HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Photo: Courtesy of the hatchery staff.

Hatchery Program:	Soos Creek (Green River) Hatchery Winter Steelhead Program (Segregated)
Species or Hatchery Stock:	Winter Steelhead (*Oncorhynchus mykiss*) Early Winter Stock
Agency/Operator:	Washington Department of Fish & Wildlife
Watershed and Region:	Duwamish/ Green River, Puget Sound
Date Submitted:	July 28, 2014
Date Last Updated:	July 26, 2014

Executive Summary

ESA Permit Status:
On March 31, 2004, the Washington Department of Fish and Wildlife (WDFW) submitted a Hatchery Genetic Management Plan (HGMP) for the Palmer Ponds (now relocated to Soos Creek) Hatchery early winter steelhead program as part of a joint state/tribal hatchery resource plan for consideration under the 4(d) rule. In a letter from NOAA Fisheries dated August 4, 2004, the co-managers were informed that NOAA Fisheries anticipated completing a draft Environmental Impact Statement (EIS) by the summer of 2005. NOAA noted that "A final EIS may then be completed by winter 2005-2006, after which time NOAA Fisheries will release ESA 4(d) Rule determinations for the hatchery plans." The letter concluded by stating that "Your work on these hatchery plans is important, and will substantially contribute to on-going salmon recovery efforts within the region." The WDFW provided updated HGMPs to NOAA Fisheries in August 2005.

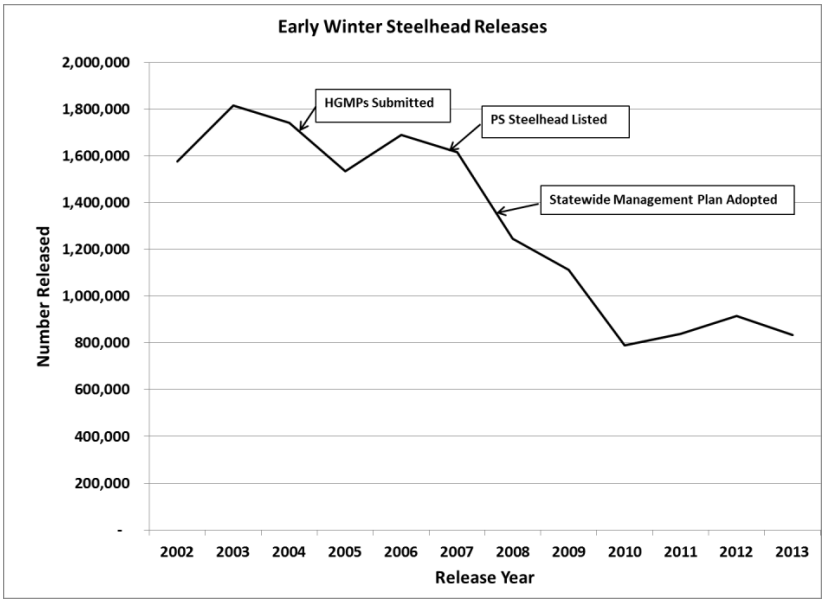
The co-managers are now re-submitting an HGMP for the Green Basin hatchery early winter steelhead program to further update the description of the program and incorporate new information and analyses.

The Puget Sound steelhead Distinct Population Segment (DPS) is listed as "Threatened" under the ESA, however, Green basin hatchery early winter steelhead are not included in the ESA-listing. The Puget Sound Technical Recovery Team has preliminarily delineated one Demographically Independent Population of native winter steelhead in the Green River.

Early Winter Steelhead - Additional Risk Reduction Measures:
The co-managers have implemented substantial additional risk reduction measures for early winter hatchery steelhead programs since the HGMPs were first submitted in 2004. The risk reduction measures were developed around the principles and recommendations of the co-managers' Resource Management Plans.

Across the Puget Sound Distinct Population Segment (DPS), these risk reduction measures include:

- >50% reduction in hatchery releases of early winter steelhead;
- >65% reduction in release locations;
- Elimination of cross-basin transfers, off-station releases, adult recycling, and fry releases into anadromous waters;
- Volitional smolt releases to minimize natural origin fish interactions;
- Hatchery broodstock collection by January 31st to enhance separation between hatchery and natural origin fish;
- Establishment of a network of wild stock gene banks; and
- Genetic monitoring of hatchery strays to natural spawning areas.



The developments of new genetic analysis techniques since July 2013 has provided significant new information to evaluate and, as necessary, modify hatchery programs.

Green River Basin Hatchery Early Winter Steelhead Program:
The purpose of the program is to produce Green River basin early winter steelhead for sustainable recreational and tribal fisheries. Program fish will be produced at the Soos Creek Hatchery, located on Soos Creek, a tributary to the Green River, and Icy Creek Pond, located on Icy Creek tributary to the Green River. The program will release 70,000 yearling smolts into the Green River basin annually (35,000 at Soos Creek Hatchery and 35,000 at Icy Creek).

The early winter hatchery programs in the Green River basin are designed to take into account potential risks of artificial propagation on listed species while still providing for some harvest by treaty tribes and recreational fisheries. Efforts to minimize potential risks of artificial propagation are described below. Likewise, to protect against overutilization of natural origin steelhead whose abundances have declined from historical levels, the NMFS Biological Opinion established a 4.2% harvest limit of the aggregate average harvest rate of natural origin steelhead in five basins: Skagit River, Snohomish River, Green River, Puyallup River, and Nisqually River. The factors driving the declining abundance of natural origin steelhead, however, have not been similarly restricted, including: 1) the present and increasing threat of destruction, modification and curtailment of natural origin steelhead freshwater, estuarine, and marine habitat; 2) predation and potentially disease, and 3) the inadequate existing regulatory mechanisms to protect natural origin steelhead habitat. The current harvest restriction severely limits the opportunities for both treaty and non-treaty fisheries on natural origin steelhead. The lack of adequate habitat protection and restoration places an unacceptable disparate burden on hatchery programs, the exercise of the tribes' treaty-secured rights, limits recreational fishing opportunities, and fails to conserve steelhead. The potential risks of this hatchery program are minimal compared to the risks of failed steelhead habitat protection and restoration measures.

The program will be operated as a "segregated" program with the intent for the hatchery population to represent a distinct population that is reproductively isolated from naturally-spawning populations. Segregation will be achieved operationally by using only adult hatchery-origin early winter steelhead (distinguished by an adipose fin-clip) returning to the Soos Creek and Icy Creek traps, and by operating the program in a manner to limit gene flow to the natural origin population. Specific risk- reduction measures that have been implemented since 2004 for this program include:

- > 65% reduction in number of fish released relative to 2005 HGMPs (215,000 to 70,000).
- > 50% reduction in release locations relative to 2003-2004 (from four to two).
- Hatchery traps now remain open through March 15 (or later as conditions allow) to provide the opportunity for all adult hatchery-origin fish to return to the hatcheries to reduce straying,
- All eggs are taken from hatchery-origin fish returning prior to January 31 to maintain the temporal separation in spawn-timing between hatchery- and natural-origin steelhead, and
- Eggs are only collected from broodstock returning to Soos Creek or Icy Creek hatcheries to promote fidelity of homing to the hatcheries.

The genetic impact from this segregated hatchery program on natural-origin steelhead will be assessed through measures of introgression and the proportion of effective hatchery contribution derived directly from DNA, based on periodic tissue sampling of key demographic/tributary groups, and linked to other harvest and habitat actions in a Total Viability Analysis (TVA) that considers the effects on all viability parameters from "All H" actions. These performance indicators are estimated using genetic samples collected from the natural populations and hatchery-origin fish straying to natural spawning areas. Given the above improvements and more direct measures of introgression and gene flow, the revised hatchery program should result in significant reductions in genetic impacts on natural origin populations provided

other factors affecting productivity remain neutral. Environmental and ecological effects that could contribute to the decline of steelhead viability are being addressed in ongoing monitoring efforts (smolt trapping, estuarine and nearshore marine monitoring done for more than 12 consecutive years) and new monitoring efforts (e.g. Salish Sea Marine Survival Project with the co-managers and 15 other agencies and entities, SeaGrant juvenile fish monitoring project, new zooplankton monitoring, etc.). Risk control measures are also in place to address other potential hazards including ecological interactions, disease transmission, and facility effects.

An integrated TVA is needed to assess the risks of the proposed hatchery program relative to other risk factors and to develop management actions that are likely to lead to recovery. As noted by the Puget Sound Technical Recovery Team (2003), "Considering the effects of one factor at a time (e.g. harvest, habitat, or hatchery management actions) on salmon population characteristics is more tractable from a technical standpoint, but such estimates of effects are sure to be wrong in most instances. Managers [are asked] to consider suites of habitat, harvest, and hatchery actions together, especially with a view towards how these factors interact..." The WDFW and Treaty tribes are now developing analytical tools to complete this task.

Harvest:
WDFW and Tribal co-managers (Muckleshoot Tribe and the Suquamish Tribe) prepare an annual Fisheries Management Plan for the harvest of Green River winter steelhead produced from this program (WDFW et al. 2008 to present). Returning early winter steelhead adults provide for limited tribal commercial and subsistence use and provide a localized recreational sport fishery, mostly from November through mid-February each year. Tribal fisheries include net and hook and line fisheries, generally from early-December through late-February. The sport fishery directed at hatchery-origin adults for the 2013-14 season was open October 16 to January 31, within selected stream reaches and until February 15 within the hatchery terminal area, with retention of two hatchery-origin steelhead over 20 inches allowed (WDFW Sport Fishing Rules 2013/2014).

Monitoring, Evaluation, and Adaptive Management:
WDFW conducts annual spawning ground surveys in the Green River mainstem and selected tributaries. Survey data are used to track annual trends in natural population abundance and spatial distribution. WDFW is also implementing a genetic monitoring program to measure the proportion effective hatchery contribution and genetic introgression between segregated hatchery steelhead and natural origin populations in the Puget Sound DPS. These monitoring programs will provide input data to a TVA model that will provide information to adaptively manage the early winter hatchery programs relative to other "All-H Actions" and viability parameters.

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of hatchery or program.

Green River Winter Steelhead Program (Soos Creek Hatchery and Icy Creek Rearing Pond).

1.2) Species and population (or stock) under propagation, and ESA status.

Green River (Early winter stock) Steelhead (*Oncorhynchus mykiss*).

Not ESA-Listed – Early winter hatchery stock perpetuated in the Green River system is not considered part of the Puget Sound Distinct Population Segment (DPS), for Puget Sound Steelhead listed as *Threatened* under the ESA (National Marine Fisheries Service, May 11, 2007).

1.3) Responsible organization and individuals

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Other agencies, Tribes, co-operators, or organizations involved, including contractors, and extent of involvement in the program:

The **Muckleshoot Indian Tribe (MIT)**, **Suquamish Tribe** and WDFW prepare an annual fishery management plan for the harvest of Green River system winter and summer steelhead from hatchery programs. In the past, some sub-yearlings were transferred to the Muckleshoot Tribal facility at Keta Creek (March) for acclimation and release -- this portion of the program has been eliminated.

1.4) Funding source, staffing level, and annual hatchery program operational costs.

Facility	Funding Sources	Operational Information (FY 2013)[1]
Soos Creek Hatchery	Puget Sound Recreational Enhancement (PSRE) Fund Wildlife Fund – State DJ-Federal Local	FTEs = 4.44 Annual operating cost (dollars) $418,922
Icy Creek Rearing Pond	PSRE fund	Full time equivalent staff – 0.88 Annual operating cost (dollars) - $86,128

[1]The above information for annual operating cost applies to all species produced at these facilities.

1.5) Location(s) of hatchery and associated facilities.

Broodstock Collection; Incubation; Rearing Locations:

Soos Creek Hatchery: Located on Big Soos Creek (WRIA 09.0072) at RM 1, tributary to the Green River (WRIA 09.0001) at RM 33.5.

Acclimation and Release:

Soos Creek Hatchery:

Icy Creek Rearing Pond: Located on Icy Creek (WRIA 09.0125), tributary to the Green River (WRIA 09.0001) at RM 48.3.

Figure 1.5.1: Green /Duwamish watershed Hatcheries and associated rearing, acclimation and release facilities.

Source: WDFW GIS Staff.

1.6) Type of program.

Segregated Harvest.

1.7) Purpose (Goal) of program.

Harvest Augmentation.

1.8) Justification for the program.

The NMFS Biological Opinion established a 4.2% limit on the aggregate average harvest rate of natural origin steelhead in five basins: Skagit River, Snohomish River, Green River, Puyallup River, and Nisqually River. This severely limits the opportunities for treaty tribe harvest and recreational fisheries.

The harvest of hatchery fish under this program is an essential part of the Tribe's federally – recognized treaty fishing rights. The role of this and other hatchery programs associated with treaty-reserved fishing rights is to support four basic values recognized by the Federal courts: (1) resource conservation, (2) ceremonial, religious, and spiritual values, (3) subsistence values, and (4) commercial values. The natural production of steelhead in the Green-Duwamish watershed has been diminished by the extensive loss and degradation of habitat. Hatchery production is needed to replace lost natural production and provide meaningful harvest opportunity in fulfillment of the Indian Tribe's treaty fishing rights as affirmed by U.S. v. Washington proceedings.

Historically, tributary spawning in the Green-Duwamish accounted for up to 55% of the total natural origin escapement to the basin (1984). The five-year average of tributary contribution dropped from 40% in 1987 to 22%-34% from 1998-2013. Since 2005 this average has remained at or below 11%. This decline is due in large part to habitat degradation in the two main tributaries, Soos and Newaukum Creeks.

In addition to habitat loss and degradation, high parasite loads (*Nanophyetus*) in the Green-Duwamish Basin severely limit the potential for natural production at self-sustaining and harvestable levels.

See Section 3.4 in this HGMP for links to habitat protection and recovery processes.

The purpose of the program is to produce Green River (early winter stock) steelhead for sustainable fisheries for harvest in terminal recreational fisheries and to fulfill Treaty Indian fishing right entitlements (*U.S. v Washington*).

To minimize impacts on listed fish from facilities operations: the following Risk Aversions are included in further sections of this HGMP (**Table 1.8.1**):

Table 1.8.1: Summary of risk aversion measures for the Soos Creek winter steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.2	Surface water rights are formalized through trust water right #S1-21122. Spring water rights at Soos are formalized though trust water right #S1-000382CL Monitoring and measurement of water usage is reported in monthly NPDES reports.

Intake Screening	4.2	Intake screens at the Soos Creek Hatchery are in compliance with state and federal guidelines (NMFS 1995, 1996), but do not meet the current Anadromous Salmonid Passage Facility Design criteria (NMFS 2011a). The 2012 budget provided WDFW with funding to replace/renovate the existing intake to meet current fish passage and screening requirements.
Effluent Discharge	4.2	This facility operates under the "Upland Fin-Fish Hatching and Rearing" National Pollution Discharge Elimination System administered by the Washington Department of Ecology (DOE) - WAG 13 – 3014 (Soos) and WAG 13 – 3013 (Icy).
Broodstock Management & Adult Passage	2.2.2, 2.2.3,7.9	Winter steelhead voluntarily enter an instream trap at Soos Creek and an off channel trap at Icy Creek during a time period (December through mid-February) when Chinook salmon are not typically present.
Disease Transmission	7.7, 9.2.7	*The Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006) details hatchery practices and operations designed to stop the introduction and/or spread of any diseases.
Competition & Predation	2.2.3, 10.11	Fish are released as smolts between April and May to foster rapid migration to marine waters and to allow juvenile listed fish to grow to a size that reduces the potential for predation.

1.9) List of program "Performance Standards".

See HGMP section 1.10. List of program "Performance Indicators", designated by "benefits" and "risks."

1.10.1) "Performance Indicators" addressing benefits.

Table 1.10.1.1: "Performance Indicators" addressing benefits.

Benefits		
Performance Standard	**Performance Indicator**	**Monitoring & Evaluation**
3.1.1 Program contributes to fulfilling tribal trust responsibility mandate and treaty rights as described in applicable agreements (*U.S. v Washington*).	Contributes to co-manager harvest.	Participate in annual coordination between co-managers to identify and report on issues of interest, coordinate management, and review programs (FBD process and annual fisheries management plans).
3.1.2 Program contributes to mitigation requirements.	Number of fish released by program, returning, or caught, applicable to given mitigation requirements.	Annually estimate survival and contribution to fisheries for each brood year released. This program provides mitigation for lost fish production due to development within the Green River system

		and contributes to sport and tribal fisheries.
3.1.3 Program addresses ESA responsibilities.	Program complies with Federal ESA-listed fish take authorizations for harvest and hatchery actions.	HGMP updated and re-submitted to NOAA with significant changes or under permit agreement.
3.2.1 Fish produced for harvest are propagated and released in a manner enabling effective harvest, as described in all applicable fisheries management plans, while adequately minimizing by-catch of non-target species.	Annual number of fish produced by program caught in all fisheries, including estimates of fish released.	Annually mass-mark hatchery steelhead releases to differentiate hatchery from natural-origin fish and record estimates of mark rate. The external mark enables mark-selective fisheries, which can reduce directed harvest mortality on natural-origin fish. Agencies monitor harvests and hatchery returns to provide up-to-date information. Estimate survival and contribution to fisheries for each brood year released.
3.5.5 Juveniles are released at fully-smolted stage to benefit juvenile to adult survival rates, and reduce the likelihood for residualism and negative ecological interactions with natural-origin fish.	Level of smoltification (size, appearance, behavior, etc.) at release compared to WDFW rearing and release guidelines (Tipping 2001). Release type (forced, volitional, or direct).	Monitor fish condition in the hatchery throughout all rearing stages. Annually monitor and report size, number, and date of release.
3.5.6 The number of adults returning to the hatchery that exceeds broodstock needs is declining.	Program is properly sized to meet harvest objectives; program fish are fully utilized in target fisheries.	Monitor harvests and hatchery returns throughout the run.
3.6.1 The hatchery program uses standard scientific procedures to evaluate various aspects of artificial propagation.	Apply basic monitoring standards in the hatchery: food conversion rates, growth trajectories, mark/tag rate error, weight distribution (CVs).	Collect annual run timing, age and sex composition data upon adult return. Annually monitor and report growth rates, mark rate and size at release and release dates.
3.8.3 Non-monetary societal benefits for which the program is designed are achieved.	Contributes to cultural and recreational benefits to the general population. Also contributes cultural, ceremonial and subsistence (C&S), and recreational benefits for PNW Native Americans. Surplus (food-grade quality) fish provides contributions to local charitable organizations. Recreational fishery angler days, length of season, number of licenses purchased.	Assess annual harvest of hatchery fish based on Catch Record Card (CRC) estimates. Annually record and report number of surplus fish donated to local charitable organizations.

