HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Photo Courtesy of Hatchery Staff

Hatchery Program:	Green River Native Winter (late) Steelhead Hatchery Program (Integrated)
Species or Hatchery Stock:	Winter (late) Steelhead (*Oncorhynchus mykiss*) Green River Stock
Agency/Operator:	Washington Department of Fish and Wildlife
Watershed and Region:	Green River (Duwamish)/ Puget Sound
Date Submitted:	November 17, 2014
Date Last Updated:	November 10, 2014

Executive Summary

ESA Permit Status:
The Washington Department of Fish and Wildlife (WDFW) is submitting to the National Marine Fisheries (NMFS) a Hatchery and Genetic Management Plan (HGMP) for the Green River winter-late endemic steelhead program under Limit 6 of the 4(d) rule. NMFS will use the information in this HGMP to evaluate the hatchery impacts on salmon and steelhead listed under the Endangered Species Act (ESA). The primary goal of an HGMP is to devise biologically-based hatchery management strategies that ensure the conservation and recovery of salmon and steelhead populations. This HGMP outlines the modifications made to WDFW hatchery programs with the adoption of the Washington Fish and Wildlife Commission Policy on Hatchery and Fishery Reform C-3619 in 2009.

The Puget Sound steelhead Distinct Population Segment (DPS) is listed as "Threatened" under the ESA, and the Green River winter-late steelhead are included in the ESA-listing. The Puget Sound Technical Recovery Team (PSTRT) has preliminarily delineated one Demographically Independent Population (DIP) of native winter steelhead in the Green River.

Green River Winter-Late Steelhead Program:
The purpose of the program is to produce Green River winter-late steelhead for conservation and recovery. The program may serve to preserve the genetic legacy of the Green River wild steelhead and provide a gene bank if intensive recovery efforts are required in the future. Program fish will be spawned and initially reared at the Soos Creek Hatchery (located on Soos Creek, tributary to the Green River), with final rearing and release at Flaming Geyser Ponds (located on Cristy Creek, tributary to the Green River) and Icy Creek Pond (located on Icy Creek, tributary to the Green River). The program will release 33,000 yearling smolts to the Green River annually (15,000 at Flaming Geyser and 18,000 at Icy Creek). Current funding for the monitoring and evaluation of this program is not sufficient to determine the smolt-to-adult survival rate and its subsequent contribution to the natural spawning population.

The program will be operated as an "integrated" program with the intent to minimize the genetic and reproductive fitness differences between the hatchery broodstock and the naturally spawning population. To achieve this, the proportion of hatchery broodstock comprised of natural-origin fish is greater than the proportion of the natural spawning population made up of hatchery-origin fish. Specific risk-reduction measures that have been implemented since 2004 include:

- Hatchery trap remains open through March 15 (or later as conditions allow) to provide opportunity for all adult hatchery fish to return to the hatchery.

Harvest:
WDFW and Tribal co-managers (Muckleshoot Tribe and the Suquamish Tribe) prepare an annual Fisheries Management Plan for the incidental harvest of Green River winter-late steelhead produced from this program (WDFW et al. 2008 to present). Fish from this program are not directly targeted in fisheries, but may be intercepted in fisheries targeting hatchery early-winter steelhead stock adults, although these fisheries typically end prior to the start of the winter-late run. Tribal fisheries include net, and hook and line fisheries, generally from early-December through late-February. The sport fishery directed at hatchery-origin adults is open October 16 through January 31, within selected stream reaches, with two adipose fin-clipped 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 continues to annually monitor natural production and smolt emigration timing via juvenile trapping on the mainstem Green River, at RKm 34.5.

1 SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1 Name of hatchery or program.

Green River Native Winter-late Steelhead Program.

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

Green River Wild Winter Steelhead (*Oncorhynchus mykiss*).

Wild winter steelhead in the Green River (Duwamish) basin along with all populations that constitute the Puget Sound DPS (Distinct Population Segment) have been listed as *Threatened* under the Endangered Species Act (71 FR 15666, March 29, 2006, 72 FR, No 91; May 11, 2007), and reaffirmed *Threatened* by five-year status review, completed August 15, 2011 (76FR50448).

1.3 Responsible organization and individuals

Hatchery Operations Staff Lead Contact

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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 Co-manage the program and prepare an annual fishery management plan for the harvest of Green River system winter and summer steelhead from hatchery programs.

The **Des Moines Chapter of Trout Unlimited** operates Dick Brice Ponds in cooperation with Flaming Geyser State Park.

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

Facility	Funding Sources	Operational Information (FY 2011)
Soos Creek Hatchery*	PSRE Fund Wildlife Fund – State DJ-Federal Local	FTEs = 4.33 Annual operating cost (dollars) $411,152.
Icy Creek Rearing Pond*	PSRE Fund	Full time equivalent staff – 1.25 Annual operating cost (dollars) - $88,000.
Flaming Geyser (Dick Brice) Ponds	No Budget	Program Staffed by volunteers, feed and oversight provided by WDFW.

* The above information for annual operating cost applies cumulatively to all species produced at the facility.

1.5 Location(s) of hatchery and associated facilities.

Table 1.5.1: Location of culturing phases, by facility.

Facility	Culturing Phase	Location
Soos Creek Hatchery	Broodstock collection, Spawning, Incubation	Located on Big Soos Creek (WRIA 09.0072) at RM 1, tributary to the Green River (WRIA 09.0001) at RM 33.5.
In-river (hook and line)	Broodstock collection	WDFW and Muckleshoot tribal staff also capture broodstock at several locations in the Middle Green River, mostly from RMs 29.3 - 44.0.
Icy Creek Rearing Pond	Broodstock collection, Rearing, Acclimation	Located on Icy Creek (WRIA 09.0125), tributary to Green River (WRIA 09.0001) at R.M. 48.3.
Flaming Geyser (Dick Brice) Ponds	Rearing, Acclimation	Located on Cristy Creek (WRIA 09.0038)at RM 0.1, tributary to Green River (WRIA 09.0001) at RM 44.3.

