit standards and allowances; and, hatchery smolt migration behavior, including EWS smolt interactions with natural origin fish. In addition to these reporting requirements, annual levels of gene flow between EWS and natural-origin steelhead populations in the Snohomish River Basin will be monitored to gauge whether the programs remain at levels that likely pose unsubstantial effects to the affected natural populations (Anderson et al. 2014a). DNA analyses results for juvenile and adult steelhead samples collected in the Snohomish River Basin, including the Skykomish and Snoqualmie river watersheds, will be analyzed and reported to allow for evaluations of whether gene flow criterion in the HGMPs are met, and whether adjustments to the programs are necessary. NMFS will review all monitoring and evaluation information, in reports provided annually, and post the reports on the NMFS website for public information purposes.

3.1.10 5(i)(J) NMFS provides written concurrence of the HGMP which specifies the implementation and reporting requirements.

Written concurrence with the RMP, and the HGMPs of which it is composed, is a requirement specific to Limit 5 of the 4(d) Rule, rather than of Limit 6, under which this RMP is considered. Instead, under Limit 6, NMFS' role is to make a determination as to whether implementing and enforcing the joint tribal/state plan will appreciably reduce the likelihood of survival and recovery of affected threatened ESUs and DPSs, including consideration of how the HGMPs address the criteria of Limit 5. With the current document, and through the biological opinion for this action (NMFS 2016), NMFS has supported its determination. NMFS will notify the co-managers of our

determination and of implementation and reporting requirements specified herein [50 CFR 223.203(b)(5)(J)].

In particular, NMFS' letter of concurrence will describe the following implementation and reporting requirements necessary to ensure that the program continues to perform in a manner consistent with NMFS' analysis. On or before October 1 of each year, tribal and state co-managers must submit an annual report to the NMFS Anadromous Production and Inland Fisheries Branch in Portland, Oregon and that report must address the information requirements in sections 3.1.8 and 3.1.9 of this determination including but not limited to:

(1) The annual abundance, diversity, spatial structure, and productivity status of the natural steelhead populations that are affected by the EWS hatchery programs relative to NMFS Puget Sound Steelhead DPS population viability objectives (Hard et al. 2015) to guide decisions regarding adjustment or continuation of the EWS hatchery programs.

(2) The level of gene flow between naturally spawning EWS and the associated natural steelhead populations in the Snohomish River watershed through analyses of natural and EWS steelhead demographics (natural spawning abundance, spatial and temporal spawn timing), mark/tag, and genetic (DNA) data collected from adult returns.

(3) The level of competition and predation between EWS hatchery smolts and juvenile steelhead and Chinook salmon from natural populations through analysis of the weekly incidence of EWS hatchery-origin smolts in downstream areas relative to the total number of EWS smolts released, and the emigration timings and individual fish sizes for EWS smolts, and natural-origin juvenile steelhead and Chinook salmon encountered through juvenile outmigrant trapping in the Skykomish and Snoqualmie rivers.

(4) Success in mass marking and/or tagging EWS smolts released each year through the hatchery programs as described in the HGMPs to allow for the differentiation of hatchery- and natural-origin juvenile and adult steelhead in the natural environment, assessment of hatchery program effects on listed fish, and monitoring and evaluation of program performance in meeting stated conservation or fisheries harvest augmentation objectives.

(5) The degree to which annual EWS smolt release levels have been maintained consistent with the maximum abundance levels described in the proposed HGMPs.

(6) The numbers, pounds, dates, tag/mark information, and locations of EWS smolt releases; results of monitoring and evaluation activities that occur within the hatchery environment; adult return numbers by fish origin to any naturally spawning area and to the hatchery programs; analyses of any scientific research data collected in direct association with the hatchery programs; documentation of any problems that may have arisen during conduct of the authorized activities; a statement as to whether or not the activities had any unforeseen effects; and steps that have been and that will be taken to coordinate research or monitoring activities with those of other researchers.