1.10.2) "Performance Indicators" addressing risks.

Table 1.10.2.1: "Performance Indicators" addressing risks.

Risks		
Performance Standard	**Performance Indicator**	**Monitoring & Evaluation**
3.1.3 Program addresses ESA responsibilities.	Program complies with Federal ESA-listed fish take authorizations for harvest and hatchery actions.	HGMP is updated to reflect any major changes in program and resubmitted to NOAA fisheries. Program risks have been addressed in this HGMP through best available science and hatchery management actions. Monitor juvenile hatchery fish size, number, date of release and mass-mark quality; monitor contribution of hatchery adult fish to fisheries and hatchery escapement.
3.2.1 Fish produced for harvest are produced and released in a manner enabling effective harvest, as described in all applicable fisheries management plans, while adequately minimizing by-catch of non-target species.	Annual number of fish produced by this program caught in all fisheries, including estimates of fish released	Annually mass-mark (adipose fin-clip) juvenile steelhead releases to differentiate hatchery- from natural-origin fish, and record estimates of mark rate. The external mark enables state agencies to initiate mark-selective fisheries, which can reduce directed harvest mortality on natural-origin fish. Harvest is regulated to meet appropriate biological assessment criteria. Agencies monitor harvests and hatchery escapements to provide up-to-date information.
3.4.3 Life history characteristics of the natural population do not change as a result of this hatchery program.	Life history patterns of juvenile and adult NOR are stable.	Spawn timing of the natural population is performed by conducting redd surveys, and smolt size, production and outmigration timing are monitored via smolt trapping data.
3.5.1 Patterns of genetic variation within and among natural populations do not change significantly as a result of artificial production.	Within and between populations, genetic structure is not significantly affected by artificial production.	Conduct genetic monitoring of the hatchery and natural populations (see HGMP section 11.1).
3.5.2 Collection of broodstock does not adversely impact the genetic diversity of the naturally-spawning population.	Total number of natural-origin spawners (if any) reaching the collection facility. Timing of collection compared to overall run timing -	All hatchery production is identifiable in some manner (fin-marks, tags, etc.). Segregated program - only marked hatchery fish are used

	broodstock-separated timing of earlier hatchery fish from later natural-origin spawners to minimize potential spawning overlap.	for broodstock purposes; fish are spawned before January 31. Collect annual run timing, origin, and age and sex composition data. Examine returning fish for the fin-mark at the hatchery. Annually monitor and report numbers of estimated hatchery (marked) and natural (unmarked).
3.5.3 Hatchery-origin adults in natural production areas do not negatively affect the total natural spawning population.	Watershed –specific introgression rates of the natural spawning populations.	Collect tissues for DNA analysis from key demographic/tributary groups in each watershed subbasin sample and refine DNA analysis to better understand the genetic composition of steelhead DIPs and monitor for signals of hybridization with hatchery fish. Input introgression data to TVA analysis and attempt to scale programs accordingly.
3.5.4 Juveniles are released on-station, or after sufficient acclimation to maximize homing ability to intended return locations.	Fish are reared and released on-station	Annually monitor and report release (information location, method, and age class) in (WDFW Hatcheries Headquarters Database).
3.5.5 Juveniles are released at fully-smolted stage.	Level of smoltification at release. Release type (forced, volitional or direct).	Annually monitor and report size, number, date of release and release type.
3.5.6 The number of adults returning to the hatchery that exceeds broodstock needs is declining.	Program is sized appropriately for harvest goals. Numbers of surplus hatchery returns are calculated annually.	Annually monitor and report numbers of adults returning to the hatchery, broodstock collected, and surplus returns.
3.7.1 Hatchery facilities are operated in compliance with all applicable fish health guidelines and facility operation standards and protocols (IHOT, PNFHPC, the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006), INAD, MDFWP).	Annual reports indicating levels of compliance with applicable standards and criteria. Periodic audits indicating level of compliance with applicable standards and criteria.	Pathologists from WDFW's Fish Health Section monitor program monthly. Exams performed at each life stage may include tests for virus, bacteria, parasites and/or pathological changes, as needed. The program is operated consistent with the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006).
3.7.2 Effluent from hatchery facility will not detrimentally affect natural populations.	Discharge water quality compared to applicable water quality standards by NPDES	Flow and discharge reported in monthly NPDES reports.

	permit. WDOE water rights permit compliance.	
3.7.3 Water withdrawals and in-stream water diversion structures for artificial production facility operation will not prevent access to natural spawning areas, affect spawning behavior of natural populations, or impact juvenile rearing environment.	Water withdrawals compared to NMFS, USFWS and WDFW applicable passage and screening criteria for juveniles and adults.	Barrier and intake structure compliance assessed and needed fixes are prioritized.
3.7.4 Releases do not introduce pathogens not already existing in the local populations, and do not significantly increase the levels of existing pathogens. Follow the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006).	Necropsies of fish to assess health, nutritional status, and culture conditions.	WDFW Fish Health Section inspects adult broodstock yearly for pathogens and monitor juvenile fish on a monthly basis to assess health and detect potential disease problems. As necessary, WDFW's Fish Health Section recommends remedial or preventative measures to prevent or treat disease, with administration of therapeutic and prophylactic treatments as deemed necessary. A fish health database will be maintained to identify trends in fish health and disease and implement fish health management plans based on findings.
	Release and/or transfer exams for pathogens and parasites.	Examine fish 1 to 6 weeks prior to transfer or release, in accordance with the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006).
	Inspection of adult broodstock for pathogens and parasites.	At spawning, lots of up to 60 adult broodstock are examined for pathogens.
	Inspection of off-station fish/eggs prior to transfer to hatchery for pathogens and parasites.	Controls of specific fish pathogens through eggs/fish movements are conducted in accordance to the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006).
3.7.5 Any distribution of carcasses or other products for nutrient enhancement is accomplished in compliance with appropriate disease control regulations and guidelines, including State, Tribal and	All applicable fish disease policies are followed. See HGMP sections 7.5 and 7.8.	Conduct controls of specific fish pathogens through eggs/fish movements in accordance to the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and

Federal carcass distribution guidelines.		WWTIT 1998, updated 2006). Record and report disposition of carcasses in the WDFW Hatcheries Headquarters Database
3.7.6 Adult broodstock collection operation does not significantly alter spatial and temporal distribution of any naturally-produced population.	Spatial and temporal spawning distribution of natural populations above and below weir/trap currently compared to historic distribution.	Trap is checked regularly. When natural-origin steelhead are mixed in with hatchery fish, they are safely returned to the river.
3.7.7 Weir/trap operations do not result in significant stress, injury or mortality in natural populations.	Mortality rates in trap. Pre-spawning mortality rates of captured fish in the hatchery and/or after release.	Trap checked regularly. Annually monitor and report abundances and observations of natural-origin and hatchery-origin fish at hatchery facilities.
3.7.8 Predation by artificially produced fish on naturally – produced fish does not significantly reduce numbers of natural fish.	Hatchery juveniles are raised to smolt-size and released from the hatchery at a time that fosters rapid migration downstream.	Hatchery smolt release size and time are monitored to quantify/minimize predation effects on naturally-produced listed fish (Sharpe et al. 2008, Pflug et al. 2013) (see also HGMP section 2.2.3). No predation data available for watershed.
3.8.1 Cost of program operation does not exceed the net economic value of fisheries in dollars per fish for all fisheries targeting this population.	Total cost of operation.	Compare annual operational cost of program to calculated fishery contribution value (Wegge 2009).

1.10) Expected size of program.

1.11.1) Proposed annual broodstock collection level (maximum number of adult fish).

Up to 80 adults collected annually.

1.11.2) Proposed annual fish release levels (maximum number) by life stage and location.

Table 1.11.2.1: Annual release levels, by site.

Life Stage	Release Location	Annual Release Level
Yearlings	Soos Creek (WRIA 09.0072)	35,000
	Icy Creek (WRIA 09.0125)	35,000
	Total Releases (Green River System)	**70,000**

Source: Future Brood Document 2013.

1.12) Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels.

Due to a lack of coded-wire tag (CWT) studies and limitations that not all fish can be accounted for as being harvested or as back-to-rack counts, smolt-to-adult survival rates (SAR) are likely underestimated. Based on the average smolt-to-adult survival of 0.32% for brood years 1996-2007 and a programmed release goal of 70,000 yearlings, the estimated adult production (goal) level would be 223 (see HGMP section 3.3.1). A significant release size decrease (145,000) was

instituted for release year 2010 with the elimination of steelhead releases from the Palmer Ponds facility.

Table 1.12.1: Green River system Hatchery winter (early) steelhead escapement 2001-2013.

Year	Hatchery Escapement		
	Soos Creek	**Palmer Ponds**	**Icy Creek**
2001/2002	0	83	N/A
2002/2003	51	0	
2003/2004	79	0	
2004/2005	111	16	
2005/2006	100	3	
2006/2007	201	42	
2007/2008	294	27	
2008/2009	89	10	
2009/2010	297	Discontinued	
2010/2011	161		
2011/2012	122		
2012/2013	109		22
Average	**135**	**23**	

Source: WDFW Hatcheries Headquarters Database 2013

1.13) Date program started (years in operation), or is expected to start.

Releases from Soos Creek Hatchery and the Icy Creek Rearing Pond began in 2003.

1.14) Expected duration of program.

Ongoing.

1.15) Watersheds targeted by program.

Duwamish/Green River (WRIA 09.0001).

1.16) Indicate alternative actions considered for attaining program goals, and reasons why those actions are not being proposed.

Alternative 1: *Reduce number of winter steelhead released* as a measure to decrease genetic and ecological risks to natural-origin steelhead. The Co-Managers did not pursue this alternative because further reductions to the proposed program size would gain negligible ecological benefits while imposing harsh consequences on harvest; this alternative would not meet enhancement or harvest objectives for the program and would not meet the goals of either Co-Manager, including providing recreational, cultural and subsistence, ceremonial, religious, commercial and non-commercial benefits, nor be compatible with Treaty Indian fishing rights (*U.S. v Washington*) for sustainable fisheries.

Alternative 2: Discontinue the program. The Co-Managers did not pursue this alternative because: 1) program is projected to meet standards; and 2) it would not meet enhancement or harvest objectives for the program and would not meet the goals of either co-Manager, which include providing recreational, cultural and subsistence, ceremonial, religious, commercial and non-commercial benefits, nor be compatible with Treaty Indian fishing rights (*U.S. v Washington*) for sustainable fisheries

Alternative 3: Replace segregated program with an integrated program. To meet conditions of the incidental take statement in NOAA's recent Biological Opinion (NMFS 2011b), the average

terminal harvest rate for Skagit, Snohomish, Green, Puyallup and Nisqually, should not to exceed 4.2%. Changing broodstock strategy from segregated to integrated would place the fishery on top of the peak natural origin run, and would be expected to exceed allowable impacts.

SECTION 2. PROGRAM EFFECTS ON NMFS ESA-LISTED SALMONID POPULATIONS. (USFWS ESA-Listed Salmonid Species and Non-Salmonid Species are addressed in Addendum A)

2.1) List all ESA permits or authorizations in hand for the hatchery program.

The Palmer Ponds winter steelhead HGMP (now Soos Creek) was previously submitted to NOAA Fisheries in 2004, but was not acted on at that time. This HGMP is submitted to NOAA Fisheries for ESA consultation, and determination regarding compliance of the plan with ESA Limit 6 of the 4(d) rule criteria for joint state/tribal hatchery resource management plans affecting listed species.

2.2) Provide descriptions, status, and projected take actions and levels for NMFS ESA-listed natural populations in the target area.

2.2.1) Description of NMFS ESA-listed salmonid population(s) affected by the program.

- Identify the NMFS ESA-listed population(s) that will be directly affected by the program.

None directly.

- Identify the NMFS ESA-listed population(s) that may be incidentally affected by the program.

Puget Sound Chinook (*Oncorhynchus tshawytscha*): Listed as *Threatened* on March 24, 1999 (64FR14308); *Threatened* status reaffirmed on June 28, 2005 (70FR37160); reaffirmed *Threatened* by five-year status review, completed August 15, 2011 (76FR50448). The Puget Sound Chinook salmon ESU is composed of 31 historically quasi-independent populations, of which 22 are believed to be extant currently. 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 (Ford 2011), as well as twenty-seven artificial propagation programs (NMFS 2013 78FR38270). In the Duwamish/ Green River basin, the Technical Recovery Team (TRT) has identified one demographically independent population (DIP) (Duwamish/ Green River Chinook) (Ruckelshaus et al. 2006).

Puget Sound steelhead *(Oncorhynchus mykiss*): Listed as *Threatened* under the ESA on May 11, 2007 (72FR26722); reaffirmed *Threatened* by five-year status review, completed August 15, 2011 (76FR50448). 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 2011). 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 (NMFS 2013 78FR38270). In the Duwamish/ Green River basin, the TRT has preliminarily delineated one demographically independent population (DIP) of winter steelhead; (Green River), no native summer run populations were identified in the basin (PSSTRT 2013).

2.2.2) Status of NMFS ESA-listed salmonid population(s) affected by the program.

- Describe the status of the listed natural population(s) relative to "critical" and "viable" population thresholds

Soos Creek (Green/Duwamish) Hatchery fall Chinook in the Puget Sound Chinook ESU. NMFS (1999) considered this stock to be in the ESU, but not essential for recovery. The stock was designated Category 2a, as the hatchery population is derived from a native, local population (SSHAG 2003). The NMFS subsequently listed hatchery production in the Green because these hatchery stocks are not significantly divergent from naturally-spawning fish in the watershed (70 FR 37160. June 28, 2005; NMFS SHIEER 2004, NMFS 2005).

Green/ Duwamish fall Chinook in the Puget Sound Chinook ESU. Recent escapement levels (2005-2012) have averaged 1,547 for natural spawners in the Green/Duwamish DIP. During this same time period, the population has shown declining trend (SaSI, WDFW 2012).

Puget Sound Chinook salmon: Updated Risk Summary. All Puget Sound Chinook populations are well below the TRT planning range for recovery escapement levels. Most populations are also consistently below the spawner recruit levels identified by the TRT as consistent with recovery. Across the ESU, most populations have declined in abundance somewhat since the last status review in 2005, and trends since 1995 are mostly flat. Several of the risk factors identified by Good et al. (2005) are also still present, including high fractions of hatchery fish in many populations and widespread loss and degradation of habitat. Many of the habitat and hatchery actions identified in the Puget Sound Chinook recovery plan are expected to take years or decades to be implemented and to produce significant improvements in natural population attributes, and these trends are consistent with these expectations. Overall, the new information on abundance, productivity, spatial structure and diversity since the 2005 review does not indicate a change in the biological risk category since the time of the last BRT status review.

See Soos Creek Fall Chinook HGMP for Viability Criteria.

Green River steelhead in the Puget Sound steelhead DPS. The number of natural-origin winter steelhead has increased in the last five years. From a low point in 2008-2009 of 304 spawners, the number of spawners increased to 714 in 2012-2013. Ford (2011) used spawner data collected through 2008 and concluded the following: "Steelhead counts in the Green River have declined steadily since the 1980's and most sharply since 2005. The estimated probability that this steelhead population would decline to 10% of its current estimated abundance (i.e., to 45 fish) is high—about 90% within 80 years. With an estimated mean population growth rate of -0.042 ($\lambda = 0.959$) and process variance of 0.001, NOAA was highly confident ($P < 0.05$) that a 90% decline in this population will not occur within the next 20 years, and that a 99% decline will not occur within the next 45 years. However, beyond the next 50 years NOAA was highly uncertain about the precise level of risk." Based on a preliminary intrinsic potential) estimate by the PSSTRT (2013), the capacity for winter steelhead is between 1,977 and 39,537 in the Green River Basin.

*Puget Sound steelhead: Updated Risk Summary***.** The number of winter steelhead spawners has increased for many populations in Puget Sound since 2009. The number of spawners for 16 Puget Sound winter steelhead populations, relative to the average number of spawners for each population in the four year period up to the listing in 2007, increased from an average of 53% in 2009 to 141% in 2013.