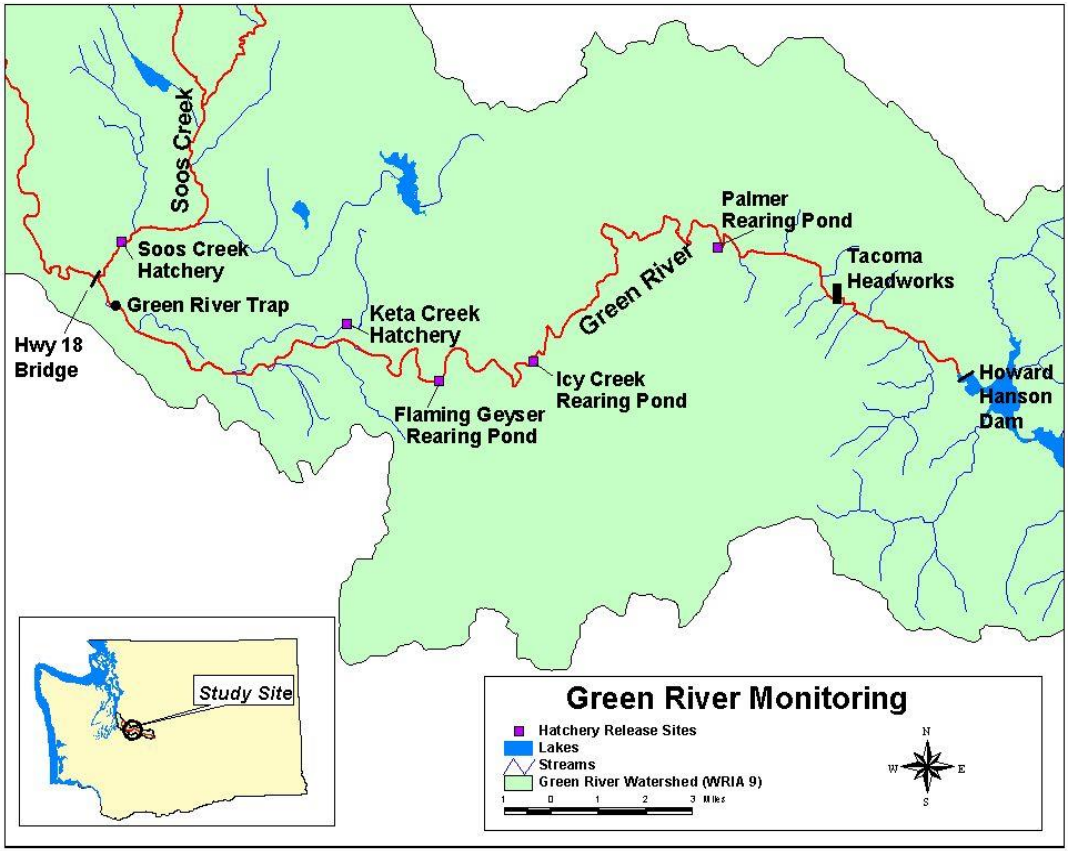

Figure 1.5.1: Location of Soos Creek Hatchery, and associated juvenile production and adult broodstock trapping, rearing, acclimation and release sites. Source: Topping and Zimmerman 2013.

1.6 Type of program.

Integrated Conservation.

1.7 Purpose (Goal) of program.

Conservation and recovery. The program may serve to preserve the genetic legacy of the Green River wild steelhead and provide a gene bank if intensive recovery efforts are required in the future.

1.8 Justification for the program.

In 2001, the Muckleshoot Indian Tribe (MIT) and WDFW initiated the wild broodstock program to enhance harvest opportunities, evaluate the survival and harvest contribution in comparison with the Chambers stock, as well as to assess the feasibility of successfully producing one year-old wild-origin steelhead smolts in a hatchery environment.

The program was redesigned in 2009, and converted to a conservation and recovery program in response to declines in the natural population, and the 2007 ESA-listing of the Puget Sound steelhead DPS.

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* (1974) proceedings.

Historically, tributary spawning in the Green-Duwamish accounted for up to 55% of the total wild 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.

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: Summary of risk aversion measures for the Green River winter-late steelhead program.

Potential Hazard	HGMP Reference	Risk Aversion Measures
Water Withdrawal	4.1	Surface water rights are formalized through trust water right #S1-21122 (Soos), # S1-00317 (Icy) and #S1-24715 (Flaming Geyser). 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. Anadromous fish do not occur upstream of the intakes at Icy Creek or Flaming Geyser.
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 (WDOE) - WAG 13 – 3014 (Soos) and WAG 13 – 3013 (Icy).

		Production at Flaming Geyser is below the 20,000 pound limit set by WDOE and does not require a NPDES permit.
Broodstock Management & Adult Passage	7.9	Broodstock is collected via hook and line in the Green River and at the Soos Creek Hatchery and Icy Creek Rearing Pond traps (February through April), when listed adult Chinook salmon are not typically present.
Disease Transmission	2.2.3, 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. Standards and indicators are referenced from Northwest Power Planning Council (NPPC) Artificial Production Review (APR) (NPPC 2001).

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**
3.1.3 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.
3.3.1 Hatchery program contributes to an increasing number of spawners returning to natural spawning areas.	Annual number of redds in selected natural production index areas.	Annually monitor and estimate number of spawners based on redd counts, returns to the hatchery, and genetic monitoring studies.
3.3.2 Releases are sufficiently marked to allow statistically significant evaluation of program contribution to natural production and to evaluate effects of the program on the local natural population.	Number of marks released and estimated proportion of marks in out-migrant juveniles and returning adults on the spawning ground. Percentage of total hatchery releases mass-marked (fin-clips, otoliths, tags, etc.) to allow for their differentiation from naturally-produced fish.	Annually monitor and record size, number, date of release and mass-mark quality (adipose fin-clip rate) of all hatchery releases. Annually sample returning fish in fisheries, at the hatchery, and on the spawning grounds (annual redd counts); record numbers of estimated hatchery (marked) and natural (unmarked) fish.
3.4.1 Fish collected for broodstock are taken throughout the return or spawning period in proportions approximating the timing and age distribution of population from which broodstock is taken.	Temporal distribution of broodstock collection at point of collection.	Collect broodstock representatively and systematically throughout the early portion of the return (mid-February through April). Collect annual run timing, age and sex composition and spawning escapement timing data.

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, date of release and release type in WDFW Hatcheries Headquarters Database.
3.5.6 The number of adults returning to the hatchery that exceeds broodstock needs is declining.	Program is sized appropriately for conservation goals.	Monitor harvest 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 (CV).	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.	Program is designed to help achieve the end goal of conserving and stabilizing natural salmon populations.	Long-term monitoring of the natural population in the watershed will indicate success of program.

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.
3.2.2 Release groups are sufficiently marked in a manner consistent with information needs and protocols to enable determination of impacts to natural- and hatchery-origin fish in fisheries.	Number of marks released and estimated proportion of marks in out-migrant juveniles and returning adults on the spawning ground. Production fish are mass-marked (fin-clip, BWT, otolith-mark, etc., depending on species) to allow for their differentiation from naturally-produced fish.	Annually monitor and record size, number, date of release and mass-mark quality (adipose fin-clip rate) of all hatchery releases, and reported in the Hatcheries Headquarters Database. All releases are 100 % marked with blank wire tags (BWT) (FBD 2014).
3.3.2 Releases are sufficiently marked to allow statistically significant evaluation of program contribution to natural production and to evaluate	All hatchery production is identifiable in some manner (fin-marks, tags, otolith, etc.) consistent with information needs.	Annually monitor and record size, number, date of release and mass-mark quality (adipose fin-clip rate) of all hatchery releases. Examine returning fish