3.1.11 5(i)(K) The HGMP is consistent with plans and conditions set within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

The Wallace/Reiter Early Winter Steelhead Hatchery and Tokul Creek Winter Steelhead HGMPs were developed jointly by WDFW and the Tulalip Tribes pursuant to the *United States v. Washington* (1974) fisheries and hatchery management framework.

There are no other plans or conditions set within Federal court proceedings with continuing jurisdiction over tribal harvest allocations, including memorandums of understanding, court orders or other management plans, that direct tribal harvest allocations with respect to operation of the proposed EWS hatchery programs in the Snohomish River basin.

4 NOTICE OF PENDING RECOMMENDATION

As required by Limit 6 of the 4(d) Rule, the Secretary sought comment from the public on the pending determination as to whether or not the RMP would appreciably reduce the likelihood of survival and recovery of the following threatened species; the Puget Sound Steelhead DPS and the Puget Sound Chinook Salmon ESU, together with a discussion of the biological analysis underlying that determination (81 FR 8941; February 23, 2016). Comments were received, and were considered in developing this final recommended determination.

5 RECOMMENDED DETERMINATION

NMFS has reviewed the two EWS plans provided by WDFW and the Tulalip Tribes pursuant to limit 6 of the 4(d) Rule, and evaluated them together against the requirements of the 4(d) Rule. Based on this review and evaluation, and the biological opinion for this action, NMFS' determination is that activities implemented as described in the two plans adversely affect but would not appreciably reduce the likelihood of survival and recovery of ESA-listed Puget Sound steelhead and Puget Sound Chinook salmon, and that the plans address all of the criteria specified in Limit 5 of the 4(d) Rule. If the Regional Administrator concurs with this recommended determination, take prohibitions for listed steelhead and salmon populations in the Snohomish River watershed would not apply to activities implemented in accordance with the two co-manager HGMPs composing the hatchery RMP.

6 REEVALUATION CRITERIA

NMFS will reevaluate this determination if: (1) the actions described by the HGMPs are modified in a way that causes an effect on ESA-listed species that was not previously considered in NMFS' evaluation; (2) new information or monitoring reveals effects that may affect listed species in a way not previously considered; or (3) a new species is listed or critical habitat is designated that may affect NMFS' evaluation of the HGMPs.

7 REFERENCES

AFS. 1994. American Fisheries Society Bluebook – Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens.

Anderson, J., K. I. Warheit, and B. Missildine. 2014a. Genetic monitoring of hatchery-wild introgressive hybridization in Puget Sound steelhead. Washington Department of Fish and Wildlife, editor, Olympia, Washington.

Anderson, J. H., G. R. Pess, R. W. Carmichael, M. J. Ford, T. D. Cooney, C. M. Baldwin, and M. M. McClure. 2014b. Planning salmon reintroductions aimed at long-term viability and recovery. North American Journal of Fisheries Management. 34: 72-92.

Busack, C., and K. P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. Pages 71-80 *in* H.L.J. Schramm and R.G. Piper, editors. Uses and effects of cultured fish in aquatic ecosystems, volume 15. American Fisheries Society 15: 71-80.

Crawford, B. A. 1979. The origin and history of the trout brood stocks of the Washington Department of Game. Olympia, WA. 76.

Ford, M. J. 2002. Selection in captivity during supportive breeding may reduce fitness in the wild. Conservation Biology. 16(3): 815-825.

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

Ford, M. J., T. Cooney, P. McElhany, N. Sands, L. Weitkamp, J. Hard, M. McClure, R. Kope, J. Myers, A. Albaugh, K. Barnas, D. Teel, P. Moran, and J. Cowen. 2011. Status Review Update for Pacific Salmon and Steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-113, 281p. Available at: http://www.nwr.noaa.gov/Publications/Biological-Status-Reviews/upload/SR-2010-all-species.pdf

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

Haring. D. 2002. Salmonid habitat limiting factors analysis - water resource inventory area 7-final report. December, 2002. Washington State Conservation Commission. Lacey, WA. 331 pp.