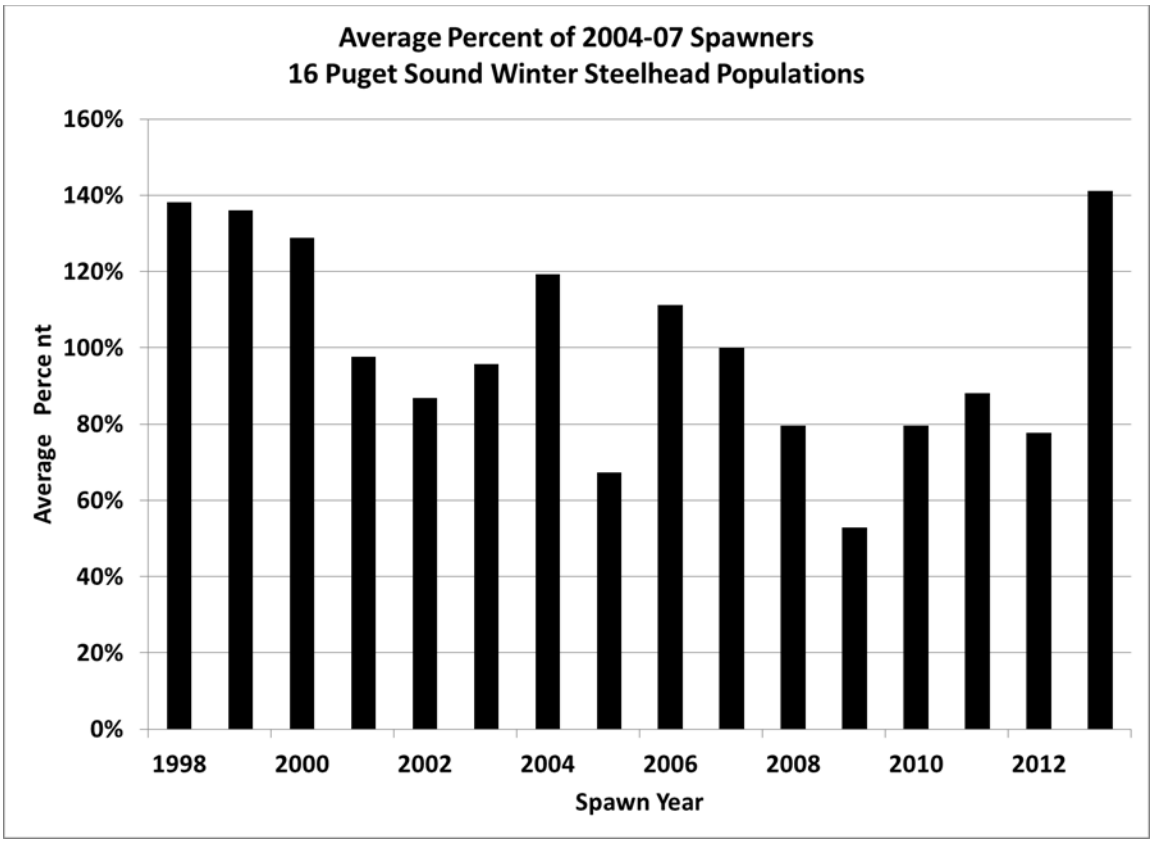

Figure 2.2.2.1: Average percent of 2004-2007 spawners for 16 Puget Sound winter steelhead populations.

These recent, short-term increases in spawners are a positive development, but do not negate the long-term risks facing Puget Sound steelhead DPS. Using spawner data collected through 2008 or 2009, Ford (2011) concluded that the status of the listed Puget Sound steelhead DPS has not changed substantially since the 2007 listing, and that steelhead in the Puget Sound DPS remain at risk of extinction throughout all or a significant portion of their range in the foreseeable future, but are not currently in danger of imminent extinction.

Table 2.2.2.1: Interim DIP abundance goals for 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.

Population Basin				Quasi Extinction Threshold	Low Abundance	Viable	Capacity
Population Name	Area km^2	Mean Elevation (m)	Total Stream Length (m)		1% SAS	5% SAS	20% SAS
Green River	1,444	463	834,472	69	1,977	9,884	39,537
Puget DPS Total				**1,462**	**30,449**	**153,194**	**613,662**

Source: Hard et al. 2014.

- Provide the most recent 12 year (e.g. 1988-present) progeny-to-parent ratios, survival data by life-stage, or other measures of productivity for the listed population.

See Soos Creek Fall Chinook HGMP for Chinook Productivity Data.

Green River steelhead (*Oncorhynchus mykiss*): WDFW natural-origin smolt monitoring activity occurs on this system.

Table 2.2.2.2: Abundance estimates, 95% confidence intervals, and coefficient of variation (CV) for natural-origin steelhead smolts rearing above the Green River juvenile trap, migration years 2009-2013.

Trap Year[a]	Abundance	95% C.I.		CV
		Lower	Upper	
2009	26,174	10,151	42,198	19.4%
2010	71,710	49,317	94,103	15.9%

Source: Topping and Zimmerman 2013.
[a] 2011 to 2013 data currently unavailable.

Table 2.2.2.3: Estimates of exponential trend in the natural logarithm (ln) of natural spawners (lambda) for winter-run populations of steelhead in the Puget Sound DPS over the entire data series (1985 – 2009; last data point is 2001) (95% CI).

Population	1985-2009	1995-2009
Green River winter-run	0.992 (0.969 - 1.016)	0.953 (0.892 - 1.019)

Source: Ford 2011. These are based on analyses reported by Ford (2011) that are not necessarily agreed to by WDFW and the Muckleshoot and Suquamish Tribes.

- Provide the most recent 12 year (e.g. 1988-1999) annual spawning abundance estimates, or any other abundance information. Indicate the source of these data.

See Soos Creek Fall Chinook HGMP for Chinook Escapement Data.

Table 2.2.2.4: Green (Duwamish) River natural origin winter steelhead spawning escapement 2000-2011.

Return Year	Escapement
2000/2001	1,402
2001/2002	1,068
2002/2003	1,612
2003/2004	2,359
2004/2005	1,298
2005/2006	1,955
2006/2007	1,452
2007/2008	833
2008/2009	304
2009/2010	423
2010/2011	855
2011/2012	**388**
Average	**1,162**

Source: (Aaron Bosworth, District Biologist, 2012). Data are total escapement estimates based on cumulative redd counts in all mainstem spawning areas and in index reaches in Soos and Newaukum creeks totaling 12 miles. Does not include natural origin brood collected for hatchery program.

- Provide the most recent 12 year (e.g. 1988-1999) estimates of annual proportions of direct hatchery-origin and listed natural-origin fish on natural spawning grounds, if known.

See Soos Creek Fall Chinook HGMP for Chinook pHOS and pNOS estimates.

Green River (Duwamish) steelhead (*Oncorhynchus mykiss*):

The early winter hatchery programs in the Green River basin are designed to take into account potential risks of artificial propagation on listed species while still providing for some harvest by treaty tribes and recreational fisheries. Efforts to minimize potential risks of artificial propagation are described below. Likewise, to protect against overutilization of natural origin steelhead whose abundances have declined from historical levels, the NMFS Biological Opinion established a 4.2% limit of the aggregate average harvest rate of natural origin steelhead in five basins: Skagit River, Snohomish River, Green River, Puyallup River, and Nisqually River. The factors driving the declining abundance of natural origin steelhead, however, have not been similarly restricted, including: 1) the present and increasing threat of destruction, modification and curtailment of natural origin steelhead freshwater, estuarine, and marine habitat; 2) predation and potentially disease, and 3) the inadequate existing regulatory mechanisms to protect natural origin steelhead habitat. The current harvest restriction severely limits the opportunities for both treaty and non-treaty fisheries on natural origin steelhead. The lack of adequate habitat protection and restoration places an unacceptable disparate burden on hatchery programs, the exercise of the tribes' treaty-secured rights, limits recreational fishing opportunities, and fails to conserve steelhead. The potential risks of this hatchery program, therefore, have to be considered in the context of failure to implement steelhead habitat protection and restoration measures commensurate with those measures imposed on steelhead hatchery and harvest programs that result in diminished fishing opportunities.

An integrated Total Viability Analysis (TVA) is needed to assess the risks of the proposed hatchery program relative to other risk factors and to develop management actions that are likely to lead to recovery. As noted by the Puget Sound Technical Recovery Team (2003), "Considering the effects of one factor at a time (e.g. harvest, habitat, or hatchery management actions) on salmon population characteristics is more tractable from a technical standpoint, but such estimates of effects are sure to be wrong in most instances. Managers [are asked] to consider suites of habitat, harvest, and hatchery actions together, especially with a view towards how these factors interact..." Rather than simplistic single sector analysis and management actions, our challenge is to develop a suite of integrated recovery actions that lead to increased production and viability of natural origin steelhead. The WDFW and Treaty tribes are now developing analytical tools to initiate this task.

Analyses of a single hatchery parameter or application of a universal standard is unlikely to lead to an informed decision regarding the potential risk of a hatchery program or to the identification of appropriate management actions. We used four analyses to evaluate the potential genetic effects of the early winter steelhead programs on natural origin steelhead. The analyses are complementary - they use multiple sources of information and address multiple questions.

1) Genetic Introgression. Introgression is the accumulation of hatchery-origin genetic changes in natural origin populations, and starts with hybridization, here between hatchery and natural origin individuals. We estimate the relative number of F1 hybrids (i.e. first generation hybrids) as a proxy for genetic introgression to address the question "How have past early winter hatchery program practices affected the genetic characteristics of natural origin steelhead?" Since our analysis relies on tissue samples from natural-origin steelhead collected in the Green River, it provides a direct measure of the identity of the parents of individuals sampled, and depending on what year the individuals were sampled, may represent the effects of the original early winter hatchery program. However, it may also reflect some practices that have now ended (e.g., off-station plants, recycling of returning adults, larger number of fish released).
2) Projected Genetic Introgression. We developed a simple, heuristic model to project how genetic introgression might change in the future based on the assumptions discussed below and the model structure.

3) Proportion Effective Hatchery Contribution. The proportion effective hatchery contribution (PEHC) is the proportion of natural spawners that are genetically derived from the early winter hatchery program and includes both hatchery-natural origin hybrids and pure natural-origin hatchery-lineage fish. We estimated the PEHC from an analysis of the genetic ancestry of tissue samples from natural-origin steelhead from the Green River (Warheit 2014). Since the PEHC includes pure hatchery-lineage fish that have the potential to generate hybrid offspring, it addresses a broader question than would genetic introgression alone: "How may early winter hatchery program practices affect the potential for genetic introgression, given the limitations to that projection as described below Table 2.2.2.5?" Like the analysis of introgression, PEHC relies on tissue samples from natural-origin steelhead collected in the Green River, and provides a direct measure of the effects of the early winter hatchery program.

4) Gene Flow. Whereas genetic introgression is a cumulative state, gene flow is the process that leads to genetic introgression. Gene flow may vary each year in response to hatchery program characteristics such as the number and location of fish released and the number of natural-origin spawners. We asked the question "What was the historical gene flow and what do we anticipate gene flow will be with the new proposed program?" We calculated a potential range of gene flow from the early winter hatchery program to the natural origin populations based on the assumptions of hatchery steelhead fitness, the overlap in spawn timing of hatchery and natural origin steelhead, and stray rate assumptions for early winter steelhead (see next section and Hoffmann 2014).

The results are summarized in Table 2.2.2.5 and discussed in greater detail in the following sections. Introgression from the early winter steelhead program was evident in the Green River Winter population (0.11) and the PEHC for previous hatchery practices was 0.055. The estimated PEHC for the proposed programs was 0.02 and gene flow was projected to be less than 2% for most parameter values (range of 0.2% to 2.5%). Several key assumptions and uncertainties of the analyses are discussed briefly below (see Warheit (2014) and Hoffmann (2014) for a more detailed discussion):

1) Uncertainty in Estimates. Although we report most statistics as point estimates, the estimates have variance associated with sampling the population and measuring biological attributes. Because of variability inherent in natural systems, and our sampling programs, we can expect substantial inter-annual variability in our point estimates, even if the true value is constant.

2) Effects of Variations in Population Abundance. Our projections for the proposed program assume that the abundance of the natural-origin population remains constant relative to when the samples were taken. Increases in population abundance will result in lower values of introgression, PEHC, and gene flow even if the hatchery programs do not change. Conversely, decreases in population abundance will result in higher values of introgression, PEHC, and gene flow than projected.

3) Time Lags. The effects of changes in hatchery programs may not be evident for 2-5 years after the changes have been made. This time lag reflects: a) the multiple years of ocean residence between smolt release and the return of adult fish; b) the multiple ages at return for adult steelhead; and c) the presence of hatchery-natural origin hybrids from previous generations that can continue to contribute to the genetic characteristics of the population.

4) Neutral Markers. The genetic analysis was based on SNP loci that were presumably neutral to natural selection. These markers were used to categorized fish as pure early winter hatchery lineage, natural origin lineage, and hybrid between the hatchery

and natural origin lineages. If a hatchery program is terminated, the amount of time it takes a natural origin population to purge itself of alleles that categorize a fish as being a hatchery or hybrid fish is a function of the frequency of the alleles and the effective size of the natural origin population.

Genetic Introgression. We evaluated genetic introgression through F1 hybridization resulting from the early winter hatchery program through an analysis of tissue samples from steelhead in the Green River (Warheit 2014).

Table 2.2.2.5. Estimates of F1 hybridization, PEHC, and gene flow from early winter hatchery programs to steelhead populations in the Green River basin for past practices and proposed programs. Ranges in gene flow reflect the minimum and maximum values for parameter values from cases 1-6.

Population	F1 Hybridization	PEHC	Gene Flow
Green River Winter			
Past Practice	0.44%	5.82%	2.69% - 16.23%
Proposed Program [1/]		0.47%	0.22% - 2.37%

[1/] PEHC and gene flow estimates for the proposed program shown were scaled to reflect changes in program size and elimination of off-station releases.

Projected Genetic Introgression. We constructed the heuristic simulation model to develop insights regarding the sensitivity of introgression to variables, the time lag between when actions are taken and when changes in introgression might become evident, and variability in the estimates of introgression that might result. The model is not intended, structured, or parameterized to provide specific predictions on past or future levels of introgression, nor does it address the need for an "All-H" viability analysis as discussed above.

The base parameter values in the model included a 20% stray rate and a 45% overlap in the timing of natural origin and hatchery-origin (including hybrid) spawners. The numbers of natural origin spawners and hatchery releases were scaled to result in an introgression rate of approximately 6%. In the model, we initiated a hatchery program at time 0 with both on-station and off-station smolt releases, we eliminated the off-station releases after year 10, and eliminated all hatchery production after year 20. Our preliminary results are summarized below:

1) The model indicates a lag of 3-5 years may occur between when a hatchery management action is implemented and when the introgression level reaches a new equilibrium (Fig. 2.2.2.2). In the model, this results from both a) the multiple years of ocean residence between smolt release and returns of adult cohorts and b) the presence of a reservoir of hatchery-natural origin hybrids from previous generations that continue to contribute to the genetic characteristics of the natural origin population.
2) With a sample size of 100 fish, estimates of introgression are likely to have substantial uncertainty when the introgression rate is relatively low (Fig. 2.2.2.2). This is a result of a small sample size and the inherent variability in an estimate of an infrequent event.

3) We conducted a preliminary analysis of the sensitivity of introgression to the abundance of natural-origin steelhead, the stray rate, and the overlap in timing of hatchery and natural-origin spawners (Table 2.2.2.6). We increased or decreased the value of each variable by 50% and assessed the effect upon the estimated introgression. Estimates of introgression were most sensitive to the straying rate and changes in the abundance of the natural origin spawners.

Table 2.2.2.6. Preliminary analysis of the sensitivity of introgression to the abundance of natural-origin spawners, straying rate, and overlap of the spawn timing of hatchery and natural-origin steelhead.

Variable	Estimated Introgression
Abundance of Natural-Origin Spawners	
+50%	0.025
Base	0.034
-50%	0.051
Stray Rate	
10%	0.016
Base (20%)	0.034
30%	0.056
Spawn-Timing Overlap	
22.5%	0.027
Base (45%)	0.034
67.5%	0.038

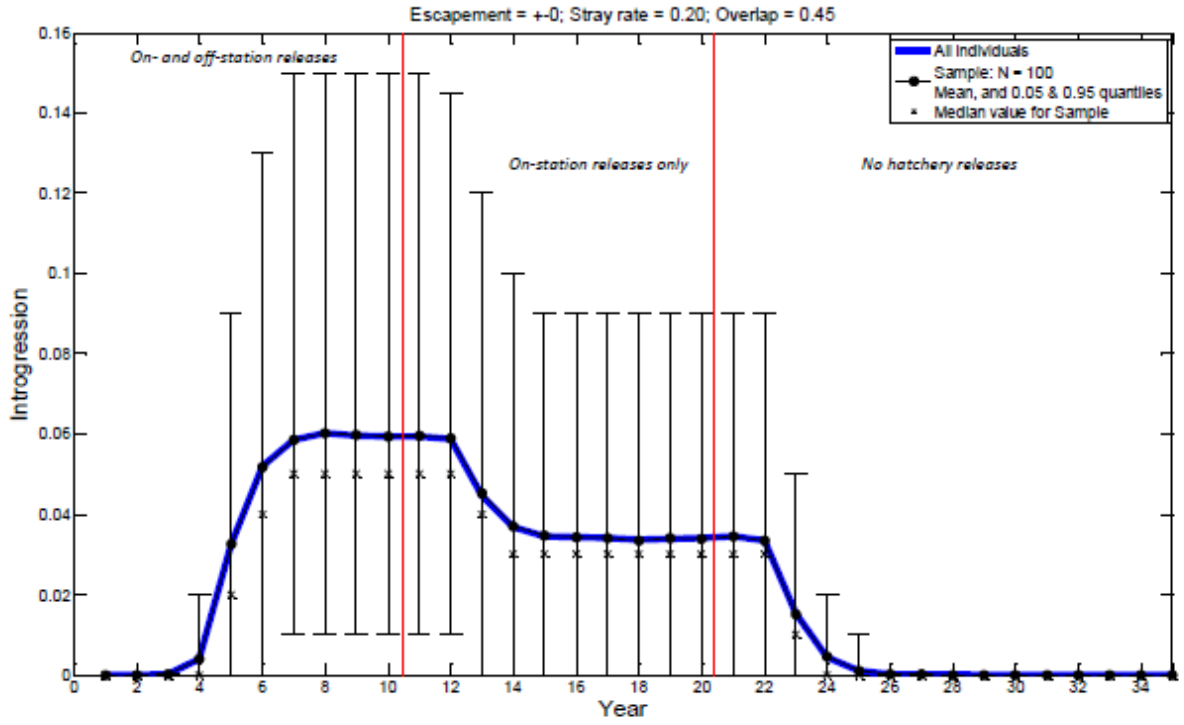

Figure 2.2.2.2. Preliminary simulation analysis of introgression including lag times in response to hatchery actions and uncertainty of estimates.