effects of the program on the local natural population.		encountered for the mass-mark (BWT) at the hatchery and on the spawning ground. Annually record numbers of estimated hatchery (marked) and natural (unmarked).
3.4.1 Fish collected for broodstock are taken throughout the return or spawning period in proportions approximating the timing and age distribution of population from which broodstock is taken.	Temporal and age distribution of broodstock collected, compared to that of naturally-produced population at collection point.	Collect annual run timing, age and sex composition and return timing data.
3.4.2 Broodstock collection does not significantly reduce potential juvenile production in natural rearing areas.	Number of spawners of natural-origin removed for broodstock.	A maximum of 50 natural-origin spawners used in broodstock; in low return years up to 50% of F1 hatchery returns may be incorporated in broodstock. Any lower natural production potential is offset by increased egg-to-fry survival and higher female/ smolt ratio provided by hatchery rearing. Survival from egg-to-fry and fry-to-smolt is monitored annually in the hatchery.
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.	Currently unknown. Plan in progress to annually monitor for production levels – age and size data collected.
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.). Collect annual run timing, origin, and age and sex composition data. Examine returning fish for the CWT at broodstock collection points and on the spawning grounds. Annually record and report numbers of estimated hatchery (marked) and natural (unmarked).
3.5.4 Juveniles are released on-station, or after sufficient acclimation to maximize homing ability to intended return locations.	Location of release (on-station, acclimation pond, direct plant). Release type (forced, volitional or direct stream release).	Annually monitor and report release information (including 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 record size, number, date of release and release type.
3.5.6 The number of adults	Program is sized appropriately	Annually record numbers of adults

returning to the hatchery that exceeds broodstock needs is declining.	for conservation goals. Numbers of surplus hatchery returns are calculated annually.	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, *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State*).	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 permit. Washington Department of Ecology (WDOE) water right permit compliance.	Flow and discharge reported in monthly NPDES reports.
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, revised 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	At spawning, all females are

	for pathogens and parasites.	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).
3.7.6 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 broodstock collection site is currently compared to historic distribution.	Not monitored at this time.
3.7.7 Weir/trapping 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.	Traps checked regularly. Annually record and report abundances and observations of natural- 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 (Seiler et al. 2002, Sharpe et al. 2008, Pflug et al. 2013) (see also HGMP section 2.2.3).

1.11 Expected size of program.

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

Up to 50 adults collected annually.

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

Table 1.11.2.1: Proposed Annual Release Levels.

Life Stage	Size (fpp)	Release Location	Annual Release Level
1+ smolt	8.0	Icy Creek (WRIA 09.0125)	18,000
1+ smolt	7.0	Cristy Creek (WRIA 09.0038)	15,000

Source: Future Brood Document 2014.

Note: Table reflects current goal (FBD 2014). Co-Managers may adjust program size and release locations based on evaluation and research needs in the future.

1.12 Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels. Indicate the source of these data.

This is a conservation program and program fish are not intended for harvest, to minimize impacts recreational fisheries are closed during the return period. Due to a lack of harvest and coded-wire tag (CWT) data, as well as limitations that not all fish can be accounted as back-to-rack counts, accurate smolt-to-adult survival rates (SAR) cannot be calculated (see also HGMP section 3.3.1).

Table 1.12.1: Green River winter-late steelhead escapement to Soos Creek Hatchery 2001-2013.

Year[a]	Hatchery Escapement[c]
2001	NA
2002	NA
2003	NA
2004	NA
2005	NA
2006	NA
2007[b]	12
2008[b]	53
2009[b]	0
2010[b]	5
2011	8
2012	0
2013	2
Average	**11**

Source: WDFW Hatcheries Headquarters Database 2014.

[a] Prior to 2007 returns were to Keta Creek Hatchery.

[b] Data from 2009 Draft Green River Wild Steelhead Population and Supplementation Project Update.

[c] Hatchery returns for this program can only be trapped at Soos Creek when flows allow and escapement only represents partial returns for this program.

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

The program began in 2001, as a co-operative effort between WDFW and the Muckleshoot Tribe.

1.14 Expected duration of program.

The program was initiated without a termination date, with the intent by the Co-managers to evaluate the program after five years of releases. As a response to both declines in the natural population escapement and the listing of the Puget Sound steelhead DPS (NMFS 2007), its status was changed from Harvest to Conservation in 2009.

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: The current goal of this program is to recover natural-origin winter steelhead to healthy and harvestable levels. At this point, the Co-managers have agreed to continue the program until the escapement goal of 2,000 fish is consistently met. Current funding for the monitoring and evaluation of this program is not sufficient to determine the smolt-to-adult survival rate and its subsequent contribution to the natural spawning population. However, if such fish culture issues as disease, adult holding mortality, or the inability to reach smolt release size prior to release are considerable and jeopardizing the number or quality of fish raised in this program, it may be terminated. More than one year of egg to smolt mortality rates of greater than 70%, pre-spawn adult mortality of greater than 50%, or the inability to consistently culture smolts of a size larger than 14 fish per pound (fpp) would be considered as reasons to terminate the program. Other reasons to discontinue this program include a lack of adequate funding, or mutual agreement of the Co-managers.

2 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.

No permits have been issued for this program. This HGMP is submitted to the NOAA Fisheries for ESA consultation and determination regarding compliance of the plan with ESA section 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.

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 Technical Recovery Team (TRT) has preliminarily delineated one demographically independent population (DIP) of winter steelhead (Green River); no summer run populations were identified in the basin (PSSTRT 2013).

- 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 TRT has identified one demographically independent population (DIP) (Duwamish/ Green River Chinook) (Ruckelshaus et al. 2006).

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 (2003-2011) have averaged 1,860 for natural spawners in the Green/Duwamish DIP. During this same time period, the population has shown declining trend (SCoRE, WDFW 2014).

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. 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 (Ford 2011). Based on a preliminary intrinsic potential (IP) estimate by the PSSTRT (2013), the capacity for winter steelhead is between 19,778 and 39,537 in the Green River Basin.

*Puget Sound steelhead: Updated Risk Summary***.** Steelhead populations in Puget Sound have shown a slight upward trend in spawners since 2009. The average number of spawners increased from 59% in 2009, to 77% in 2010, to 102% in 2011, and to 90% in 2012 relative to the four years leading up to the ESA-listing in 2007.