Hoffmann, A. 2014. Estimates of gene flow for Puget Sound hatchery steelhead programs. Washington Department of Fish and Wildlife, editor, Mill Creek, Washington.

Jones, R. 2011. 2010 5-Year Reviews. Updated Evaluation of the Relatedness of Pacific Northwest hatchery Programs to 18 Salmon Evolutionarily Significant Units and Steelhead Distinct Population Segments listed under the Endangered Species Act. June 29, 2011 memorandum to Donna Darm, NMFS Northeast Region Protected Resources Division. Salmon Management Division, Northwest Region, NMFS. Portland, Oregon. 56p.

Jones, R. 2014. Jones, R., to Anderson, Philip, WDFW, Director; Loomis, Lorraine, NWIFC, Chairwoman. NMFS' sufficiency letter for five updated HGMPs for early winter steelhead, submitted by WDFW and the Puget Sound Treaty Tribes. 14p. NMFS. Novenber 12, 2014.

Jones, R. 2015. 2015 5-Year Review - Listing Status under the Endangered Species Act for Hatchery Programs Associated with 28 Salmon Evolutionarily Significant Units and Steelhead Distinct Population Segments. September 28, 2015 memorandum to Chris Yates, NMFS West Coast Region. Sustainable Fisheries Division, West Coast Region. Portland, Oregon.

McElhany, P., M. H. Rucklelshaus, M. J. Ford, T. C. Wainwright, and E. P. Bjorkstedt. 2000. Viable Salmonid Populations and the Recovery of Evolutionarily Significant Units. U.S. Dept. of Commerce, NOAA Tech. Memo, NMFS-NWFSC-42. 174p.

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

NMFS. 1999. Endangered and threatened wildlife and plants; definition of "harm". Federal Register. Volume 64 No. 215 (November 8, 1999):60727-60731. Final rule.

NMFS. 2000. A risk assessment procedure for evaluating harvest mortality of Pacific salmonids. May 30, 2000. Sustainable Fisheries Division, NMFS, Northwest Region. 33p.

NMFS. 2002. Biological Opinion on artificial propagation in the Hood Canal and Eastern Strait of Juan de Fuca regions of Washington State. Hood Canal summer chum salmon hatchery programs by the U.S. Fish and Wildlife Service and the Washington Department of Fish and Wildlife and Federal and non-Federal hatchery programs producing unlisted salmonid species. NMFS, Northwest Region, Sustainable Fisheries and Salmon Recovery Divisions.

NMFS. 2003. Hatchery Broodstock Summaries and Assessments for chum, coho, and Chinook salmon and steelhead stocks within Evolutionarily Significant Units listed under the

Endangered Species Act. Salmon Steelhead Hatchery Assessment Group. National Marine Fisheries Service, Northwest Fisheries Science Center. Seattle, Washington.

NMFS. 2007. Final Supplemental to the Shared Strategy's Puget Sound Salmon Recovery Plan. NMFS. Northwest Region, Portland, Oregon, 47p.

NMFS. 2009. Evaluation and Recommended Determination of a Tribal Resource Management Plan Submitted for Consideration Under the Endangered Species Act's Tribal Plan Limit [50 CFR 223.204] for the Period January 1, 2009 - December 31, 2016 Tribal Research in Puget Sound, Washington. NMFS, Protected Resources Division. Portland, Oregon.

NMFS. 2012. Effects of Hatchery Programs on Salmon and Steelhead Populations: Reference Document for NMFS ESA Hatchery Consultations. NMFS, editor. Northwest Region, Salmon Managment Division, Portland, Oregon.

NMFS 2015a. Letter to Charmane Ashbrook, Washington State Department of Fish and Wildlife, from William W. Steele, National Marine Fisheries Service responding to request for evaluation of fishery research program under the Endangered Species Act 4(d) rule's research limit (50 CFR 223.203(b)(7) and determination that take prohibitions under Section 9 of the ESA do not apply to research activities specified in the WDFW fishery research program as submitted. March 4, 2015. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region. Long Beach, California.