Proportion Effective Hatchery Contribution. We estimated the PEHC from the early winter hatchery program from a genetic analysis of juvenile and adult steelhead (Warheit 2014). The PEHC was estimated as 0.0582 from an analysis of 146 samples from adults collected in 2004 and 2013 and smolts collected in 2007 and 2008. The estimated PEHC reflects the previous hatchery practices that affected the juvenile and adult fish in the years when the samples were collected. The average number of juvenile fish released in the period affecting these samples was 163,999 (Table 2.2.2.7). We projected the PEHC for the proposed program of 70,000 smolts, using methods in Hoffmann (2014), to be 0.0047.

Table 2.2.2.7. Genetic samples and associated hatchery releases of winter steelhead into the Green River.

Sample	Life Stage	Sample Collection Year	Primary Spawn Year	Primary Release Year	Releases
Green	Adult	2004	2000	1998	198,000
Green	Smolt	2007	2005	2003	155,432
Green	Smolt	2008	2006	2004	76,895
Green	Adult	2013	2009	2007	225,669

Gene Flow. We estimated the gene flow from stray rates for on-station and off-station releases (Hoffmann 2014). We used a stray rate of 100% for off-station releases and stray rates of 20% and 30% for on-station releases.

We estimated gene flow using the methods of Scott and Gill (2008) and the following sources for parameter estimates:

Spawn Timing of Hatchery-Origin Spawners (o_H). The spawn timing of early winter hatchery steelhead (Hoffmann 2014) was estimated from: a) the spawn timing at the Tokul Creek Hatchery; and b) entry timing of winter steelhead into the Soos Creek Hatchery.

Spawn Timing of Natural-Origin Spawners (o_N). The spawn-timing of natural-origin fish in the Green River population (Hoffmann 2014) was estimated from: a) the range of values from Scott and Gill (2008) to bracket the likely spawn timing; and b) the spawn-timing observed for natural populations in the Green River.

Relative Fitness of HxH Crosses (k_1). The early winter hatchery programs are operated with a segregated, nonlocal broodstock that has been domesticated over a period of more than 60 years. Unlike well run integrated hatchery programs, we can anticipate that the relative fitness will be low for fish produced from this type of program. We used a range of values (0.02 to 0.13) for relative fitness drawn from the empirical studies for steelhead programs that use nonlocal broodstock (Araki et al. (2008)). These studies were not conducted with Puget Sound steelhead populations. The co-managers are committed to continuing research and monitoring to refine estimates of fitness and overlap in spawning to better understand gen flow between early winter steelhead and natural-origin steelhead.

Relative Fitness of HxW Crosses (k_2). We used a value of 0.54 which is halfway between the average value for HxH crosses (0.084) and a relative fitness of 1.0.

Proportion of Total Natural Spawners of Hatchery-Origin (q). We estimated the proportion of hatchery-origin spawners using the assumed stray rate of 100% for off-station releases and 20% or 30% for on-station releases.

Combinations of parameter values used for the six cases analyzed are summarized in Table 2.2.2.8.

The estimated gene flow for six cases of alternative parameter values are provided in table 2.2.2.9.

Table 2.2.2.8. Parameter values for six alternative cases for estimating gene flow.

Parameter	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
o_H	Spawn timing of early winter steelhead at Tokul Creek Hatchery.	Spawn timing of early winter steelhead at Tokul Creek Hatchery.	Entry timing of hatchery steelhead at Soos Creek Hatchery.	Spawn timing of early winter steelhead at Tokul Creek Hatchery.	Spawn timing of early winter steelhead at Tokul Creek Hatchery.	Entry timing of hatchery steelhead at Soos Creek Hatchery.
o_N	Spawn timing of natural origin steelhead in Snow Creek.	Spawn timing of natural origin steelhead in Clearwater River.	Spawn timing of natural origin steelhead for the population analyzed.	Spawn timing of natural origin steelhead in Snow Creek.	Spawn timing of natural origin steelhead in Clearwater River.	Spawn timing of natural origin steelhead for the population analyzed.
Stray Rate	0.20	0.20	0.20	0.30	0.30	0.30
k_1	0.02, 0.13	0.02, 0.13	0.02, 0.13	0.02, 0.13	0.02, 0.13	0.02, 0.13
k_2	0.54	0.54	0.54	0.54	0.54	0.54

Table 2.2.2.9. Estimated effective gene flow for the Green River Winter steelhead population under six alternative cases..

Spawn Year	**Case 1** Natural: Snow Creek Hatchery: Tokul Creek Stray Rate = 0.20		**Case 2** Natural: Clearwater R. Hatchery: Tokul Creek Stray Rate = 0.20		**Case 3** Natural: Green Hatchery: Soos Creek Stray Rate = 0.20		**Case 4** Natural: Snow Creek Hatchery: Tokul Creek Stray Rate = 0.30		**Case 5** Natural: Clearwater R. Hatchery: Tokul Creek Stray Rate = 0.30		**Case 6** Natural: Green Hatchery: Soos Creek Stray Rate = 0.30	
	K_1= 0.02	K_1= 0.13	K_1= 0.02	K_1= 0.13	K_1= 0.02	K_1= 0.13	K_1= 0.02	K_1= 0.13	K_1= 0.02	K_1= 0.13	K_1= 0.02	K_1= 0.13
2001-2002	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2002-2003	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2003-2004	0.24%	0.54%	0.13%	0.66%	0.32%	0.87%	0.28%	0.65%	0.15%	0.79%	0.37%	1.03%
2004-2005	1.37%	3.42%	0.79%	4.29%	1.24%	4.96%	1.57%	3.98%	0.93%	5.01%	1.39%	5.74%
2005-2006	0.26%	0.60%	0.14%	0.73%	0.35%	0.95%	0.32%	0.73%	0.17%	0.89%	0.41%	1.15%
2006-2007	3.21%	9.23%	2.23%	11.91%	2.78%	13.13%	3.55%	10.48%	2.55%	13.56%	3.13%	14.87%
2007-2008	5.52%	18.01%	4.70%	23.34%	5.43%	25.16%	6.08%	20.21%	5.39%	26.13%	6.17%	28.06%
2008-2009	4.55%	14.24%	3.59%	18.49%	4.24%	20.08%	5.03%	16.10%	4.13%	20.90%	4.81%	22.61%
2009-2010	7.48%	25.56%	7.19%	32.70%	8.09%	34.85%	8.27%	28.45%	8.25%	36.15%	9.22%	38.37%
2010-2011	3.77%	11.27%	2.76%	14.59%	3.36%	15.97%	4.17%	12.76%	3.17%	16.55%	3.79%	18.04%
2011-2012	0.52%	1.21%	0.28%	1.49%	0.59%	1.85%	0.69%	1.62%	0.37%	2.00%	0.73%	2.43%
Through 2011	3.30%	10.36%	2.69%	13.34%	3.23%	14.50%	3.66%	11.67%	3.09%	15.00%	3.66%	16.23%
All Years	2.99%	9.34%	2.42%	12.02%	2.93%	13.09%	3.33%	10.55%	2.79%	13.55%	3.34%	14.70%
No Offstation	0.23%	0.53%	0.12%	0.65%	0.29%	0.83%	0.39%	0.90%	0.21%	1.10%	0.44%	1.37%
Release 70,000	0.41%	0.96%	0.22%	1.18%	0.46%	1.45%	0.66%	1.60%	0.37%	1.99%	0.67%	2.37%

2.2.3) Describe hatchery activities, including associated monitoring and evaluation and research programs, that may lead to the take of NMFS listed fish in the target area, and provide estimated annual levels of take

- Describe hatchery activities that may lead to the take of listed salmonid populations in the target area, including how, where, and when the takes may occur, the risk potential for their occurrence, and the likely effects of the take.

Broodstock Collection: Natural origin steelhead encountered at the Soos Creek weir are identified by presence of an adipose fin and returned to stream immediately. The trapping facility at Icy Creek is a hatchery outlet-only with little or no incentive for listed fish to voluntarily enter. Broodstock collection of winter steelhead takes place between November and January 31; however the trap is operated until March 15 or later as conditions allow, insuring that any hatchery-origin adults are captured and removed from the system. This timing typically outside the return time of listed Chinook stocks and is earlier than timing of the bulk of natural origin winter steelhead returning in the Green River system. Only hatchery identified (missing adipose fin) adults are used for broodstock. Sorting at collection facilities and release may result in some physical damage but little or no mortality has been observed by staff as a majority of the natural origin escapement occurs later in the season.

Broodstock Spawning/Pathology Sampling: Only hatchery identified steelhead are spawned at Soos Creek Hatchery. After spawning, all broodstock (up to 60 total), moribund females or even fresh pond mortality may be kidney/spleen sampled for thorough pathogen screening per the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington* (WDFW and WWTIT 1998, updated 2006).

Rearing Program: Only hatchery origin steelhead are reared for this program. Listed fish are not reared in this program.

Residualism:

Rearing and release strategies are key components to minimizing risks from hatchery programs on outmigrating salmonids. Ideally, hatchery steelhead are released when fish are smolting to encourage rapid outmigration to minimize the opportunity for predation or residualism risks (Fuss et al. 1999 and Snow et al. 2013) of hatchery fish on natural outmigrants. Studies conducted on predation risks to natural-origin Chinook (Sharpe et al. 2008) and steelhead (Naman and Sharpe 2012; Pflug et al. 2013) have shown predation risks to be minimal. Short outmigrating travel times have also been shown to minimize opportunity for negative interactions (9 days Moore et al. 2013 Puget Sound wide; 16.4 days Goetz et al. 2014, Green River).
Based on 30 years of staff observations and the studies conducted to evaluate predation and residualization risks, the current protocol as described incorporates the following risk aversion factors into best practices to reduce risks to ESA-listed populations while meeting management goals.

- FISH UNIFORMITY: Monitor population uniformity of hatchery steelhead through CVs and condition factors prior to release to ensure release criteria are met (uniform size, condition, etc).
- FISH SIZE: Release groups will meet the minimum size criteria of 10 fpp established by Tipping 2001.
- RELEASE TIMING: Releases of hatchery smolts will occur on or after April 15 to minimize predation risks on out-migrating natural-origin listed fry in the freshwater system so long as the first two criteria of fish uniformity and fish size (Tynan 2012 analysis-unpublished; Iverson and Missildine 2013 unpublished).
- VOLITIONAL RELEASE: Releases of hatchery smolts will be volitional to minimize residualization risks.

- Volitional release will begin after April 15 when steelhead display cues of outward physical signs and behaviors of active smoltification, such as loss of parr marks, banding of tail, actively cruising pond edges, inflow, and outflow areas.
- Hatchery Staff will pull screens to provide the opportunity for steelhead smolts ready to emigrate to leave the pond(s) or raceway(s).
- Steelhead that have not volitionally left the holding area by the end of the release period (approximately one month (Fuss 1999; Tipping 2001) will be transferred to non-anadromous lakes for angling opportunities.

For more information on predation and competition risks see HGMP 2.2.3 *Competition/Niche-Displacement* and *Predation* sections below.

Operation of Hatchery Facilities: Potential facility operation impacts on listed fish include; water withdrawal, hatchery effluent, and intake compliance or barrier blockages. The intake screens at Soos Creek are in compliance with state and federal guidelines (NMFS 1995, 1996), but do not meet the current *Anadromous Salmonid Passage Facility Design* criteria (NMFS 2011a). Monitoring and maintenance of hatchery facilities is conducted regularly. Effluent at outfall areas is rapidly diluted with main stem flows and operation is within permitted guidelines (see HGMP sections 4.1 and 4.2). All permit requirements are followed in order to minimize the potential indirect 'Take" associated with the operations of these facilities. No take of listed fish is reported by staff during the normal operation of the hatchery.

Genetic Introgression: Genetic introgression may occur if hatchery adults spawn in the wild with both temporal and spatial separation of hatchery and natural origin steelhead playing a role in the amount of potential impact. Run timing for natural origin winter steelhead stocks in Puget Sound systems range from November to June with the current existing peak spawn time in most populations from mid-April through May (SaSI, WDFW 2012). Where native summer steelhead stocks are present, run timing occurs from April to December with peak spawn time believed to be approximately one month earlier than the winter stock (SaSI, WDFW 2012). There are no historic native summer steelhead populations in the Green/ Duwamish system (PSSTRT 2013).

Plants to various locations in the system occurred in the past, but have been eliminated and program fish are currently released on-station (100% mass marked) and with no out of basin transfers. This reduces overlap potential and straying incidences. For the early winter steelhead stocks in Puget Sound, eggs will not be collected later than January 31 in order to reduce potential overlap of hatchery fish from the existing natural-origin winter steelhead peak spawning time frame in the Green River system. The natural-origin winter run steelhead spawning generally occurs from early March to early June.

The expected gene flow rate can be much lower than the "stray" rate. In a well-run segregated program, the level of gene flow should be quite low for three reasons: 1) the numbers of hatchery-origin fish that have escaped harvest should be low compared to the number of natural-origin fish present; 2) the reproductive success of the hatchery-origin fish can be expected to be low (Leider et al. 1990; Kostow et al. 2003; McLean et al. 2003; McLean et al. 2004); and 3) spawning overlap may be low (Scott and Gill 2008).

Operational changes were implemented in 2009 to remove hatchery fish, including adults trapped above broodstock needs. These will not be re-cycled for additional sport opportunities and trapping facilities will continue removing hatchery fish until March 15 or later as conditions allow.

Disease Transmission: Interactions between hatchery reared and naturally produced populations may be a source of pathogen and disease transmission although there is little evidence showing that diseases are transmitted from hatchery fish to natural-origin fish (Steward and Bjornn 1990).

WDFW conducts fish disease examinations to ensure minimal disease transmission and to prevent the introduction and/or spread of any fish diseases. Fish health-monitoring efforts include fish health examinations and virus sampling, abnormal fish loss investigations, and pre-transfer and pre-liberation inspections. All activities are done in accordance with guidelines developed under the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006).

Competition/Niche-Displacement: Freshwater carrying capacity may be compromised if hatchery steelhead smolts planted or those produced naturally from hatchery spawners competitively displace or compete with natural origin fish in their natural rearing habitats. Smolts from on station releases in large river systems travel rapidly – migration rates of approximately 20 river miles per day have been observed with steelhead smolts released in the Cowlitz River (Harza 1999). Interactions with listed salmonids in the estuarine and nearshore environment are likely to be limited. Telemetry studies indicate that steelhead migrate out of the Puget Sound quickly, with an average travel time of approximately 9 days to the Strait of Juan de Fuca (Moore et al. 2013, Moore et al. 2010, Goetz et al. 2008).

Predation: Steelhead released from hatchery programs are unlikely to prey upon listed species of salmonids, but the magnitude of predation will depend upon the characteristic of the listed population of salmonids, the habitat in which the population occurs, and the characteristics of the hatchery program (e.g., release time, release location, number released, and size of fish released). Based on stomach fullness, most steelhead smolts do not begin to feed extensively until about a week after release (Cannamela 1993). Recent WDFW research (Sharpe et al. 2008) has shown that the predation risks from hatchery steelhead smolt releases are minimal on smaller prey fish and that most sub-yearling Chinook have already emigrated or grown large enough to reduce or eliminate their susceptibility to predation when hatchery steelhead are released. Based on a study in the Skagit basin, Pflug et al. 2013 showed that hatchery steelhead smolts did not prey on natural origin steelhead juveniles.

- Provide information regarding past takes associated with the hatchery program, (if known) including numbers taken, and observed injury or mortality levels for listed fish.

No listed steelhead are targeted for this segregated program (see also the Green River Native winter-late steelhead HGMP for listed steelhead take). Natural origin steelhead may be inadvertently handled and released from trapping facilities, but operational protocols are in place to return these adults back to stream as quickly as possible when and where they occur. Inadvertent mortality on all listed fish encountered at these trapping sites and returned back to stream is estimated to be 0-1 fish yearly. In most years the staff have reported none.

- Provide projected annual take levels for listed fish by life stage (juvenile and adult) quantified (to the extent feasible) by the type of take resulting from the hatchery program (e.g. capture, handling, tagging, injury, or lethal take).

See comments listed above.

- Indicate contingency plans for addressing situations where take levels within a given year have exceeded, or are projected to exceed, take levels described in this plan for the program.

Any additional mortality from these activities, above what is anticipated and described above, would be communicated to WDFW Fish Program and NOAA staff for additional guidance.

SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1) Describe alignment of the hatchery program with any ESU-wide hatchery plan (e.g. *Hood Canal Summer Chum Conservation Initiative*) or other regionally accepted policies (e.g. the NPPC *Annual Production Review* Report and Recommendations - NPPC document 99-15). Explain any proposed deviations from the plan or policies.