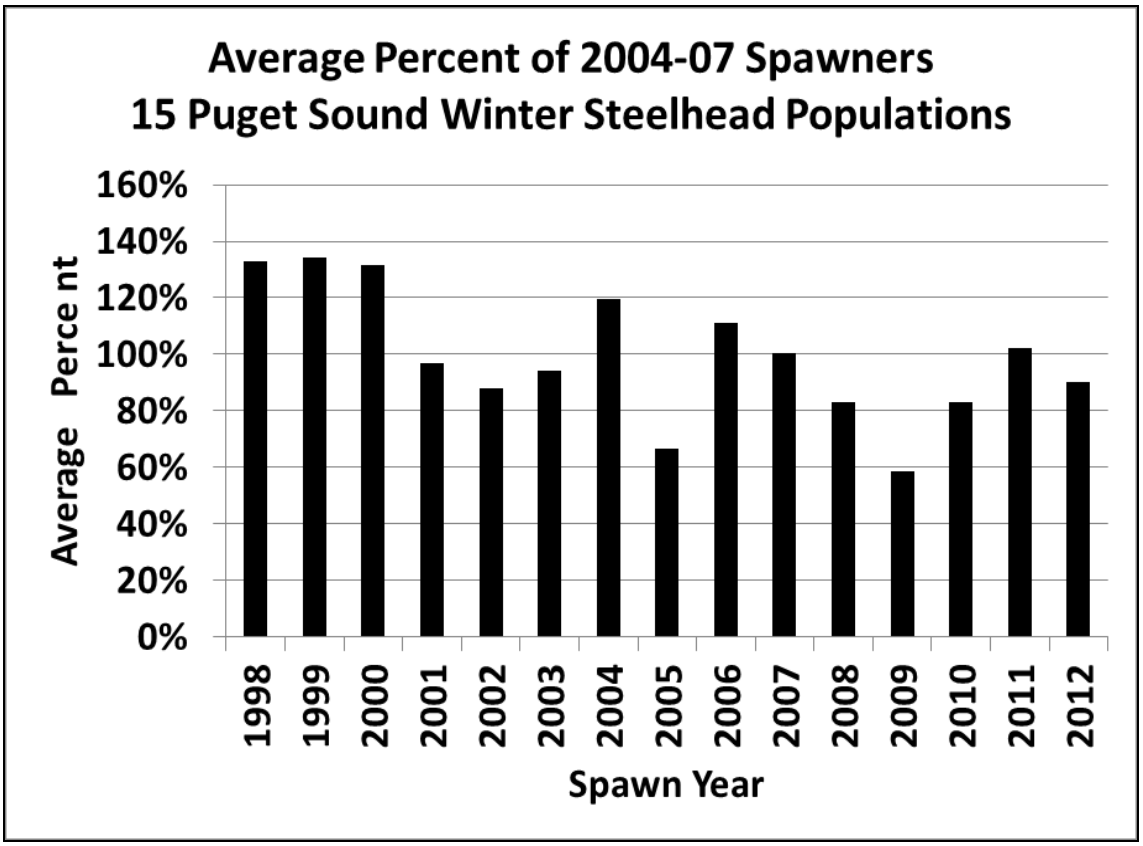

Figure 2.2.2.1: **Average percent of 2004-2007 spawners for 15 Puget Sound winter steelhead populations.**

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. Minimum abundance = 100 (Low Abundance), 250 (Viable).

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.

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.

- 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 wild winter steelhead spawning escapement 2001-2012.

Return Year	Escapement
2001	1,402
2002	1,068
2003	1,612
2004	2,359
2005	1,298
2006	1,955
2007	1,452
2008	833
2009	304
2010	423
2011	855
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 wild 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 level of hatchery origin winter-late run steelhead from this program that spawn naturally in the Green River is currently unknown.

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: The total annual goal (maximum of 25 pairs) will be collected by hook and line and from broodstock fish returning to the Soos Creek and Icy Creek broodstock collection facilities. The broodstock portion represents about 4.2% of the average spawner escapement in this system (1,185 for the last 12 years, 2001-2012). In 2008/09, spawner escapement fell to a low of 304, with the goal of 50 fish for broodstock collection representing about 16.4% of the total escapement (see **Table 2.2.2.4**). Due to low numbers of fish in the river in 2009, however, only 6 natural-origin fish were collected for broodstock (about 2% of the escapement) and F1 hatchery-origin returns were used to meet the remaining broodstock needs. Mortality may occur during collection although fishing techniques, adult netting materials, holding protocols and transfer from boat to tanker trucks are under the area biologist supervision and implemented to maximize survival of listed fish.

Broodstock Holding and Spawning: Adults to be used in broodstock are currently held in 3' x 3' x 16' fiberglass raceways in the Soos Creek Hatchery building (see **Table 2.2.3.1**). As of brood year 2010, adult broodstock are live-spawned when possible (based on fish condition). Live-spawned fish are allowed to recover from the CO_2, and returned back to the stream to allow an opportunity for repeat spawning. Fish culture activities from handling procedures, fertilization procedures, water temperature, water quality, water flow, feeding and any transport may result in some mortality and disease. The current egg-take goal for this program is 50,000 green eggs; egg-takes and survival rates may vary (see **Tables 9.1.1.1 and 9.2.1.1**).

Pathology Sampling: Currently, *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006) guidelines require that a minimum of 60 fish from steelhead hatchery programs are kidney/spleen sampled (WDFW and WWTIT 1998, updated 2006). This total minimal lethal sampling goal of 60 exceeds the annual number of broodstock (50) for this program. A combination of wild fish used as broodstock along with F1 hatchery adults collected from the Soos Creek Hatchery weir may be used in order to fulfill virology sampling needs. A portion of swim-up fry (up to 10) may be used in lieu of any un-sampled (lethal) females. All mortalities are sampled and ovarian fluid samples are collected from all spawned females. If needed, sampling protocols may be updated and the Area Fish Pathologist may undertake additional monitoring activities.

Rearing Program: Incubation and initial rearing occurs on spring water at Soos Creek Hatchery. At 300 to 250 fpp, juveniles are transferred to Icy Creek or Flaming Geyser ponds for rearing, acclimation and release the following spring. Fish at Icy Creek are initially held in a net pen within the pond, but are transferred to the upper section of the pond for final rearing until release.

Residualism: WDFW steelhead programs are reared and released in a smolted condition according to the following rearing parameters:

- To maximize smolting characteristics and minimize residual steelhead, WDFW adheres to a combination of acclimation, volitional release strategies, and release guidelines with releases occurring after April 15.

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 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). No anadromous fish exist above the intake screens at Icy Creek and Flaming Geyser ponds, so

there is no risk of entrainment of salmonids on the intake screen. 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.

Monitoring and Evaluation: All smolts are marked in order to distinguish the smolts upon return as adults. Fish from this program are blank wire tagged, to ensure that they can be differentiated from the segregated program fish (see also HGMP section 10.7). DNA samples from natural-origin fish and some carcass surveys have been conducted since 2002 by the Co-managers. Multi-agency ongoing or proposed future research may include or request usage of hatchery produced fish for several studies such as radio telemetry studies and DNA sampling. These may be for hatchery fish (fry, sub-yearlings and yearlings) from both integrated (wild stock) and segregated (early winter or early summer) hatchery stocks. Fish from segregated stock hatchery programs are not included in current steelhead listings and therefore would only need to be agreed upon by the co-managers. Hatchery fish of integrated stock programs utilized in these studies are not lethal takes but may need to be communicated on a case by case basis with NOAA staff.

Fish Health Activities (Viral Sampling): Currently the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006) guidelines require that a minimum of 60 fish from steelhead hatchery programs are kidney/spleen sampled (WDFW and WWTIT 1998, updated 2006). This total minimal lethal sampling goal of 60 exceeds the annual number of broodstock (50) for this program. A combination of wild fish used as broodstock along with F1 hatchery adults collected from the Soos Creek Hatchery weir may be used in order to fulfill virology sampling needs. A portion of swim-up fry (up to 10) may be used in lieu of any un-sampled (lethal) females. All mortalities are sampled and ovarian fluid samples are collected from all spawned females. If needed, sampling protocols may be updated and the Area Fish Pathologist may undertake additional monitoring activities.

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 wild 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 nine 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 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 wild 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.

The Muckleshoot Tribe and WDFW broodstock collection may result in lethal takes for this program. See also "Take" table at the end of this document for loss of eggs and juvenile fish.

Table 2.2.3.1: Disposition of wild (endemic) fish collected for broodstock, Green River winter (late) steelhead.