NMFS. 2015b. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation on Impacts of Programs Administered by the Bureau of Indian Affairs that Support Puget Sound Tribal Salmon Fisheries, Salmon Fishing Activities Authorized by the U.S. Fish and Wildlife Service, and Fisheries Authorized by the U.S. Fraser Panel in 2015. NMFS Consultation Number: F/WCR-2015-2433. NMFS West Coast Region, Sustainable Fisheries Division. Seattle, Washington.

NMFS. 2016. Endangered Species Act - Section 7 Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation for Two Hatchery and Genetic Management Plans for Early Winter Steelhead in the Snohomish River basin under Limit 6 of the Endangered Species Act Section 4(d) Rule. NMFS Consultation Number: WCR-2015-3441. National Marine Fisheries Service, West Coast Region. Portland, Oregon.

NPPC (Northwest Power Planning Council). 2001. Performance standards and indicators for the use of artificial production for anadromous and resident fish populations in the Pacific Northwest. Portland, Oregon. 19 pp. January 17, 2001. Available at: http://www.nwr.noaa.gov/publications/hatchery/hgmp-perf-standards.pdf.

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

PNFHPC (Pacific Northwest Fish Health Protection Committee). 1989. Model comprehensive fish health protection program. Olympia, Washington.

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

PSSMP (Puget Sound Salmon Management Plan). 1985. United States vs. Washington 1606 F.Supp. 1405. 42 pp.

PSIT and WDFW. 2010b. Draft Puget Sound Steelhead Harvest Management Plan. Pages 224p in. NWIFC, Lacey, WA.

Rawson, K., and M. Crewson. 2014. Recent productivity of Skykomish and Snoqualmie natural origin Chinook salmon (Oncorhynchus tshawhtscha). Unpublished report submitted to Tulalip Tribes Natural Resources Department. Tulalip Tribes, Marysville, Washington.

Ruckelshaus, B., K. P. Currens, R. R. Fuerstenberg, W. H. Graeber, K. Rawson, N. J. Sands, and J. B. Scott. 2002. Planning Ranges and Preliminary Guidelines for the Delisting and Recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit Puget Sound Technical Recovery Team April 30, 200. 20p.

Ruckelshaus, M. H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J. B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. U. S. D. Commerce. NOAA Tech. Memo. NMFS-NWFSC-78, 125 pp.

Sands, N. J., K. Rawson, K. Currens, W. Graeber, M. H. Ruckelshaus, R. Fuerstenberg, and J. Scott. 2009. Determination of independent populations and viability criteria for the Hood Canal summer chum salmon evolutionarily significant unit. U. S. D. o. Commerce. NOAA Tech. Memo., NMFS-NWFSC-101, 58p.

Scott, J. B., Jr. 2014. Letter from Scott, J. B., Jr., to Robert Turner, NMFS, WCR, SMD. Resubmittal of five early winter steelhead HGMPs in Puget Sound for review under Limit 6 of the ESA 4(d) rule (50 CFR Part 223). July 28, 2014. Washington Department of Fish and Wildlife. 1p.

Scott, J. B., Jr. 2015. Letter from Scott, J. B., Jr., to Robert Turner, NMFS, WCR, SFD. Submittal of HGMPs for the Skykomish/Snoqualmie and Tokul Creek early winter steelhead hatchery programs for review under Limit 6 of the ESA 4(d) rule . January 12, 2015. Washington Department of Fish and Wildlife. 1p.

Scott, J. B., and W. T. Gill, editors. 2008a. Oncorhynchus mykiss: Assessment of Washington State's steelhead populations and programs. Preliminary draft for Washington Fish & Wildlife Commission. 424p. Washington Department of Fish and Wildlife, Olympia, Washington.