This HGMP is a component of the co-managers comprehensive resource management plan for Puget Sound steelhead.

3.2) List all existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which program operates.

The program is implemented in accordance with the legislatively-mandated *Puget Sound Recreational Fish Enhancement* Program.

Future Brood Document (FBD): Hatchery salmon and steelhead production levels are detailed in the annual Future Brood Document, which is a pre-season planning document for fish hatchery production in Washington State for the upcoming brood stock collection and fish rearing season (July 1 – June 30). The FBD is coordinated between WDFW, the Northwest Indian Fisheries Commission (NWIFC) representing Puget Sound and coastal treaty tribes, eastern Washington treaty tribes, and Federal fish hatcheries. Hatchery production by volunteers, schools, and Regional Fisheries Enhancement Groups are represented by WDFW.

WDFW hatcheries operate under *U.S. v Washington* that provides the legal framework for coordinating these programs, defining artificial production objectives, and maintaining treaty-fishing rights through the *Puget Sound Salmon Management Plan* (PSSMP 1985). This co-management process requires that both the State of Washington and the relevant Puget Sound Tribe(s) develop program goals and objectives and agree on the function, purpose and release strategies of all hatchery programs.

Equilibrium and Future Brood Document (EBD and FBD): The PSSMP defines the EBD as the annual expression of the equilibrium brood document as it pertains to the coming year's run of salmon and describes the standard mode of operation for existing facilities/functions, associated with fish culture activities. The EBD provide descriptions of facilities, species propagated, and fishery management, hatchery production, broodstock management, eggtake, rearing, and release goals for each facility. While it does not include all of the requirements of the EBD, the Future Brood Document (FBD) is currently used as a pre-season planning document for EBD fish hatchery production reporting information in Washington State for the upcoming brood stock collection and fish rearing season (July 1 –June 30). The FBD is coordinated between WDFW, Puget Sound and coastal treaty tribes, the Northwest Indian Fisheries Commission (NWIFC), eastern Washington treaty tribes, and Federal fish hatcheries. Hatchery production by volunteers, schools, and Regional Fisheries Enhancement Groups are represented by WDFW.

See also HGMP section 3.1 above.

3.3) Relationship to harvest objectives.

WDFW general harvest goals are to provide fishing opportunities consistent with the mandate of the agency for restoration and recovery of natural origin indigenous salmonid runs, the Pacific Salmon Treaty, the *Puget Sound Salmon Management Plan,* the *Statewide Steelhead Management Plan*, annual fisheries management plans, *U.S. v Washington*, and other state, federal, and international legal obligations. The Muckleshoot and Suquamish Tribes along with WDFW prepare an annual fishery management plan for the harvest of Green/Duwamish River system summer and winter steelhead released from hatchery programs. To minimize impacts on listed fish, the tribal net fishery for hatchery steelhead from this program has typically ended no later than the first week of January (WDFW et al. 2008 to present).

3.3.1) Describe fisheries benefitting from the program, and indicate harvest levels and rates for program-origin fish for the last twelve years (1988-99), if available.

Harvest on targeted hatchery fish: Duwamish-Green system programs benefit the in-river recreational fishery and the Muckleshoot and Suquamish tribes commercial and subsistence fisheries. Watershed Resource Management Plans (RMPs) when developed will manage maximum harvest impacts to listed steelhead in the system. As the Green River winter sport harvest season ends by February 1, and summer begins the first Saturday in June (WDFW Sport Fishing Rules 2013/2014), most of the incidental catch and release may be prior to significant amounts of the natural origin winter run being present in the system.

Table 3.3.1.1: Green River system Hatchery winter (early) steelhead harvest 2000-2011.

Return Year[a]	Smolt Release[a]	Freshwater Sport[b]	Tribal Harvest[c]	Hatchery Return[d]	Smolt-to-Adult Contribution (%)
1999/00	158,288	324	235	14	0.36%
2000/01	149,395	390	490	19	0.60%
2001/02	240,292	944	748	83	0.74%
2002/03	133,718	237	179	51	0.35%
2003/04	74,183	290	184	79	0.75%
2004/05	155,432	228	238	127	0.38%
2005/06	69,155	383	249	103	1.06%
2006/07	225,418	409	163	243	0.36%
2007/08	218,446	423	132	321	0.40%
2008/09	223,669	350	58	99	0.23%
2009/10	228,550	218	NA	297	0.23%
2010/11	248,500	304	NA	161	0.19%
Average	**177,087**	**375**	**268**	**133**	**0.47%**

Source: WDFW Catch Record Card (CRC) Database 2012, WDFW Hatcheries Headquarters Database 2013.

[a] Smolt releases made two years earlier in the spring (Release years = 1998 to 2009). Catch may include fish caught during the return year and early the following year.

[b] 2- or 3-salt returns cannot be broken out and is the total of the Green River system.

[c] Tribal harvest may include unmarked fish and is not used in the SAR %.

[d] Prior to 2001, broodstock was supplied from Reiter Ponds (WRIA 7) so no adult trapping occurred in this system.

Incidental impact on non-targeted natural origin steelhead*:* Implementation of selective-fishing rules which requires the release of all natural origin, unmarked steelhead in Puget Sound began in the 1990s. This has reduced natural origin steelhead harvest statewide to approximately 1% of the catch. Cool water temperatures at this time minimize mortality on listed steelhead. Non-targeted natural origin steelhead may be hooked and released with an unknown impact for most streams and direct studies have not been done in this system. Nelson et al. (2005) showed catch and release mortalities of 1.4% to 5.8% in 1999 and 2000 respectively on steelhead caught in recreational fisheries on the Chilliwack River in British Columbia. This study also showed no indication of increased mortality on fish that had been caught released multiple times. A hook and line mortality study conducted in the Samish River on winter-run steelhead also showed similar results to this, although it indicated that there may be a negative relationship between a fish being caught in a sport fishery and its survival to out migration as kelts (Ashbrook et al. in press). Taylor and Barnhart (1999) determined that summer steelhead caught and released in the Mad

and Trinity Rivers of California had a 9.5% mortality rate, with 83% of the mortalities occurring at water temperatures of 21°C or greater. This study also showed no indication of increased mortality on fish that had been caught released multiple times. As such hooking mortality associated with recreational sport harvest is generally believed to be less than 10% of fish hooked and released.

3.4) Relationship to habitat protection and recovery strategies.

The hatchery steelhead program provides treaty and non-treaty harvest opportunity in light of habitat loss and degradation limiting natural production in the Green-Duwamish River basin (WRIA 9) streams and Puget Sound. Howard Hanson Dam near river mile 64 is an impassable barrier to fish migration and prevents natural production of salmonids into over 100 miles of stream habitat in the upper Green River watershed. This federally owned dam currently lacks fish passage facilities and plans to construct a safe downstream passage outlet are on hold due to high costs and a lack of federal funds. The fish passage efficiency and survival associated with potential future juvenile fish passage at the dam are uncertain due to anticipated budget constraints and predicted in-reservoir migration delay. The majority of the lower half of the accessible basin is highly developed, channelized, and/or industrialized. Ninety eight percent of the historic estuary has been lost to development. Riprap and other structures line the intertidal and marine shorelines, along with levees and revetments in the middle and lower river. Agriculture and urban development have degraded the hydrology, water quality, floodplain, channel diversity, and riparian areas of most lowland streams, reducing the potential for natural production over much of the historic salmonid distribution. Water temperatures in the Green River have exceeded lethal levels for salmonids at times due to inadequate shade. These and other factors have degraded or eliminated habitat and the natural habitat processes important for salmonids, reducing the abundance and productivity of the natural populations in the watershed.

Efforts continue in WRIA 9 by tribal, state, local and federal governments to try to protect and improve instream flows, water quality, fish passage, near shore, riparian floodplain habitats, and where possible, the underlying natural ecosystem processes that create and maintain salmonid habitat. Unfortunately, the resulting net habitat change to date is not yet positive. Habitat loss and degradation has continued despite efforts at restoration (Judge, M.M. 2011).

King County is lead entity for the WRIA 9 salmon recovery planning group, a coalition of local governments and stakeholders. The WRIA 9 Salmon Habitat Plan (August, 2005) outlined projects and programs focusing on habitat limitations in the Duwamish Estuary, middle and lower river, and nearshore marine areas, and spawning habitat in the middle and lower river (see also http://www.rco.wa.gov/salmon_recovery/lead_entities.shtml).

The Army Corps of Engineers' Ecosystem Restoration Program has funded projects intended to improve habitat conditions for salmon in the basin, unfortunately, at the same time, other Corps' programs and projects continue to negatively affect salmon and salmon habitat. The non-governmental Mid-Puget Sound Regional Enhancement Group works to implement habitat restoration projects in cooperation with other entities to benefit salmonids in the system. A number of habitat restoration actions were initiated under the 2001 Tacoma Water Green River Habitat Conservation Plan in the upper river, and a Superfund cleanup plan is being developed to address toxic contamination of Duwamish River Sediments. The net cumulative effect of these activities is uncertain, and salmon habitat was reported to be in continued decline since the adoption of the Puget Sound Chinook Recovery Plan (M. Judge, 2011).

Salmon Recovery Funding Board (SRFB): Composed of five citizens appointed by the Governor and five state agency directors, the Board provides grant funds to protect or restore salmon habitat

and assist related activities. It works closely with local watershed groups known as lead entities (see below). SRFB has helped finance over 500 projects. The Board supports salmon recovery by funding habitat protection and restoration projects. It also supports related programs and activities that produce sustainable and measurable benefits for fish and their habitat.

Regional Fisheries Enhancement Groups (*RFEGs*)*:* Several citizen based groups in conjunction with local governments work on habitat actions to benefit both listed and non-listed stock in the system including the Mid Puget Sound Regional Enhancement Group (RFEG).

Puget Sound Partnership Action Plan: An ESU-wide recovery planning effort is being undertaken by the Puget Sound Partnership, a collaborative group dedicated to restoring salmon and steelhead throughout Puget Sound (online at http://www.pugetsoundpartnership.org).

State of Our Watersheds: Individual member Tribes have worked with the NWIFC and SSHIAP to create the State of Our Watersheds report. This document examines key indicators of habitat quality and quantity across more than 20 watersheds in western Washington that lie within tribal Usual and Accustomed fishing areas as defined by *U.S. vs. Washington* (1974). The Green River habitat section can be found under the Muckleshoot chapter at http://maps.nwifc.org:8080/sow2012/.

3.5) Ecological interactions.

(1) *Salmonid and non-salmonid fishes or other species that could negatively impact the program.* Negative impacts by fishes and other species on the Soos Creek Hatchery winter steelhead program could occur directly through predation on program fish, or indirectly through food resource competition, genetic effects, or other ecological interactions. In particular, fishes and other species could negatively impact steelhead survival rates through predation on newly released, emigrating juvenile fish in the freshwater and marine areas. Certain avian and mammalian species may also prey on juvenile steelhead while the fish are rearing at the hatchery site, if these species are not excluded from the rearing areas. Species that could negatively impact juvenile steelhead through predation include the following:

- Avian predators, including mergansers, cormorants, belted kingfishers, great blue herons, and green herons
- Mammalian predators, including mink, river otters, harbor seals, and sea lions
- Cutthroat trout

Rearing and migrating adult steelhead originating through the program may also serve as prey for large, mammalian predators in marine areas, nearshore marine areas and in the Green River and Soos Creek to the detriment of population abundance and the program's success in harvest augmentation. Species that may negatively impact program fish through predation may include:

- Orcas
- Sea lions
- Harbor seals
- River otters

(2) *Salmonid and non-salmonid fishes or other species that could be negatively impacted by the program (focus is on listed and candidate salmonid species).*

- Puget Sound Chinook
- Puget Sound steelhead
- Puget Sound bull trout

(3) *Salmonid and non-salmonid fishes or other species that could positively impact the program.* Fish species that could positively impact the program may include trout and other salmonid species present in the Green River watershed through natural production. Juvenile fish of these species may serve as prey items for the steelhead during their downstream migration in

freshwater and into the marine area. Decaying carcasses of spawned adult fish may contribute nutrients that increase productivity in the watershed, providing food resources for the emigrating steelhead. Salmonid adults that return to the creek and any seeding efforts using adult salmon carcasses may provide a source of nutrients and stimulate stream productivity. Many watersheds in the Pacific Northwest appear to be nutrient-limited (Gregory et al. 1987; Kline et al. 1997) and salmonid carcasses can be an important source of marine derived nutrients (Levy 1997). Carcasses from returning adult salmon have been found to elevate stream productivity through several pathways, including: 1) the releases of nutrients from decaying carcasses has been observed to stimulate primary productivity (Wipfli et al. 1998); 2) the decaying carcasses have been found to enrich the food base of aquatic invertebrates (Mathisen et al. 1988); and 3) juvenile salmonids have been observed to feed directly on the carcasses (Bilby et al. 1996). Addition of nutrients has been observed to increase the production of salmonids (Slaney and Ward 1993; Slaney et al. 2003; Ward et al. 2003).

(4) *Salmonid and non-salmonid fishes or other species that could be positively impacted by the program.* The steelhead program could positively impact freshwater and marine fish species that prey on juvenile fish. Nutrients provided by decaying steelhead carcasses might also benefit fish in freshwater. These species include:

- Northern pikeminnow
- Cutthroat trout
- Bull trout
- Chinook salmon
- Coho salmon
- Pacific staghorn sculpin
- Numerous marine pelagic fish species

SECTION 4. WATER SOURCE

4.1) Provide a quantitative and narrative description of the water source (spring, well, surface), water quality profile, and natural limitations to production attributable to the water source.

Table 4.1.1: Water sources available at Soos Creek Hatchery and Icy Creek Rearing Pond.

Facility	Water Source	Available Water Flow (gpm)	Temp. (ºF)	Usage	Limitations
Soos Creek Hatchery	Spring	50	47	Adult holding, incubation, rearing	Available in small volume
	Big Soos Cr (surface)	Up to 13,000	32-70	Adult holding, incubation, rearing	No limitation
Icy Creek RP	Spring	Up to 4,000	45-48	Rearing, acclimation	No limitations

Soos Creek Hatchery: Is supplied by surface water from Soos Creek. Water is withdrawn via four pumps at the hatchery site, which have the ability to produce up to 13,500 gallons per minute (gpm). In addition, a small spring water supply (50 gpm) can be utilized in the incubation building. Soos Creek responds quickly to heavy rainfall and is prone to rapid fluctuations. Heavy bed loads and winter floods are increasingly common due to extensive watershed development. In 2012, the Legislature passed a jobs creation bill that provided WDFW with funding for hatchery capital improvements at Soos Creek. These projects include replacing the water distribution tower and main supply lines to the tower (see **Table 5.8.1**).

The facility is supplied with surface water from Soos Creek. Water rights are regulated through permit # S1-21122. Spring water withdrawal is regulated through permit #S1-00382CL.

Icy Creek Rearing Pond: Consists of an earthen pond, which is gravity-fed with spring water. The spring water quality is excellent, but flows vary with the season from a low of 2.2cfs in the late fall to 13cfs in the late spring. Water usage is regulated under permit #S1-22710.

Table 4.1.2. Record of NPDES permit compliance at Soos Creek Hatchery and Icy Creek Rearing Pond.

Facility/ Permit #	Reports Submitted Y/N			Last Inspection Date	Violations Last 5 yrs (see Table 4.2.2)	Corrective Actions Y/N	Meets Compliance Y/N
	Monthly	Qtrly	Annual				
Soos Creek WAG13-3014	Y	Y	Y	1/10/2012	3	N	Y
Icy Creek WAG13-3013	Y	Y	Y	1/10/2012	2	N	Y

Source: Ann West, WDFW Hatcheries Headquarters Database 2013.

Table 4.1.3. List of NPDES violations at Soos Creek Hatchery and Icy Creek Rearing Pond, over the last five years (2008-2012).

Facility	Monitoring Month	Parameter	Sample Type	Result/ Violation	Permit Limit	Comment	Action
Soos Creek Hatchery	September 2008	TSS	Avg. Net Composite	21.6 mg/L	5.0 mg/L	River mixing with effluent sample and possible salmon in discharge pipe.	None
		TSS	Max Net Composite	29.0 mg/L	15.0 mg/L		
	January 2009	TSS	Avg. Net Composite	13.0 mg/L	15.0 mg/L	Due to flooding.	
Icy Creek RP	April 2009	SS	Avg. Net Composite	Unreported	0.1 ml/L	Unreported sample. Sampler retired and records could not be located.	None
	May 2009	SS	Avg. Net Composite	Unreported	0.1 ml/L		

Source: Ann West, WDFW Hatcheries Headquarters Database 2013.
Note: These violations did not result in non-compliance with NPDES permit.

4.2) Indicate risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish as a result of hatchery water withdrawal, screening, or effluent discharge.

Soos Creek Hatchery: The hatchery water intake structure is in compliance with state and federal guidelines (NMFS 1995, 1996), but does not meet the current Anadromous Salmonid Passage Facility Design criteria (NMFS 2011a). The 2012 budget provided WDFW with funding to replace/renovate the existing intake to meet current fish passage and screening requirements.

Monitoring and reporting of effluent discharge results have been in compliance with NPDES permit number WAG 13-3014 (see **Table 4.2.1**). The 2012 Legislature provided WDFW with funding to build a new two-bay pollution abatement pond system.

Icy Creek Rearing Pond: Due to its extremely steep stream gradient, no natural-origin anadromous salmonid population has used the watershed upstream of the Icy Creek Rearing Pond water intake. A permanent trap was installed in 2012 at Icy Creek below the hatchery facility to trap and remove marked hatchery-origin Chinook and steelhead, and to release any stray

unmarked, presumably natural-origin Chinook salmon and steelhead back into the Green River. The Icy Creek facility is operated to ensure that hatchery effluent is not detrimental to downstream aquatic life by meeting or exceeding applicable NPDES Permit standards (see Table 4.2.1).