Brood Year	Total Collected	Lethal Spawn/Kidney Spleen Virology		Pond Mortality	
		Females	Males	Females	Males
2002	NA	NA	NA	----	----
2003	NA	NA	NA	----	----
2004	40	12	13	3	2
2005	24	9	NA	----	----
2006	43	10	NA	1	----
2007	39	15	18	6	----
2008	29	5	6	----	2
2009	6	2	1	----	3
2010	17	----	----	----	----
2011	29	----	----	3	----
2012	**39**	----	----	2	2
2013	**50**	----	----	4	7
Average	**32**	**9**	**10**	**3**	**3**

Source: WDFW Hatcheries Headquarters Database 2014.

Note: Total disposition of fish numbers may or may not add up to number collected. Number collected may be estimates and fish spawned may include live-spawned and those returned back to stream.

Genetic Introgression: By utilizing three release sites, returning adults are encouraged to spread throughout the Green River system. However the acclimated release sites from Icy Creek Rearing Pond (R.M. 48.3) and Cristy Creek (RM 44.3) may congregate hatchery fish in these areas, and may lead to disproportionate use of the habitat up to the Tacoma Public Utilities (TPU) fish collection facility (~RM 61.5).

Monitoring: Annual smolt migration and adult escapement monitoring including redd expansion surveys, live and dead spawner counts are conducted by WDFW and the Muckleshoot Indian Tribe in the Green River system. These activities are indirect to the HGMP and not covered as "take" in this document. From 2006 to 2009, WDFW conducted an acoustic tagging study on out-migrating wild and hatchery winter steelhead to assess freshwater migration pathways, rates and use of estuary, nearshore, and marine habitat by juvenile steelhead. Wild smolts were captured in downstream smolt trapping activities or by hook and line so there was not a direct association with this hatchery program. Results are being compiled and will be reported (Goetz et al. 2008, final report unpublished; Moore et al. 2013).

- 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 "take" tables at the end of this document. Up to 50 adults will be taken with a goal of 25 females and 25 males.

- 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.

Methods to collect broodstock (hook and line and hatchery trapping) have had capture, handling and holding protocols in place since the inception of the initial program in 2001. These protocols and all other takes described in this HGMP will be reviewed annually by the Co-Managers in consultation with NOAA Fisheries in order to minimize "take" of listed fish. Any projected take that will exceed the estimates given in this HGMP from this operation on a yearly basis would be communicated to the WDFW Fish Program, the Technical Advisory Committee (TAC) and NOAA Fisheries staff for additional guidance.

The majority of the broodstock for this program is collected via hook and line, which gives the flexibility to discontinue broodstock collection at any time. Once the goal for the program is achieved (up to 50 fish) no additional fish are collected. Since its inception in 2001, the broodstock collection goal for this program has not greatly exceeded 50 fish (see **Table 7.4.2.1**).

3 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 part of the Co-managers' plan for implementing hatchery programs in the Green/Duwamish watershed.

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 Muckleshoot Indian Tribe (MIT) and Suquamish Tribe, along with WDFW, prepare an annual fishery management plan, which addresses incidental harvest of Green/Duwamish River system steelhead produced from this program (WDFW et al. 2008 to present).

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* (1974) that provides the legal framework for coordinating these programs, defining artificial production objectives, and maintaining treaty-fishing rights through the court-ordered *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.

See also HGMP section 3.1.

3.3 Relationship to harvest objectives.

This is a conservation program and does not directly contribute to harvest at this time. To minimize impacts on listed fish, the tribal net fishery for hatchery (early winter stock) steelhead has typically ended no later than the first week of January (WDFW et al. 2008 to present) and the in-river recreational fishery targeting the segregated early winter stock ends on January 31 (WDFW Fishing in Washington Regulations 2014/2015). Emergency in-season regulations may restrict fishing when hatchery escapement shortfalls are anticipated (WDFW et al. 2008 to present) (see also Soos Creek Early Winter Steelhead HGMP).

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.

The Co-managers (MIT and WDFW) originally initiated the wild broodstock program in 2001, to evaluate the survival and harvest contribution in comparison with the early winter stock program. In 2009, the program was re-designed as a conservation and recovery program, in response to the recent listing of Puget Sound steelhead. Limited tribal fisheries may occur on this stock, but there are currently no targeted recreational fisheries during the wild run period.

Selective fishing rules requiring the release of all wild unmarked steelhead in Puget Sound Rivers began in the 1990s, allowing retention of only hatchery-produced adipose fin-clipped fish. This has reduced wild steelhead harvest statewide to approximately 1% of the catch (Scott and Gill 2008). Tribal harvest figures, which cannot distinguish between wild or hatchery steelhead, have been much-reduced on most rivers since 1995. The winter steelhead selective sport season ends by February 1, minimizing interaction with most of the wild winter stock. This selective fishery regulation (adipose fin-clip only) is in effect for the winter run steelhead in the Green River.

Past practices focused on producing harvestable hatchery stocks, whose run timing is significantly earlier than wild stocks, to allow for harvest with minimal impact to wild stocks. Returns from this integrated program will closely mirror the later timing of the wild winter-run.

3.4 Relationship to habitat protection and recovery strategies.

The intent of this program is to recover the population to a level that it can provide treaty and non-treaty harvest opportunity in light of habitat loss and degradation. This loss limits natural production in the Green-Duwamish River basin (WRIA 9) streams and Puget Sound. Howard Hanson Dam (~R.M 64) is an impassable barrier to fish migration and prevents natural production of salmonids in 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 salmonid populations within the system. A number of habitat restoration actions were initiated under the City of Tacoma Water's *Green River Habitat Conservation Plan* (July 2001) 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 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 (available 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. v 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 Green River winter-late 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 smolts 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 night 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 restoration. 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. 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
- Coho salmon
- Pacific staghorn sculpin
- Numerous marine pelagic fish species

4 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, Icy Creek Rearing Pond and Flaming Geyser Ponds.

Facility	Water Source	Water Right		Available Water Flow	Water Temp. (F°)	Usage	Limitations
		Record/Cert. No.	Permit No.				
Soos Creek Hatchery	Unnamed spring	S1-000382CL	----	0.71 cfs	47	Adult holding, incubation, early-rearing	Available in small volume
	Big Soos Creek (surface)	S1-000449CL	-----	2.64 cfs	32-70	Adult holding	Excessive pathogen loads
		S1-21122C WRIS	-----	5.0 cfs			
		S1-*19055C WRIS/ 09667	14011	30.0 cfs			
Icy Creek rearing pond	Icy Creek	S1-22710C WRIS	-----	20.0 cfs	45-48	Rearing, acclimation	No limitations
Flaming Geyser Ponds	Unnamed Stream	S1-24715C WRIS	-----	1.5 cfs	46-48	Rearing, acclimation	No limitations

Source: Phinney 2006, WDOE Water Resources Explorer 2014, WDFW hatchery data.

Soos Creek Hatchery: Surface water from Soos Creek is used for adult holding. Water is withdrawn via four pumps at the hatchery, which have the capability to produce 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 in flow. In 2012, the Legislature passed a jobs creation bill that provided WDFW with funding for hatchery capital improvements in addition to our capital budget request. These projects include replacing the water distribution tower and main supply lines to the tower (see HGMP section 5.8).

Water rights for surface water at Soos Creek Hatchery were formalized through the Washington Department of Ecology (WDOE), and were obtained in 1965 and 1973for the purpose of fish propagation.