Scott, J. B., Jr., and T. G. Gill. 2008b. Oncorhynchus mykiss: Assessment of Washington State's Steelhead Populations and Programs (Preliminary Draft). February 1, 2008.

SIWG. 1984. Evaluation of potential interaction effects in the planning and selection of salmonid enhancement projects. J. Rensel, chairman and K. Fresh editor. Report prepared for the Enhancement Planning Team for implementation of the Salmon and Steelhead Conservation and Enhancement Act of 1980. Washington Dept. Fish and Wildlife. Olympia, WA. 80p.

Snohomish Basin Salmon Recovery Forum (SBSRF). 2005. Snohomish River basin salmon conservation plan. Available at: http://www1.co.snohomish.wa.us/Departments/Public_Works/Divisions/SWM/Work_Areas/Habitat/Salmon/Snohomish/Snohomish_Basin_Salmon_Conservation_Plan.htm.

Snohomish Basin Salmonid Recovery Technical Committee (SBSRTC). 1999. Initial Snohomish River basin Chinook salmon conservation/recovery technical work plan. Committee included 31 members and contributing authors. Snohomish County Public Works, Surface Water Management Division. Everett, Washington. 151 p.

Snohomish County. 2013. Snohomish County Smith Island restoration project final environmental impact statement. June 2013. Snohomish County Department of Public Works, Everett, Washington. Vol 1 of 2. 62 p.

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

SSPS. 2005. Snohomish Watershed Profile. WRIA 17. In Volume II of the Shared Strategy for Puget Sound. Plan adopted by the National Marine Fisheries Service (NMFS) January 19, 2007. Submitted by the Shared Strategy Development Committee. Shared Strategy for Puget Sound. Seattle, Washington. June 2005. 12 p.

SSPS. 2007. Shared Strategy for Puget Sound- Puget Sound Salmon Recovery Plan. 1411 4th Avenue, Suite 1015, Seattle, WA 98101. January, 2007.

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

Tipping, J. 2001. Profile of a great hatchery steelhead smolt. WDFW Tech. Memo. Washington Department of Fish and Wildlife. Olympia, Washington. 7pp.

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

Unsworth, J. 2016. Letter from James Unsworth, Ph.D., Director, Washington Department of Fish and Wildlife to Robert Turner, Assistant Regional Administrator, NMFS, West Coast Region Sustainable Fisheries Division, regarding updating of the early winter steelhead HGMP for the Skykomish-Snohomish River Winter Steelhead Hatchery Program (Segregated), and the state's continuing operation of its separate summer steelhead hatchery programs. January 19, 2016. Washington Department of Fish and Wildlife. Olympia, WA.

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

WDF (Washington Department of Fisheries) and WWTIT (Western Washington Treaty Indian Tribes). 1994. 1992 Washington state salmon and steelhead stock inventory. Appendix two: coastal stocks. 1994. 588p.

WDFW (Washington Department of Fish and Wildlife). 2008. Statewide steelhead management plan: Statewide policies, strategies, and actions. Olympia, Washington. February 29, 2008.

WDFW. 2014a. Wallace/Reiter Early Winter Steelhead Hatchery Program (Segregated) Hatchery and Genetic Management Plan. Washington Department of Fish and Wildlife. Olympia, WA. July 28, 2014; updated February 16, 2016. 64p

WDFW. 2014b. Tokul Creek Winter Steelhead Hatchery Program (Segregated) Hatchery and Genetic Management Plan. Washington Department of Fish and Wildlife. Olympia, WA. July 28, 2014; updated November 24, 2014. 64p.

WDFW and NWIFC (Northwest Indian Fisheries Commission). 1998 (updated 2006). The salmonid disease control policy of the fisheries co-managers of Washington state, version 3. 38pp.

Williams, R. W., R. M. Laramie, and J. J. Ames. 1975. A catalog of Washington streams and salmon utilization, Vol. 1. Washington Dept. Fisheries. Olympia.