These facilities operate under the "Upland Fin-Fish Hatching and Rearing" National Pollution Discharge Elimination System (NPDES) general permit which conducts effluent monitoring and reporting and operates within the limitations established in its permit administered by the Washington Department of Ecology (DOE), WAG 13-3002. Monthly and annual reports on water quality sampling, use of chemicals at this facility, compliance records are available from DOE.

Discharges from the cleaning treatment system are monitored as follows:

- *Total Suspended Solids (TSS)* 1 to 2 times per month on composite effluent, maximum effluent and influent samples.
- *Settleable Solids (SS)* 1 to 2 times per week on effluent and influent samples.
- *In-hatchery Water Temperature* - daily maximum and minimum readings.

SECTION 5. FACILITIES

Soos Creek Hatchery is under design and permitting. Permits are expected fall 2014 for Phase I, which includes addressing intake fixes, replacing the main water distribution tower, moving the adult holding area out of the creek and improving the trapping facilities. Upland work for Phase I will occur in 2014 and 2015 and in water work will begin in 2015. Phase 2 is scheduled and is highly placed in the 15-17 capital budget.

5.1) Broodstock collection facilities (or methods).

Soos Creek Hatchery: Broodstock is collected from Soos Creek, adjacent to the Soos Creek Hatchery. Reconditioned kelts may also be utilized for broodstock if local facilities are available. Returning steelhead adults are trapped in an in-stream, run-of-the-river pond framed by two semi-temporary weirs, with a "V"-entry into the lower weir. The trap measures approximately 150' x 200'.

Icy Creek Rearing Pond: A new permanent trap built on Icy Creek began operation in fall 2012. This trap can be used to collect marked hatchery-origin adults homing to the hatchery release site for broodstock or removal from the watershed.

5.2) Fish transportation equipment (description of pen, tank truck, or container used).

Depending on the size of the fish transfer, two tanker trucks (300 and 1,500-gallons), equipped with aerators and oxygen tanks are available for fish transportation.

5.3) Broodstock holding and spawning facilities.

Winter steelhead collected for broodstock are held in 16'x3'x3' fiberglass raceways and spawned on-site. Ripe adults not selected for kelt reconditioning are killed and spawned. The adults selected for kelt reconditioning will be live spawned, rehabilitated and reared.

5.4) Incubation facilities.

A portion of the live spawned adults may undergo kelt reconditioning, if local facilities are available, as a backup source for eggs in the future if sufficient volitionally returning adults are not expected to be available.

Table 5.4.1: Incubation vessels available at Soos Creek Hatchery.

Type	Number	Size
Shallow troughs	160	15' x 1' x 4"
Deep troughs	24	Not used for steelhead

Deep troughs are used for incubation for Chinook only, not coho or steelhead.

Funding has been provided to construct a new hatchery/ incubation building outside the 100-year flood plain (see HGMP section 5.8).

There are no incubation facilities at the Icy Creek Rearing Pond.

5.5) Rearing facilities.

Table 5.5.1: Rearing vessels available at Soos Creek Hatchery.

Type	Number	Size
Asphalt lined rearing ponds	3	0..25 acres
Standard concrete raceways	8	10’ x 80’ x 3’
Concrete rearing ponds	8	17.5’ x 95’ x 3’
Fiberglass raceways	12	16’ x 3 x 3’
Fiberglass circular ponds	2	16-ft diameter
Fiberglass circular ponds	6	6-ft diameter
Shallow troughs	160	15' x 1' x 4”
Deep troughs	24	15' x 1.5' x 1'

Soos Creek Hatchery: The ponds and raceways are surrounded by bird netting and otter fences to minimize predation losses.

Table 5.5.2: Rearing vessels available at the Icy Creek Rearing Pond.

Type	Number	Size
Earthen bottom pond	1 (can be split into 2)	0.5 acre

Icy Creek Rearing Pond: The pond is equipped with bird netting and surrounded by electric fences to minimize predation losses.

See **Table 5.8.1** for planned pond renovations/upgrades.

5.6) Acclimation/release facilities.

Soos Creek Hatchery: Steelhead are reared and acclimated on surface water from Soos Creek during their entire time at the hatchery and are released directly into the creek.

Icy Creek Rearing Pond: The fish transferred to the Icy Creek Rearing Pond in December and reared and acclimated on Icy Creek surface water the entire time they are at the hatchery (~5 months), then are released directly into Icy Creek.

5.7) Describe operational difficulties or disasters that led to significant fish mortality.

Soos Creek Hatchery is subject to flooding during high flow events. This causes the pump intake screens to become clogged frequently due to heavy debris loads. In addition, flood risks limit the use of the eight low-lying, concrete rearing ponds (17.5’ x 95’ x 3’). Flood waters often inundate the lower ponds, which may result in the premature release of the fish. As such these ponds are unusable between November and March. Funding has was provided in 2012 to replace/renovate the existing intake and also construct new ponds necessary for the hatchery to operate properly and in compliance with current requirements (see HGMP section 5.8).

Icy Creek has never had fish loss due to flooding or operational failures.

5.8) Indicate available back-up systems, and risk aversion measures that will be applied, that minimize the likelihood for the take of listed natural fish that may result from equipment failure, water loss, flooding, disease transmission, or other events that could lead to injury or mortality.

Soos Creek Hatchery: Listed fish are not reared in this program, but the hatchery stock is protected by risk aversion measures that are currently in place. A member of the hatchery staff is on stand-by at all times to monitor hatchery operations and respond to any unexpected events. The facility is equipped with low water alarms and a back-up generator in case of power loss.

Icy Creek Rearing Pond: This is a satellite facility and an employee is present when needed (primarily feeding times). Water is gravity fed to the pond and there is no need for a back-up generator. As a risk aversion measure the facility is equipped with low water alarms.

Fish rearing practices at both facilities are conducted in compliance with the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006). Adherence to artificial propagation, sanitation and disease control practices defined in the policy should reduce the risk of any fish disease or pathogen transfers.

Table 5.8.1: The 2012, the Legislature passed a jobs creation bill that provided WDFW with funding for hatchery capital improvements in addition to our capital budget request. At Soos Creek Hatchery, this allowed for the following improvements (see also HGMP section 4).

Project
Renovate or replace existing intake to meet current fish passage and screening requirements. (PHASE 1)
Construct new hatchery/ incubation building outside the 100 year flood plain. (PHASE 2)
Construct EIGHT new 120' x 20' ponds. (PHASE 2)
Demolish north side ponds and current adult handling facilities. (PHASE 2)
Construct new adult handling facilities and ponds. (PHASE 1)
Construct a new incubation settling pond. (PHASE 2)
Construct new two bay pollution abatement ponds. (PHASE 2)
Replace water distribution tower. (PHASE 2)
Replace main supply line to distribution tower. (PHASE 1)

SECTION 6. BROODSTOCK ORIGIN AND IDENTITY

Describe the origin and identity of broodstock used in the program, its ESA-listing status, annual collection goals, and relationship to natural origin fish of the same species/population.

6.1) Source.

Adult hatchery winter steelhead (identified by an adipose-fin clip) returning to the traps at Soos and Icy creeks until January 31. Early winter stock is used for this hatchery program and is not ESA-listed.

6.2) Supporting information.

6.2.1) History.

Hatchery releases of winter run steelhead have occurred in Green River system since the early 1930s (WDFW Historical Database – Pre 1960 & SSHAG 2003). Washington Department of Game (WDG) operated a natural origin stock winter hatchery program from 1935 to 1940 (Meigs and Pautzke 1941, PSSTRT 2013a).

In 1969, Palmer Ponds began a hatchery winter steelhead program and using the early winter hatchery stock. This stock was established in 1945 from a winter run steelhead population collected at the South Tacoma Hatchery (now Lakewood Hatchery -WRIA 12) (Scott and Gill 2008). Warmer water available at the location was used to accelerate the spawning time and encourage growing smolts as a one year age product rather than two, thereby significantly reducing cost of rearing in freshwater (Crawford 1979). The early winter hatchery stock, as a part of the Regional Egg Source, was utilized in Puget Sound by several hatcheries and transferred to and between several river systems including the Skykomish, Snoqualmie, Skagit, Stillaguamish and Bogachiel Rivers. Prior to 2001, broodstock for the Green/Duwamish winter steelhead program were provided by Tokul Creek Hatchery/Reiter Ponds (WRIA 7) via South Tacoma Hatchery, so no adult trapping occurred in this system.

In 2002, broodstock collection, incubation and early rearing of the fish were moved to Soos Creek Hatchery and fish were released at both Soos Creek and Palmer Ponds. In 2003, fish were also released from the Icy Creek Rearing Pond; releases at Flaming Geyser Ponds began in 2004. Palmer Ponds was closed in 2009, eliminating releases at that facility; the last fish release from this program at Flaming Geyser Ponds occurred in 2012. Currently adults are trapped at the Soos Creek and Icy Creek facilities.

6.2.2) Annual size.

Up to 40 pairs adults are collected for broodstock. No natural-origin fish are included.

6.2.3) Past and proposed level of natural fish in broodstock.

Prior to the implementation of mass-marking of steelhead by the Washington State Department of Game in 1981, any level of mixing natural fish in the broodstock in the past could not be identified (B. Crawford pers. comm. 2006). As most steelhead programs had volunteer collection sites on small tributary streams in the past, natural origin stock spawners may not have had a strong incentive to enter those trapping sites.

Currently this winter steelhead program is managed as segregated, which means that the hatchery broodstock is reproductively segregated from naturally spawning populations and is composed entirely of returning hatchery-origin adults identified by a missing adipose fin.

6.2.4) Genetic or ecological differences.

Steelhead collected at the Soos Creek Hatchery trap are of locally-adapted early winter hatchery stock and are segregated from the natural-origin population both spatially and temporally. Phelps et al. (1997) compared genetic samples, collected in two time periods (1975 and 1993-1996), from natural-origin winter steelhead and early winter stock hatchery steelhead. DNA collections and analysis has been conducted recently to update genetic makeup of endemic and non-local steelhead stocks in Puget Sound (See HGMP Section 2.2.2 for current results).

The early winter stock hatchery fish typically return from late-November through early-February, while their natural origin counterparts return from November through June. Peak hatchery spawning occurs in January, while peak natural-origin winter spawning occurs in late-April, with peak natural origin summer steelhead spawning one-two months earlier. Hatchery steelhead are released as age 1+ smolts, whereas natural-origin steelhead are predominately age 2+ smolts. Out-migration timing for both life history types is similar but is slightly earlier for hatchery component (Fuss et al. 1998).

See also "*Genetic Introgression*" in HGMP section 2.2.3.

6.2.5) Reasons for choosing.

The early winter hatchery steelhead stock was selected for its early arrival and spawn timing (as compared to natural origin steelhead), availability and the ability to release one-year smolts (Crawford 1979). This stock has been used statewide to provide fish for recreational and/or tribal harvest with minimal overlap in time and space with natural origin steelhead.

6.3) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish that may occur as a result of broodstock selection practices.

Fish collected for this hatchery program are from the early winter hatchery stock and priority is given to keeping hatchery returns to Snoqualmie facilities (Tokul Creek) and the Skykomish facilities (Wallace and Reiter) within each respective river basin in an effort to promote local adaptation and reduce straying. No natural-origin fish are included in the broodstock. No eggs are collected after January 31 (change implemented with the 2008 broodstock collection). Target of 100% mass marking allows exclusion of natural-origin fish from the hatchery broodstock and selection for earlier-maturing fish deepens temporal separation, keeping the hatchery and naturally-spawning fish genetically different and increasing divergence of the populations.

This production is managed as a segregated program with the intent to separate hatchery and natural origin stocks and excludes utilization of natural-origin (adipose present) steelhead. The separation was achieved by producing fish that spawn earlier than natural origin fish. Early winter stock hatchery fish typically return from late-November through early-February, while their wild counterparts return from November through June. Peak hatchery spawning takes place in January, while the peak spawn timing for natural origin winter steelhead is from late-April through early May (Hoffmann 2014). To further accentuate and minimize spawning overlap with known natural origin winter steelhead present in the system, adipose clipped hatchery broodstock collection period was further limited to fish maturing before January 31st, from the previously accepted date of February 28.

The proposed rules for listing Puget Sound steelhead (71 FR15666; March 29, 2006) stated "Several BRT members noted that anecdotal historical accounts discuss significant early runs of wild steelhead, but expressed concern that these early wild spawners have apparently disappeared from several river systems." While we acknowledge that significant uncertainty exists in our understanding of the historical run and spawn timing of steelhead, we believed that it was important to evaluate the risk that the proposed early winter hatchery programs could suppress re-expression of this potential component of the population. This could occur, for example, if the early spawning natural origin steelhead spawned with hatchery-origin steelhead, and if the resulting hybrids had a lower chance of survival than natural origin by natural origin crosses.

One important piece of information to evaluate this risk is the historical spawn timing of steelhead in Puget Sound rivers. The PSSTRT (2013) compiled historical records from a wide variety of sources to help define the historical populations of steelhead in the Puget Sound DPS. We have summarized this information in Table 6.3.1. The limited information available from these sources is consistent with our current observations for the spawn timing of Puget Sound natural origin winter steelhead (Hoffmann 2014).

Table 6.3.1. Summary of historical information regarding the spawn timing of steelhead in the Puget Sound DPS.

River Basin	Timing	Comments
Baker	March 8 – May 9	Collection of adults in 1900 for Baker Lake Hatchery. May include summer-run. Ravenal (1900) cited in PSSTRT (2013).
Sauk	Early February through June 15	Collection of steelhead spawn in 1906. Riseland (1907) as cited in PSSTRT (2013).

Sultan	April 8 – June 4	Spawning at the Sultan River Hatchery in 1920s. Leach (1923) as cited in PSSTRT (2013).
Quilcene	February 27 – June 7	Spawning at the Quilcene National Fishery Hatchery in 1922. USBF (1923) as cited in PSSTRT (2013)
Hood Canal West Side Tributaries	March 24 – May 1	Spawning of ripe fish in 1926. Leach (1927) as cited in PSSTRT (2013).

The PSSTRT (2013) also reviewed records of steelhead spawning at Washington Department of Game hatcheries in the 1930s. The PSSTRT cautioned that the timing of egg collection "may not be fully representative of natural spawn timing"; however, little if any spawning occurred at the Nooksack, Samish, Skykomish, or Dungeness hatcheries prior to March 1. In some years, spawning did occur earlier at the Puyallup Hatchery (as early as early February in two of six years analyzed) and the Green Hatchery (as early as early-February), but there is no evidence that these early spawning fish comprised a significant component of the return,

A third source of information is Snow Creek, a small lowland tributary to the Strait of Juan de Fuca. The Department has conducted extensive research on Snow Creek for more than 30 years. Fishing has been prohibited since 1977, and no releases of hatchery-origin steelhead have occurred that would affect the timing of spawners. The initial redds in this stream can be constructed as early as February or March. For example, the date of first redd construction was the week of March 1 in 1979 and February 4 in 1980. The average date of spawning in these years was March 28th , and 95% of the spawning occurs after the end of February (Hoffmann 2014).

The PSSTRT (2013) concluded that "steelhead spawn earlier in small lowland streams where water temperatures are generally warmer than in larger rivers with higher elevation headwaters." Our analysis of historical information and current data support this conclusion and suggest that natural origin steelhead spawn from early March through mid-June in rivers originating in the Cascades or Olympics. As evident from Snow Creek, initial spawning in small lowland streams can be earlier, early February to early March.

This information, and the substantial modification of early winter steelhead programs that have occurred since 2008, suggest that interbreeding of early winter hatchery-origin and natural origin steelhead is unlikely to suppress re-expression of a potential early spawning component of a natural origin steelhead population. In the larger rivers with higher elevation headwaters, the hatchery-origin early winter steelhead spawn well before the natural origin steelhead. In small lowland streams, like Snow Creek, the potential for genetic interaction between hatchery-origin early winter steelhead and natural origin steelhead is greater, but remains small. Even in this case, Hoffmann (2014) estimated that only 7.4% of Snow Creek natural origin steelhead would spawn during the same time period as early winter steelhead from the Tokul Creek Hatchery. Even more importantly, the elimination of all off-station releases and the cessation of releasing steelhead in small streams (e.g., Samish River, Pilchuck Creek, Pilchuck River, Raging River, Tolt River, Sultan River, east side Hood Canal rivers) provided additional risk control measures.

SECTION 7. BROODSTOCK COLLECTION

7.1) Life-history stage to be collected (adults, eggs, or juveniles).

Adults.

7.2) Collection or sampling design.

In the past, all adult steelhead available were trapped volitionally from December through February, and were spawned from December through February (in some rare cases into early March). New guidelines, implemented in brood year 2008, eliminated egg-takes after January 31. Early winter stock winter fish are differentiated from summer fish by run timing, appearance and physical condition. In addition, summer fish utilized for broodstock are trapped between June and October in order to segregate them from winter origin fish. Any fish that fail to ripen by this date or those returning after January 31 will be removed from the system. In order to develop a local broodstock source for the Green River system, harvest restrictions (to ensure enough hatchery fish for broodstock) and alternative methods to collect broodstock (hook and line if necessary on the mainstem Green River prior to broodstock spawning deadlines) or kelt reconditioning will be implemented.

7.3) Identity.

All fish released through this hatchery program have been 100% mass-marked (adipose fin-clipped) since the 1983 releases (brood year 1984), with exception of brood years 1994 and 1995.