Icy Creek Rearing Pond: The earthen pond at Icy Creek is supplied with gravity-fed spring water. The spring water quality is excellent, but the flow varies throughout the season from a low of 2.2cfs in the late fall to 13cfs in the late spring. Water rights are formalized through the WDOE, and were obtained in 1976 for the purpose of fish propagation.

Flaming Geyser Ponds: Consists of two small concrete lined ponds, gravity fed with spring water. Water rights for Flaming Geyser ponds were formalized through the WDOE, and were obtained by the Washington Department of Game in 1985for the purpose of fish propagation.

NPDES permits:
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 (WDOE), WAG 13-3014 and WAG 13-3002. Monthly and annual reports on water quality sampling, use of chemicals at this facility, compliance records are available from WDOE.

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.

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 2014.

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 2014.
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 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 (see HGMP section 5.8).

Monitoring and reporting of effluent discharge results have been in compliance with NPDES permits (see **Table 4.1.2**). 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 pond water intake. A permanent adult trap was installed in 2012 at the outflow of the ponds on Icy Creek to trap and remove marked hatchery-origin Chinook and steelhead, and to release any stray unmarked, natural-origin Chinook salmon and steelhead back into the Green River. Icy Creek

Rearing Pond is operated to ensure that hatchery effluent is not detrimental to downstream aquatic life by meeting or exceeding applicable NPDES Permit standards (see **Table 4.1.2**).

Flaming Geyser Ponds: The intake box was replaced in 2012 to meeting current fish passage and screening criteria (NMFS 2011a). Fish production is relatively small, well under the 20,000 pounds limit set by WDOE for concern regarding hatchery effluent discharge effects and for the requirement of an NPDES permit.

5 SECTION 5. FACILITIES

5.1 Broodstock collection facilities (or methods).

Broodstock for this program is collected by:

1. Hook and line on the Green River between river miles (R.M.) 29.3 and 44. Fish are collected from boats, by Tribal and WDFW staff from late February through April.
2. Trapping adults at the Soos Creek Hatchery and Icy Creek Rearing Pond traps. Returning steelhead adults at Soos Creek 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'. The trap is checked daily and fish are sorted and either kept for broodstock or passed upstream. A permanent trap built on Icy Creek began operation in fall 2012.

5.2 Fish transportation equipment.

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.

Juveniles: Fish destined for release at Icy Creek and Flaming Geyser ponds (approximately 30 minutes transportation time one way to either facility) are transferred using a 1500-gallon tank equipped with re-circulating pumps.

5.3 Broodstock holding and spawning facilities.

Adult steelhead are held in up to four 3'x3'x16' fiberglass raceways supplied with Soos Creek surface water.

5.4 Incubation facilities.

Table 5.4.1: Incubation vessels available at Soos Creek Hatchery.

Type	Number	Size
Shallow troughs	160	15' x 1' x 4"

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

There are currently no incubation facilities at the Icy Creek Rearing Pond or Flaming Geyser Ponds.

5.5 Rearing facilities.

Table 5.5.1: Rearing vessels available at Soos Creek Hatchery.

Type	Number	Size
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 5'

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

Type	Number	Size
Earthen bottom pond	1[a]	½ acre
Net pens[b]	2	16’ x 16’ x 5’

[a] The pond may be divided into two sections by a screen structure
[b] Steelhead smolts for this program are held in net pens in the earthen pond.

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

Table 5.5.3: Rearing vessels available at Flaming Geyser Ponds.

Type	Number	Size
Concrete lined pond	1	10’ x 20’ x 4
Concrete lined pond	1	15’ x 30’ x 4

Flaming Geyser Ponds: The ponds at Flaming Geyser are covered with bird netting.

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

After fry have buttoned up, they are transferred to fiberglass troughs for initial feeding at 25,000 per trough.

5.6 Acclimation/release facilities.

Icy Creek Rearing Pond: Facilities consist of a large, approximately ½-acre rearing pond that is divided into two sections by a screen structure. The pond is supplied with gravity-fed spring water. Fish are released both volitionally and forced into Icy Creek, which flows approximately 40 yards before entering the Green River at R.M. 48.3.

Flaming Geyser Ponds: Facilities consist of two small spring-fed concrete lined ponds. Smolts are released volitionally for approximately one month before being force-released into Cristy Creek.

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

Soos Creek Hatchery: 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, high water events may damage the fish collection rack and lead to an inability to trap and sort returning adults. In 2013, 90% of the 2-year smolt release group, and 50% of the 1-year smolt release group held at Soos Creek Hatchery were lost to *Nanophyetus*. Plans are in place, beginning in 2014, to rear and release the entire program from Icy Creek and Flaming Geyser ponds to eliminate the risk of future losses due to parasites present in Soos Creek Hatchery water drawn from the Green River.

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 Rearing Pond: Rearing and acclimation at this facility takes place in pathogen-free gravity-fed spring water. Predation risks are minimized by bird-netting and otter-fences.

Flaming Geyser Ponds: Rearing and acclimation at this facility takes place in pathogen-free gravity-fed spring water. The intake has clogged with debris and caused fish loss in the past, although this is an infrequent occurence.

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: A member of the hatchery staff is on stand-by at all times to monitor hatchery operations and respond to any unexpected events. The hatchery is equipped with a back-up generator and adequate fuel supply in the event of a power outage. An upgraded alarm system is designed to detect changes in flow and power status. The risk of disease transmission shall be limited by rearing fish within widely recognized guidelines and using effective medication, as prescribed and in a timely manner.

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.

Flaming Geyser Ponds: This is a gravity-fed pond system that is staffed by volunteers; no alarms or back-up systems exist at this facility.

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.

The 2012, the Washington State 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 hatchery capital improvements at Soos Creek Hatchery (**Table 5.8.1**). See also HGMP section 4.

Table 5.8.1: Capital improvements scheduled for Soos Creek Hatchery under the "Jobs Now" Act (ESB 5127), Washington State Legislature 2012.

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).

6 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 wild fish of the same species/population.

6.1 Source.

Adult native Green River winter steelhead. Program fish are collected by "hook-and-line" from the Green River and by trapping returning fish to the Soos Creek Hatchery and Icy Creek Rearing Pond traps. Unmarked natural-origin steelhead representing timing and spatial distribution of the true wild stock are preferred for broodstock; however, during low return years it may be

necessary to incorporate up to 50% of F1 hatchery-origin returns for the program. The Duwamish/ Green River winter steelhead DIP is listed as *Threatened* (NMFS 2007).

6.2 Supporting information.

6.2.1 History.

This program was initiated by the Co-managers (WDFW and the Muckleshoot Tribe) in 2001. The initial goals of the program were to enhance harvest opportunities, evaluate survival rates, and harvest contribution in comparison to the existing Chambers-stock winter steelhead hatchery program, as well as to assess the feasibility of successfully producing one year-old natural-origin steelhead smolts in a hatchery environment. The program was redesigned as a conservation program in 2009, in response to declines in the natural population escapement and the ESA listing of the Puget Sound steelhead DPS (NMFS 2007).

Program operation initially involved Keta Creek, Crisp Creek and Soos Creek hatcheries. From 2005-2010, the program was operated exclusively from Soos Creek Hatchery. Icy Creek Rearing Pond was added as a new release site in spring 2011, and the Flaming Geyser Ponds were added in 2013. As of 2014, rearing and releases will be conducted out of Icy Creek and Flaming Geyser ponds.

6.2.2 Annual size.

Up to 50 adults are collected for broodstock.

See HGMP section 2.2.2 for critical and viable thresholds for this population.

6.2.3 Past and proposed level of natural fish in broodstock.

This program was initiated with broodstock collected exclusively from unmarked fish, with a preference to continue recruiting 100% unmarked broodstock. Recent low return years resulted in inadequate numbers of unmarked fish collected to meet the program's needs, and hatchery-origin returns from program fish have been used (see **Table 7.4.2.1**). In such years, up to 50% of first generation (F1) hatchery returns into the program have been incorporated, with emphasis to utilize as few of the hatchery returns as possible.

6.2.4 Genetic or ecological differences.

Genetic samples (fin-clips or punches) have been collected from hatchery (early winter and early summer stocks) and natural-origin winter- late steelhead in the Green River basin. Based on an allozyme analysis, run timing and spawn timing, the indigenous wild steelhead are considered to be genetically and behaviorally distinct from the hatchery early winter steelhead, which have traditionally been released in the Green River and successfully return to the hatchery (Phelps et al. 1994). Broodstock DNA sampling occurs for this program and began with fish taken to Keta Creek Hatchery (Muckleshoot Tribe) in 2002.

At the inception of the Green River winter-late hatchery steelhead program, broodstock was collected exclusively from unmarked adults. Program fish represent the historical genetic structure of the natural population and broodstock collection is timed to mimic natural return timing as much as possible. It is expected that hatchery adults returning in late-winter and spring (beginning in March and thereafter) should be representative of the integrated conservation program.

6.2.5 Reasons for choosing.

The original intent of this program was to take progeny from the natural-origin native Green River steelhead stock, obtained via hook and line from the Green River, which spawn prior to April 15, and utilize them to produce a one year smolt to enhance harvest opportunity. These juvenile, natural-origin steelhead received a differential mark (right or left ventral fin-clip) to be distinguished from the early-winter hatchery releases upon return, with the intent of evaluating the differential survival of these two winter steelhead stocks after several years. In response to the

a declining population trend and the 2007 listing of Puget Sound Steelhead as "*Threatened*" (NMFS 2007), the original program was transitioned to the current conservation program.

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.

Use of wild, natural-origin adult steelhead for broodstock will provide the greatest protection of the populations' overall genetic structure (minimize loss of genetic diversity). Only adults representing the endemic stock through genetic analysis or return and maturity timing characteristics will be considered. The maximum number of F1s that will be used as brood in any given year will not exceed 50%.

First generational hatchery returns (F1) from this program may be used as broodstock in a wild by hatchery cross (WxH), although preference will be given to WxW crosses. Factorial mating crosses will be employed to maximize genetic possibilities for effective population and ensure that viable milt is used.

All hatchery activities including holding and viral sampling will be conducted in a manner consistent with the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006), and consultation with NOAA Fisheries to reduce risk or harm to listed fish and preserving genetic material.

See also HGMP section 1.10.

7 SECTION 7. BROODSTOCK COLLECTION

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

Adults.

7.2 Collection or sampling design.

The Co-managers agreed on a maximum of 50 fish total broodstock collection. While natural-origin steelhead returns to the Green River have shown significant declines, 50 fish for broodstock is still well within the 20% operational guidelines for wild populations having 150 fish or more total escapement.

Wild adults are collected via hook and line on the Green River between R.M 29.3 and 44.0, and in limited numbers from adults captured in the Soos Creek Hatchery weir and the Icy Creek trap. Trapped F1 hatchery adults at these sites have been included in the broodstock since 2009. Other broodstock collection locations in the basin may be identified in the future. Most wild winter steelhead in the Green River begin to spawn in the system in early-March and continue through June, with the peak during the third week of April (T. Cropp WDFW, pers. comm. 2006). Although earlier (December – February) and later (May – June) broodstock components may be available, the hatchery program needs to target adults that ripen in mid-March through the end of April to incorporate those fish into the one year smolt program.

The timeframe for broodstock collection allows WDFW to successfully facilitate the rearing goals of the program to meet rearing and release guidelines by the following May. Studies conducted on Kalama River wild steelhead programs (Lower Columbia ESU) have indicated that broodstock taken from the peak periods of the spawning timeframe, offer the best way to preserve an equal opportunity of genetic expression for earlier and later returning population segments (Kalama River Research Studies, 1998 to present).

7.3 Identity.

All fish released through this hatchery program have been consistently 100% marked using various marking methods (**Table 10.7.1**).

7.4 Proposed number to be collected:

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

Up to 50 adults are 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: Soos Creek Hatchery winter-late steelhead broodstock collection 2002-2013.

Brood Year	Total Collected	Spawned	Pond Mortality
2002	Na	Na	Na
2003	Na	Na	Na
2004	40	25	5
2005	24	18	0
2006	43	22	1
2007	39	15	6
2008	29	11	2
2009	6	3	3
2010	33*	32*	1
2011	39*	7+32*	4
2012	43	39	4
2013	50	29	11
Average	**34**	**20**	**4**

Source: WDFW hatchery records 2013.
Note: +indicates live spawn fish
* Estimated number collected and spawned. Data has not been reconciled.

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

Hatchery returns in surplus to broodstock needs are released above the weir on Soos Creek, or back to the Green River and allowed to spawn naturally to seed the watershed. In the future, surplus adults may be tagged and released in underutilized areas of the upper and middle Green River to facilitate full seeding of the watershed.

7.6 Fish transportation and holding methods.

Fish are collected from the Green River and placed in 6-8" PVC holding tubes suspended underwater from the side of the boats until they reach a specified take-out point, where a tanker truck from the hatchery meets them. Fish are moved from the tubes into the tank, which contains a 0.5% salt solution for mild sedation during transportation to the Soos Creek Hatchery. The transportation time takes between five and fifteen minutes. Once at the hatchery, steelhead are placed in up to four fiberglass raceways inside the hatchery building, where they are held and checked weekly for spawning condition.

Unmarked fish collected in excess of broodstock needs are transported back to the river in the 300 gallon tanker truck. The transportation time is 5 minutes.

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. Broodstock receives routine formalin treatments to minimize fungal infections, although the holding time and cool water temperatures may minimize fungus problems. Ovarian fluid from spawned females and pond mortalities are collected for pathology examination.

The adult holding area is separated from all other hatchery operations and disinfection procedures using chlorine solution are followed by personnel to sanitize equipment and keep the hatchery building clean. Iodophor solution is used as disinfectant during spawning.

Females are air spawned to prevent mucus loss associated with stripping of the body cavity. Staff only attempt to spawn fish when they are fully ripe.

7.8 Disposition of carcasses.

With the decreasing population trend, wild fish are currently live-spawned when fish condition allows and released back to the river after spawning. Carcasses of hatchery-origin fish used in broodstock are utilized for nutrient enhancement, and any live spawned individuals are released into the Green River to spawn naturally.

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.

Only adults with the highest probability of being endemic late stock through time and distribution patterns will be considered. WDFW will attempt to collect broodstock at the peak spawn time of wild steelhead to prevent divergence from the natural population.