7.4) Proposed number to be collected:

7.4.1) Program goal (assuming 1:1 sex ratio for adults):

Up to 80 adults collected for broodstock.

7.4.2) Broodstock collection levels for the last twelve years (e.g. 1988-99), or for most recent years available:

Table 7.4.2.1: Sex composition of winter steelhead broodstock spawned at Soos Creek Hatchery.

Brood Year	Females	Males
2000	7	7
2001	6	13
2002	38	38
2003	28	22
2004	22	18 + 13
2005	59	40 + 21
2006	46 + 3	28 + 32
2007	94	57 + 10
2008	98	78
2009	38	37+2
2010	42	43
2011	36	40
2012	43	44
2013	36	39
Average	**43**	**42**

Source: WDFW Hatcheries Headquarters Database 2013.
Note: "+number" indicate live spawned males.

7.5) Disposition of hatchery-origin fish collected in surplus of broodstock needs.

Fish collected above broodstock needs (surplus) are removed from the system, no recycling occurs. Surplus fish that are of quality for human consumption may be donated to the local tribes or approved charitable organizations, or used for nutrient enhancement.

7.6) Fish transportation and holding methods.

Adults are not transported and are held in 16' x 3' x 3' fiberglass raceways prior to spawning.

7.7) Describe fish health maintenance and sanitation procedures applied.

Standard fish health protocols, as defined in the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006) are adhered to. No antibiotics or formalin treatment are applied as the fish are typically ready to spawn shortly after arriving at the hatchery and the cool water temperatures during this time of the year.

7.8) Disposition of carcasses.

Food-grade quality carcasses may be distributed to approved charitable organizations and local tribes for ceremonial and subsistence purposes. Nonfood-grade carcasses are used in local streams for nutrient enhancement if approved by the Fish Health Specialist.

7.9) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.

This program is managed as segregated with the intent to separate hatchery- and natural-origin stocks and as such listed steelhead are not targeted in the hatchery broodstock.

In the past, eggs for this program were collected through February. A policy introduced in 2008 eliminated egg-takes after January 31. Early winter stock hatchery fish typically return from late-November through early-February, while their natural-origin counterparts return from November through June. Peak hatchery spawning takes place in January, while peak natural-origin fish spawning occurs in late-April. The new collection period takes place earlier than much of the natural-origin winter steelhead escapement seen in the system, and may further accentuate and minimize overlap with current known natural-origin winter steelhead present in the system. This collection timeframe also mostly, if not totally, avoids listed Chinook during the trapping season and bull trout are not encountered at these sites. Any natural origin steelhead encountered during broodstock collection would be identified from the hatchery broodstock by the presence of an adipose fin and would be immediately returned back to the stream.

SECTION 8. MATING

Describe fish mating procedures that will be used, including those applied to meet performance indicators identified previously.

8.1) Selection method.

Steelhead for broodstock are selected randomly and based on ripeness on spawn days. No steelhead are spawned after January 31 for this program.

8.2) Males.

All males collected, including jacks, are considered for spawning and are selected randomly on spawn days.

Steelhead males can be live-spawned in low male return years to ensure enough males are available for mating. Live-spawned males are operculum-punched and reused only when necessary, and no more than two times.

Steelhead jacks are not seen at this facility, but may be used at up to 2%, if present.

8.3) Fertilization.

Eggs from each female are collected in a separate container and mixed with milt from one male (pairwise spawning). Eggs mixed with milt are allowed 30-60 seconds for fertilization and then transferred into 5-gallon buckets for transportation to the incubation room.

8.4) Cryopreserved gametes.

Cryopreserved gametes are not used.

8.5) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme.

Listed fish are not used in the broodstock.

SECTION 9. INCUBATION AND REARING

Specify any management *goals* (e.g. "egg to smolt survival") that the hatchery is currently operating under for the hatchery stock in the appropriate sections below. Provide data on the success of meeting the desired hatchery goals.

9.1) Incubation:

Current egg-take goal (FBD 2013) for the early-winter steelhead program at Soos Creek Hatchery is 125,000 for both on-station and Icy Creek releases.

9.1.1) Number of eggs taken and survival rates to eye-up and/or ponding.

Table 9.1.1.1: Egg-to–ponding survival of winter steelhead eggs at Soos Creek Hatchery.

Brood Year	Eggs Collected	Survival Rates (%)	
		Green-to-Eyed Up	Eyed-Up-to-Ponding
2000	23,300	NA	NA
2001	18,000	NA	NA
2002	116,700	NA	NA
2003	92,500	NA	NA
2004	141,300	90.0	90.0
2005	218,400	96.0	90.0
2006	197,600	86.0	90.0
2007	345,600	84.0	90.0
2008	409,000	80.0	90.0
2009	141,100	88.0	90.0
2010	164,000	89.0	90.0
2011	115,200	88.0	90.0
2012	157,500	90.0	90.0
Average	**164,631**	**87.9**	**90.0**

Source: WDFW Hatchery Records 2012.

9.1.2) Cause for, and disposition of surplus egg takes.

Extra eggs may be collected for this program, to allow for a larger effective gene pool and to offset losses to predation and disease. When additional eggs are taken, the surplus is typically

culled at picking or after initial swim up. If losses are too high, then the program goals may not be met.

9.1.3) Loading densities applied during incubation.

Fertilized eggs are placed in baskets and in shallow troughs at 20,000 per basket.

9.1.4) Incubation conditions.

Fertilized eggs are incubated at Soos Creek Hatchery in shallow troughs supplied with spring water at a rate of 8 gpm. Water temperatures are monitored daily and on average range between 47-50°F. Dissolved oxygen is checked as needed.

9.1.5) Ponding.

Initial feeding begins in the shallow troughs when the fish are 95% buttoned up. In May/June, the fry (500 to 1,000 fpp) are moved to the standard concrete 10' x 80' x 4'raceways.

9.1.6) Fish health maintenance and monitoring.

All fertilized eggs are water hardened in an iodophor solution. Fungus in troughs is controlled by a formalin drip (15-minute every day drip at a target dose of 1,667-ppm formalin), throughout incubation and until just prior to hatching. Once eyed, the eggs are shocked and mortalities are removed. Fry loss is picked daily.

9.1.7) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation.

Listed fish are not incubated for this program.

9.2) Rearing:

9.2.1) Provide survival rate data (*average program performance*) by hatchery life stage (fry to sub-yearling; sub-yearling to smolt) for the most recent twelve years (1988-99), or for years dependable data are available.

Table 9.2.1.1: Fry-to-sub-yearling and sub-yearling-to-smolt survival of winter steelhead at Soos Creek Hatchery, and Icy Creek and Flaming Geyser ponds.

Brood Year	Survival Rates (%)			
	Soos Creek		Icy Creek	Flaming Geyser
	Fry-to-Sub-yearling	Sub-yearling-to-Smolt		
2000	No release	No release	No release	No release
2001				
2002			90.0	
2003			90.0	100.0
2004	88.0	92.0	90.0	100.0
2005	82.0	91.0	90.0	100.0
2006	81.0	93.0	90.0	100.0
2007	83.0	92.0	90.0	100.0
2008	80.0	91.0	95.0	100.0
2009	73.0	94.0	95.0	NA
2010	75.0	93.0	95.0	100.0
2011	89.7	NA	NA	NA
2012	NA	NA	NA	NA
Average	**81.5**	**92.3**	**91.7**	**100.0**

Source: WDFW Hatchery Records 2012.

Bird and otter predation have been the most significant contributors to fish mortalities. Installation of bird netting and an otter fence have substantially decreased losses.

9.2.2) Density and loading criteria (goals and actual levels).

Fish reared at Soos Creek, follow loading parameters set in *Fish Hatchery Management* (Piper et al. 1982) and the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006). In all facilities within the Green River system, densities are kept at or below 3.3 lbs /gpm and 0.5 lbs /cu ft. before the last loading reduction in the fall of the year. Trough maximum loading is 40 lbs at 12 gpm (3.33 lbs/gpm). Tank and raceway maximum loading for early rearing is 132 lbs for the tanks at 40 gpm (3.3 lbs/gpm) and 800 lbs per raceway at 300 gpm (2.66 lbs/gpm). The final maximum loading per raceway is approximately 3200 lbs. at 300 gpm (10.6 lbs/gpm). Once density levels in the fiberglass troughs reach 0.20 lbs fish/gpm, the steelhead are moved to the 10’ x 80’ x 4’ outdoors standard concrete raceways. Flow index (FLI) is monitored monthly for all programs at Soos Creek Hatchery and would not exceed 80% of the allowable loading (Piper et al. 1982). Loadings could be lighter than these, but feeding the population to achieve size consistency is a priority.

9.2.3) Fish rearing conditions.

Soos Creek Hatchery: Additional rearing through the sub-yearling stage occurs in the 10’x80'x4’ raceways or 17.5' x 95' x 4’ concrete rearing ponds or 0.25 acre asphalt ponds supplied with Creek water. Marking takes place in July and August when fish are 100 to150 fpp. Fish for on-station releases are reared in the 0.25 acre rearing ponds until the May release.

All ponds at Soos Creek receive ambient surface water from the creek. Ambient oxygen levels range between 10-12 ppm entering to 8-10 ppm leaving the raceway, depending on ambient air temperature and number of fish in the raceway. Flow index (FLI) is monitored monthly and would not exceeds 80% of the allowable loading (Piper et al. 1982).

Icy Creek Rearing Pond: Depending on the amount of water available, initial rearing vessels used at Soos Creek Hatchery to rear fish for the Icy Creek program receive pathogen free spring water from a spring adjacent to Soos Creek. In December, a group of around 40,000 marked fish, destined for release at Icy Creek are transferred to the facility’s earthen bottom pond supplied with creek water, where they remain until the May release.

Table 9.2.3.1: Monthly average surface water temperature (°F) at Soos Creek.

Month	Soos Creek	Icy Creek
January	41	47
February	41	47
March	45	48
April	49	48
May	51	48
June	56	49
July	58	49
August	58	49
September	56	49
October	50	49
November	43	48
December	41	48

Source: WDFW Hatchery Records 2012.

9.2.4) Indicate biweekly or monthly fish growth information (average program performance), including length, weight, and condition factor data collected during rearing, if available.

Table 9.2.4.1: Average size (fpp), by month, of juvenile winter steelhead reared at Soos Creek Hatchery and Icy Creek Rearing Pond.

Month	Average Size (fpp)	
	Soos Creek	Icy Creek
April	939	
May	478	
June	197	
July	150	
August	100	
September	43	
October	33	
November	14	
December	9.4	9.4
January	9	9
February	8	8
March	7	7
April	6	5.5
May	5	

Source: Hatchery Records 2012.

9.2.5) Indicate monthly fish growth rate and energy reserve data (average program performance), if available.

See **Table 9.2.4.1** for growth information. No energy reserve data available.

9.2.6) Indicate food type used, daily application schedule, feeding rate range (e.g. % B.W./day and lbs/gpm inflow), and estimates of total food conversion efficiency during rearing (average program performance).

Steelhead are fed a variety of diet formulations including starter, crumbles and pellets of various brands; the feed brand may vary, depending on cost and vendor contacts. Feeding frequencies vary depending on the fish size and water temperature and usually begin at seven feedings/seven days a week, and end at one feeding a day/from two to seven days a week. Feed rates vary from 0.5% to 5% B.W./day. The overall seasonal food conversion rate is approximately 1.1:1.

9.2.7) Fish health monitoring, disease treatment and sanitation procedures.

Fish health is monitored on a daily basis by the hatchery staff and at least monthly by a state Fish Health Specialist (FHS). Hatchery personnel carry out treatments prescribed by the FHS. Procedures are consistent with the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006). See also HGMP section 10.9 for WDFW Standard Fish Health Procedures.

9.2.8) Smolt development indices (e.g. gill ATPase activity), if applicable.

The migratory state of the release population is determined by fish behavior. Aggressive screen and inflow crowding, leaner condition factors, a more silvery physical appearance, banded tails and loose scales during feeding events are signs of smolt development. ATPase activity is not measured.

9.2.9) Indicate the use of "natural" rearing methods as applied in the program.

No "NATURES" type rearing methods are applied through the program.

9.2.10) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation.

This program is managed as segregated. Listed steelhead are not included in the hatchery broodstock and are not reared in this program.

Hatchery fish are reared to meet *Statewide Steelhead Rearing and Release Guidelines* (Tipping 2001) to achieve a size and condition factor at the time of releases that represents the best chance for survival in order to meet adult goals. Rearing fish to a yearling smolt stage is mandatory in order to foster out-migration and subsequent survival when the fish vacate the system. Fry or sub-yearlings will not be reared and released from this program in order to eliminate or minimize interactions with listed fish rearing in the system.

All reasonable and prudent measures are employed to minimize rearing and incubation losses. These include the use of high quality spring or well water for incubation, high quality feeds for rearing, rearing densities and loadings that conform to best management practices, frequent fish health inspections and presence of professionally trained personnel to operate facilities. Hatcheries are designed to provide safe and secure rearing environment through the use of alarm systems, backup generators and water re-use pumping systems to prevent catastrophic fish losses.

SECTION 10. RELEASE

Describe fish release levels, and release practices applied through the hatchery program.

10.1) Proposed fish release levels.

Table 10.1.1: Proposed release levels, by release site.

Facility	Age Class	Maximum Number	Size (fpp)	Release Date	Release Location
Soos Creek	Yearling	35,000	5.0	April/May	Green River
Icy Creek	Yearling	35,000	5.5	April/May	

Note: 5 fpp ~210 mm fork length.

* Releases from Soos Creek Hatchery Icy Creek RP began in May 2003and April 1999, respectively.

10.2) Specific location(s) of proposed release(s).

Stream, river, or watercourse:
1. Soos Creek (WRIA 09.0072)
2. Icy Creek (WRIA 09.0125)

Release point:
1. R.M. 1
2. Approximately 40 yards from the confluence with Green River at RM 48

Major watershed: Duwamish/Green River

Basin or Region: Puget Sound

10.3) Actual numbers and sizes of fish released by age class through the program.

Non-migratory fish will be planted into lakes that are functionally isolated from anadromous accessible freshwater and in compliance with the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006).

Table 10.3.1: Actual numbers and sizes of winter steelhead released through the Soos Creek Hatchery, 2002-2013.

Release Year	Yearling					
	Icy Creek RP	Flaming Geyser Ponds	Soos Creek Hatchery	Palmer Ponds	Avg. size (fpp)	CV
2002	-----	-----	-----	74,183	5.0	6.6
2003	7,752	-----	37,100	110,580	5.5	9.6
2004	11,250	7,740	38,600	19,305	5.1	6.2
2005	-----	7,000	34,500	190,918	5.1	8.4
2006	4,176	8,000	32,000	174,270	5.8	8.9
2007	8,000	2,000	33,200	182,469	5.3	6.6
2008	4,000	4,800	40,000	184,550	5.9	8.9
2009	24,000	10,000	40,000	174,500	6.2	n/a
2010	18,400	-----	35,599	Discontinued	7.8	n/a
2011	25,000	9,997	55,033		7.0	7.8
2012	19,984	14,490	32,000		6.0	n/a
2013	40,000	Discontinued	40,382		6.0	n/a
Average	**15,857**	**8,003**	**38,038**	**138,847**	**5.9**	**7.9**

Source: WDFW Hatchery Headquarters Database 2013.

Note: Releases of early winter steelhead stocks from Flaming Geyser Ponds were discontinued after 2012.
5 fpp ~210 mm fork length (fl); 6 fpp ~198 mm fl; .7 fpp ~188 mm fl.

10.4) Actual dates of release and description of release protocols.

Table 10.4.1: Actual dates and release methods of winter steelhead released through the Soos Creek Hatchery program.

Release Year	Icy Creek RP	Flaming Geyser	Soos Creek	Palmer Ponds	Release Method
2002	No release	No release	No release	5/1-5/21	Forced/Volitional
2003	5/1-5/2		5/1	5/1-5/2	Forced/Volitional
2004	5/1-5/3	5/8	4/26	4/1-4/2	Forced/Volitional
2005	-----	5/8	5/1	5/1-5/10	Forced/Volitional
2006	4/1	5/6	5/1	5/1-5/6	Forced/Volitional
2007	5/1	5/5	5/1	5/1-5/8	Forced/Volitional
2008	5/5	5/4	5/1	5/1-5/4	Forced/Volitional
2009	5/1	5/2	5/1	5/1-5/7	Forced/Volitional
2010	4/23	No release	5/3	Discontinued	Forced/Volitional
2011	5/6	-----	5/4		Forced/Volitional
2012	5/1	5/5	5/1		Forced/Volitional
2013	4/15-19	Discontinued	5/1		Forced/Volitional

Source: WDFW Hatchery Headquarters Database 2013.

Soos Creek Hatchery: Fish will be volitionally released no earlier than April 15 (under same criteria as stated in **HGMP Section 2.2.3 - Residualism**) and force released by the first week of May. Once the rebuild is complete (See **HGMP Table 5.8.1**), WDFW will have more options and will likely be able to accommodate a desired prolonged volitional release period of up to one month. Currently at this facility the screens will be open for up to two weeks, or less if all the fish out-migrate. WDFW currently does not have the ability to separate fish that do not volitionally out-migrate at this facility.

Icy Creek Rearing Ponds: Volitional releases would occur no earlier than April 15th (under same criteria as stated in **HGMP Section 2.2.3 - Residualism**. Currently at this facility the screens will be open for up to three weeks, or less if all the fish out-migrate, due to constraints on available high quality water and rearing space needed for the next year's on-station fry. Once the rebuild at Soos Creek Hatchery is complete (See **HGMP Table 5.8.1**), WDFW will have more options and will likely be able to accommodate a desired prolonged volitional release period of up to one month. Fish that do not volitionally out-migrate will be placed into landlocked lakes.

10.5) Fish transportation procedures, if applicable.

Fish released from the Icy Creek Rearing Pond are transported from Soos Creek Hatchery in either the 300 or 1,500-gallon tanker trucks, equipped aerators and oxygen tanks. The loadings do not exceed 0.5 pound of fish per gallon of water. The transportation time is approximately half an hour.

10.6) Acclimation procedures.

Soos Creek Hatchery: With exception of initial rearing, winter steelhead are reared on Soos Creek surface water the entire time at the facility.

Icy Creek Rearing Pond: Winter steelhead are reared on Icy Creek surface water during their entire time in the facility.

10.7) Marks applied, and proportions of the total hatchery population marked, to identify hatchery adults.

Table 10.7.1: Number and mark type released, by location.

Brood Year	Release		Mark Type
	Soos Creek	Icy Creek	
2013-14	35,000	35,000	AD-only

Source: Future Brood Document 2013.

Hatchery steelhead released from this program are intended to be 100% adipose-fin clipped. Due to regeneration of a partially clipped adipose fin or fin missed completely, some hatchery adults may return with an adipose fin. WDFW performs Quality Assurance/Quality Control checks to measure the successful clip rate during the marking process. Partial or missed clips are enumerated and recorded annually.

10.8) Disposition plans for fish identified at the time of release as surplus to programmed or approved levels.

Egg-take is carefully managed to minimize the likelihood of collecting surplus eggs or raising surplus fry. Annual fluctuation in survival rates may result in production levels above release goals, and actual release of up to 10% above release goal is acceptable. If fish are available for release in excess of 10% acceptable level, regional staff and NOAA Fisheries will be informed and consulted for proper action to be taken. In the past, fish available over 10% limit were planted, accordingly to the direction of fish management, into lakes for use in non-anadromous programs.

10.9) Fish health certification procedures applied pre-release.

Standard Fish Health Procedures performed at the facility:

- *All fish health monitoring is conducted by a qualified WDFW Fish Health Specialist.*
- *Juvenile fish examinations are conducted at least monthly and more often if necessary*. A representative sample (at the discretion of the fish health specialist) of healthy and moribund fish from each lot is examined.
- *Abnormal levels of fish loss are investigated if they occur.*

- *Fish health status is determined prior to release or transfer to another facility*. The exam may occur during the regular monthly monitoring visit, i.e. within one month of release or transfer.
- *Appropriate actions, including drug or chemical treatments are recommended as necessary*. If a bacterial pathogen requires treatment with antibiotics a drug sensitivity profile is be generated when possible.
- *Findings and results of fish health monitoring are recorded on a standard fish health reporting form and maintained in a fish health database.*
- *Fish culture practices are reviewed as necessary with facility personnel*. Where pertinent; nutrition, water flow and chemistry, loading and density indices, handling, disinfecting procedures and treatments are discussed.

10.10) Emergency release procedures in response to flooding or water system failure.

Soos Creek Hatchery: During severe flood events the screens are generally not pulled because floodwaters rise to the point where they breach the ponds. Past experience has shown that the fish tend to lie on the bottom of the pond during flooding events and only those that are inadvertently swept out are able to leave.

Icy Creek Rearing Pond: Flooding is not a problem at this facility and no emergency procedures have been developed. During severe drought conditions, fish may be moved to Soos Creek if water and space are available.

10.11) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases.

WDFW has taken following actions to minimize adverse genetic and ecological effects to listed species resulting from hatchery releases:

- Eliminated transfers of eggs and juveniles between watersheds.
- Eliminated egg-takes after January 31, to keep hatchery and natural populations temporally segregated.
- Eliminated off-station releases where no trapping facilities are available.
- Eliminated recycling fish back into the river for sport fishing opportunities.
- Eliminated fry and sub-yearling releases, and mandatory rearing; release only yearling smolts, which are in migratory condition. This promotes rapid out-migration and thus minimizes the time spent in the river, in order to minimize or eliminate interactions with natural-origin salmonids rearing in the system (*Statewide Steelhead Rearing and Release Guidelines*; Tipping 2001).
- Leave trapping facilities open during the entire return time for adults of the segregated stock.
- Promoted volitional releases to foster rapid seaward migration and limit residualism and freshwater interactions with listed Chinook and steelhead juveniles, bull trout and other naturally-produced salmonids.
- Mass-mark all releases for harvest selection and removal from the system.
- Release fish no earlier than April 15, to allow listed stocks (Chinook, chum and steelhead) and pink salmon, to emigrate out of the system, and/or provide time for additional growth to minimize potential predation.
- Continue monitoring, research and reporting of hatchery smolt migration performance behavior, and interactions with natural origin fish to assess and adjust, if necessary, hatchery production and release strategies to minimize effects on natural origin fish.

Hatchery steelhead releases have been 100% mass-marked since 1980s to enable identification during selective harvest, broodstock selection and, most recently, removal from the system.

WDFW continues monitoring, research and reporting of hatchery smolt migration performance behavior, and interactions with natural-origin fish to assess and adjust, if necessary, hatchery production and release strategies to minimize effects on natural-origin fish. WDFW is conducting research on the effects of volitional releases in Upper Columbia basin. This study is not yet fully completed, but preliminary results suggest faster fish migration, and lower rates of residualism when released volitionally (Snow et al. 2013).

With changes already being implemented, WDFW continues monitoring its hatchery programs and the affected watersheds to observe the effects on the populations at the hatcheries and natural spawning grounds.

See also Section 2.2.3.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

11.1) Monitoring and evaluation of "Performance Indicators" presented in Section 1.10.

11.1.1) Describe plans and methods proposed to collect data necessary to respond to each "Performance Indicator" identified for the program.

The purpose of monitoring is to identify and evaluate the benefits and risks from this hatchery program, elements of which are identified in HGMP section 1.10. The co-managers conduct numerous ongoing monitoring programs, including, catch, escapement, marking, tagging, smolt trapping and fish health testing. The focus of enhanced monitoring and evaluation programs will be on the risks posed by ecological interactions with listed species.

WDFW monitors salmon escapement to the natural spawning areas above and below the hatchery release sites to estimate the number of tagged, untagged, and marked fish escaping each year. This will allow for assessment of the status of the target population and the success of the program in achieving restoration objectives. Also, WDFW will continue to monitor smolt emigration rate post-release, timing of emigration and predation assessment via smolt trapping (Topping and Zimmerman 2011).

WDFW's Wild Salmon Production/Evaluation Unit (WSPE) operates a juvenile out-migrant trap at River Mile 33 above the confluence with Soos Creek. This trap enumerates Chinook, coho, chum, pink, and steelhead, as well as facilitates the collection of biological data on age, size and timing.

From 2006 to 2009, WDFW conducted an acoustic tagging study on out-migrating natural origin and hatchery winter steelhead to assess freshwater migration pathways, rates and use of estuary, nearshore, and marine habitat by juvenile steelhead. Results are being compiled and will be reported (WDFW pers. comm. October 2011, Goetz et al. 2008).

Additional research, monitoring and evaluation in the Green River watershed: Table 11.1.1.1 should be considered preliminary as this framework is still under development and subject to change.

Table 11.1.1.1: WDFW Green River steelhead monitoring.

Project	Description
Hatchery Reform Implementation	This project focuses on the implementation of hatchery reform actions called for by the Washington Fish and Wildlife Commission Policy on Hatchery and Fishery Reform. Activities include oversight and implementation of WDFW Hatcheries, spawning ground surveys and weir operations. Additional activities include in-season

	management of broodstock collection activities at WDFW facilities to implement hatchery reform actions. Deliverables include: development of hatchery management plans that will contribute to HGMP updates; estimation of performance metrics for WDFW hatchery programs includes adult run timing, spawn timing, broodstock mortality (including handling and pathology), fecundity, egg mortality rate, sex ratios, and juvenile marking protocols).
Monitoring of Populations of Winter Steelhead	This project will continue to conduct spawning ground (redd) surveys in the Green River and its tributaries that support populations of winter steelhead. *Green River DIP*: Streams surveyed include: sections of the Green River mainstem (WRIA 09.0001) (RM 26 to RM 61), Soos Creek (WRIA 09.0072), Covington Creek (WRIA 09.0083), Jenkins Creek (WRIA 09.0087) and Newaukum Creek (WRIA 09.0114). Surveys will provide data regarding adult abundance and spatial diversity of spawning, which are key VSP parameters.
Monitoring Summer Steelhead Populations	Not currently monitored. No native summer run population is known to occur in the Green River watershed (PSSTRT 2013).
Monitoring of Gene Flow/Introgression from Hatchery Steelhead Populations to Natural origin Steelhead Populations	WDFW is implementing a genetic monitoring program to measure PEHC and gene flow between segregated hatchery (early winter stock) steelhead and natural origin populations in the Puget Sound DPS (see Appendix for additional details).

11.1.2) Indicate whether funding, staffing, and other support logistics are available or committed to allow implementation of the monitoring and evaluation program.

See HGMP section 11.1.1.

11.2) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from monitoring and evaluation activities.

Risk aversion measures will be developed in conjunction with the monitoring and evaluation plans.

SECTION 12. RESEARCH

12.1) Objective or purpose.

Research specific to Soos Creek winter steelhead is not currently conducted.

12.2) Cooperating and funding agencies.

Not applicable.

12.3) Principle investigator or project supervisor and staff.

Not applicable.

12.4) Status of stock, particularly the group affected by project, if different than the stock(s) described in Section 2.

Not applicable.

12.5) Techniques: include capture methods, drugs, samples collected, tags applied.

Not applicable.

12.6) Dates or time period in which research activity occurs.

Not applicable.

12.7) Care and maintenance of live fish or eggs, holding duration, transport methods.

Not applicable.

12.8) Expected type and effects of take and potential for injury or mortality.

Not applicable.

12.9) Level of take of listed fish: number or range of fish handled, injured, or killed by sex, age, or size, if not already indicated in Section 2 and the attached "take table" (Table 1).

Not applicable.

12.10) Alternative methods to achieve project objectives.

Not applicable.

12.11) List species similar or related to the threatened species; provide number and causes of mortality related to this research project.

Not applicable.

12.12) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse ecological effects, injury, or mortality to listed fish as a result of the proposed research activities.

Not applicable.

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SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the information provided is complete, true and correct to the best of my knowledge and belief. I understand that the information provided in this HGMP is submitted for the purpose of receiving limits from take prohibitions specified under the Endangered Species Act of 1973 (16 U.S.C.1531-1543) and regulations promulgated thereafter for the proposed hatchery program, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or penalties provided under the Endangered Species Act of 1973."

Name, Title, and Signature of Applicant:

Certified by_____ Date:_____

ADDENDUM A. PROGRAM EFFECTS ON OTHER (AQUATIC OR TERRESTRIAL) ESA-LISTED POPULATIONS. (Anadromous salmonid effects are addressed in Section 2)

15.1) List all ESA permits or authorizations for USFWS ESA-listed, proposed, and candidate salmonid and non-salmonid species associated with the hatchery program.

The WDFW and the USFWS have a Cooperative Agreement pursuant to section 6(c) of the Endangered Species Act that covers the majority of the WDFW actions, including hatchery operations.

> "The department is authorized by the USFWS for certain activities that may result in take of bull trout, including salmon/steelhead hatchery broodstocking, hatchery monitoring and evaluation activities and conservation activities such as adult traps, juvenile monitoring, spawning ground surveys..."

15.2) Describe USFWS ESA-listed, proposed, and candidate salmonid and non-salmonid species and habitat that may be affected by hatchery program.

Green (Duwamish) Bull Trout *(Salvelinus confluentus):* Bull trout were listed as a threatened species in the Coastal-Puget Sound Distinct Population Segment on November 1, 1999 (64 FR 58910). The Green River is considered critical habitat for bull trout and is thought to serve rearing, migration and overwintering purposes (USFWS 2004). Bull trout have been document in the Green River as far upstream as RM 41 in recent years and are consistently reported in the lower Duwamish River. It is unclear whether these fish represent a local spawning population or transients from other systems as there is no information on timing or distribution of spawning in the basin if any occurs (SaSI 2004).

Habitat--The Green River watershed has been heavily impacted by human activities, which include logging, road construction, flood control and municipal water supply diversion dams, agricultural development, river channelization, intensive industrial and residential development, and estuarine dredging and filling. Historically the contribution of the White and Black Rivers which accounted for two-thirds of the flow of the Duwamish would have greatly increased the amount of favorable bull trout habitat in the system. It is unknown if the current habitat can support bull trout, but suitable habitat may still be available in the upper watershed above Howard Hanson Dam. It is not known if bull trout occupied the upper watershed in the past; they do not appear to be present now (Watson and Toth 1994).

Several listed and candidate species are found in King County; however the hatchery operations and facilities for this program do not fall within the critical habitat for any of these species. As such there are no effects anticipated for these species.

Listed or candidate species:
"No effect" for the following species:

Marbled murrelet (*Brachyramphus marmoratus*) –Threatened [critical habitat designated]
Canada Lynx (*Lynx canadensis*) –Threatened [critical habitat designated]
Gray Wolf (*Canis lupus*) –Threatened
Grizzly bear (*Ursus arctos horribilis*) –Threatened
Northern Spotted owl (*Strix occidentalis caurina*) –Threatened [critical habitat designated]

Candidate Species
Fisher *(Martes pennanti)* – West Coast DPS
North American wolverine *(Gulo gulo luteus)* – contiguous U.S. DPS
Oregon spotted frog *(Rana pretiosa)* [historic]
Yellow-billed cuckoo *(Coccyzus americanus)*

Whitebark pine *(Pinus albicaulis*)

15.3) Analyze effects.

Hatchery activities, including in-river broodstock collection, hatchery trap, and water intake structures may pose a risk to system bull trout populations. Annual estimates of bull trout encounters through the hatchery activities are recorded and reported.

15.4 Actions taken to minimize potential effects.

Trap is checked at least daily. Any bull trout encountered at the trap are immediately returned to the stream. Bull trout may be encountered in other hatchery programs during broodstock collection activities (steelhead or coho) that would directly impact or create potential effects on bull trout in this system based on the current understanding of the status of these fish.

15.5 References

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Table 1a. Estimated listed salmonid take levels of by hatchery activity.

Listed species affected: Steelhead *(Oncorhynchus mykiss)*	**ESU/Population:** Green River/ Puget Sound Steelhead		**Activity:** Green River Winter Steelhead Program	
Location of hatchery activity: Soos Creek Hatchery, RM 1 Big Soos Creek (09.0072)	**Dates of activity:** December- May		**Hatchery program operator:** WDFW	
Type of Take	**Annual Take of Listed Fish By Life Stage *(Number of Fish)***			
	Egg/Fry	**Juvenile/Smolt**	**Adult**	**Carcass**
Observe or harass a)	-	-	-	-
Collect for transport b)	-	-	-	-
Capture, handle, and release c)	-	-	Up to 50	-
Capture, handle, tag/mark/tissue sample, and release d)	-	-	-	-
Removal (e.g. broodstock) e)	-	-	-	-
Intentional lethal take f)	-	-		-
Unintentional lethal take g)	-	-	-1	-
Other Take (specify) h)	-	-	-	-

a. Contact with listed fish through stream surveys, carcass and mark recovery projects, or migrational delay at weirs.
b. Take associated with weir or trapping operations where listed fish are captured and transported for release.
c. Take associated with weir or trapping operations where listed fish are captured, handled and released upstream or downstream.
d. Take occurring due to tagging and/or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
e. Listed fish removed from the natural origin and collected for use as broodstock.
f. Intentional mortality of listed fish, usually as a result of spawning as broodstock.
g. Unintentional mortality of listed fish, including loss of fish during transport or holding prior to spawning or prior to release into the wild, or, for integrated programs, mortalities during incubation and rearing.
h. Other takes not identified above as a category.

Table 1b. Estimated listed salmonid take levels of by hatchery activity.

Listed species affected: Fall Chinook *(Oncorhynchus tshawytscha)*	**ESU/Population:** Puget Sound Chinook	**Activity:** Green River Winter Steelhead Program
Location of hatchery activity: Soos Creek Hatchery, RM 1 Big Soos Creek (09.0072)	**Dates of activity:** December- May	**Hatchery program operator:** WDFW

Type of Take	**Annual Take of Listed Fish By Life Stage *(Number of Fish)***			
	Egg/Fry	**Juvenile/Smolt**	**Adult**	**Carcass**
Observe or harass a)	-	-	-	-
Collect for transport b)	-	-	-	-
Capture, handle, and release c)	-	-	0	-
Capture, handle, tag/mark/tissue sample, and release d)	-	-	-	-
Removal (e.g. broodstock) e)	-	-	-	-
Intentional lethal take f)	-	-	-	-
Unintentional lethal take g)	-	-	-	-
Other Take (specify) h)	-	-	-	-

a. Contact with listed fish through stream surveys, carcass and mark recovery projects, or migrational delay at weirs.
b. Take associated with weir or trapping operations where listed fish are captured and transported for release.
c. Take associated with weir or trapping operations where listed fish are captured, handled and released upstream or downstream.
d. Take occurring due to tagging and/or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
e. Listed fish removed from the wild and collected for use as broodstock.
f. Intentional mortality of listed fish, usually as a result of spawning as broodstock.
g. Unintentional mortality of listed fish, including loss of fish during transport or holding prior to spawning or prior to release into the wild, or, for integrated programs, mortalities during incubation and rearing.
h. Other takes not identified above as a category.