This program will use only hook and line techniques that minimize hooking and release mortalities. Specific fishing techniques, adult netting materials and holding protocols will be reviewed in consultation with NOAA Fisheries to minimize impact on listed fish.

Fish collected in excess of broodstock needs will be released back into the Green River system in order to preserve as much genetic material as possible.

Continued DNA sampling of all broodstock will be vital to identifying fish from the native stock and may also be used determine potential repeat spawner success of live-spawned adults released back to stream.

All hatchery releases will be consistent with the *Salmonid Disease Control Policy of the Fisheries Co-Managers of Washington State* (WDFW and WWTIT 1998, updated 2006) to minimize any health risks to the listed populations.

8 SECTION 8. MATING

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

8.1 Selection method.

As broodstock is collected in various stages of sexual maturity, the fish are checked periodically for ripeness. Spawners are selected randomly from ripe fish on a given spawn day and no selection criteria based on size or shape is used.

8.2 Males.

All males are prioritized based on ripeness and factorial crosses needed. In some cases, male collections may exceed the female collection in order to provide viable milt on spawn days. When primary males are not available to meet factorial scenarios on a given spawn day, secondary males may be used more than once. In those cases, males are used no more than four times as primary spawners. If they are used more than once, they are tagged for identification purposes to track the number of times a particular male has been used.

As there are only 25 pairs to spawn with maturation potentially spread out over a month, the small number of fish ripe on individual days could potentially limit spawning options. Up to 25 males may be captured to prevent not having enough ripe males on hand to fertilize eggs on a given day.

8.3 Fertilization.

Fertilization occurs in factorial crosses, preferably 2x2 or 3x3, when possible depending on number of ripe spawners available on a given day. If equal factorial crosses may not be performed other combinations (e.g. 2x3) may be used. If only one female is ripe on a spawning day, eggs will be collected and fertilized with milt from one male (pairwise spawning); if available a backup male is always used in the spawning.

After fertilization water is added to enhance performance of the milt. After 30 seconds of initial fertilization, eggs are combined into one container to provide back-up, in case any of the milt used was of poor quality.

After fertilization, eggs are rinsed in a buffered iodine solution (100 ppm) to control viral and bacterial disease, and allowed to water harden for one hour in the same solution.

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.

The appropriate mating scheme for a particular program is chosen based on total number of adults needed to achieve the production goal. For this program, up to 25 pairs are collected for broodstock and, as such, a factorial-mating scheme (see HGMP section 8.3) was chosen as most the most appropriate method. This mating scheme is usually reserved for comparatively small conservation broodstock (such as this program) for which the maximization of genotypic diversity among progeny is of high priority (Campton 2004).

With a small number of broodstock collected and the possibility of spawning maturation spread out over a month, low numbers of fish ripe on individual days could potentially limit spawning options. A pairwise (1:1) spawning scheme may be used when only one female is ripe on a spawning day in order to include a pair in the broodstock. Postponing spawning a ripe female is not considered a viable option, as it may result in fish mortality and lost genetic material.

To avoid sperm competition that may reduce the effective number of spawners, eggs are fertilized for at least 30 seconds prior to being combined into one container for possible back up (in case used milt was of poor quality).

9 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 2014) for the winter- late steelhead program at Soos Creek is 50,000 for releases from Icy Creek and Flaming Geyser ponds.

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

Table 9.1.1.1: Survival from egg take to ponding, Green River winter-late steelhead, 2002-2012.

Brood Year	Eggs Collected	Green Eggs-to-Fry Survival Rates (%)
2002	NA	NA
2003	NA	NA
2004	64,400	NA

2005	36,000	76.2
2006	48,000	66.3
2007	40,000	59.0
2008	21,000	95.1
2009	6,500	76.9
2010	72,000	80.1
2011	64,000	94.1
2012	47,900	83.5
2013	53,300	79.4
Average	**45,310**	**79.0**

Source: WDFW hatchery records 2014.

9.1.2 Cause for, and disposition of surplus egg takes.

Extra eggs may be taken as a safeguard against potential incubation and rearing losses. Initial program survival data for 2005- 2006 (66.6 - 76.2) indicated that an approximate 48,000 egg take will get the desired release goal of 33,000 smolts).

9.1.3 Loading densities applied during incubation.

Fertilized eggs are placed into baskets in the shallow troughs. The baskets are initially filled with ~25,000 green eggs per basket and up to 15,000 eggs per basket once the eggs reach the eyed stage.

9.1.4 Incubation conditions.

Fertilized eggs are incubated in shallow troughs supplied with spring water (unheated or heated, for slower or accelerated development) and Soos Creek surface water at 6-8 gpm. Water temperatures are monitored daily, with surface water temperatures ranging from the high-30s°F to mid-50s°F (average around 47-50°F). Heated water may be up to 8°F warmer than surface water from Soos Creek. Dissolved oxygen is checked as needed, and the baskets are periodically flushed to remove accumulated silt, as Soos Creek water is subject of heavy silt loads.

9.1.5 Ponding.

The baskets are removed after the eggs hatch, and alevin continue rearing in the shallow troughs. Feeding begins when yolk is absorbed (button-up phase). Once active feeding and growth has been initiated, the fry are transferred (forced) to a fiberglass rearing raceways (~25,000 per raceway), with water flow at 50 gpm.

9.1.6 Fish health maintenance and monitoring.

All fertilized eggs are water-hardened in an iodophor solution. Fungus in the 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.

Fish health is monitored daily by trained hatchery specialists. As soon as potential problems are identified, they are immediately communicated to a WDFW Fish Health Specialist for diagnosis and treatment recommendations to limit mortality and reduce possible disease transmission. In addition, fish health specialists conduct inspections monthly.

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.

All incubation systems at the hatchery are protected with 24-hr/day low water alarms and an emergency backup generator to prevent egg and fish loss caused by disruptions in water flow.

Water temperatures and silt deposition are monitored, and excess silt is removed as needed. Integrated winter-late steelhead are incubated separately from other species and segregated program summer and winter (early winter and early summer stock) steelhead.

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: Survival rates from fry to yearling release, Green River winter-late steelhead, brood years 2005-2012.

Brood Year	Survival Rates (%)
2005	90.5
2006	95.5
2007	NA
2008	73.9
2009	57.8
2010	79.8
2011	56.0
2012	54.5
Average	**72.6**

Source: WDFW hatchery records 2013.

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

The fish are reared using the loading densities recommended 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).

9.2.3 Fish rearing conditions

Soos Creek Hatchery: The initial rearing and feeding takes place in shallow troughs. When fry begin actively feeding (generally July to August), they are transferred to the fiberglass rearing raceways (~25,000 per raceway) located in the incubation building and supplied with Soos Creek surface water at a flow of 30 gpm.

In February, 18,000 yearlings are transferred to the Icy Creek Rearing Pond for release as yearling smolts. Fish are marked at Icy Creek in January or February at ~30 fpp. All rearing vessels at Soos Creek Hatchery used to rear fish for the Icy Creek program receive pathogen-free water from a spring adjacent to Soos Creek.

The group released from Flaming Geyser Ponds is transferred in March: 15,000 yearlings at 12 fpp.

Icy Creek Rearing Pond: Transferred fish are placed in 16’ x 16’ x 5’ net pens in the earthen-bottom pond supplied with creek water. The fish are transferred into the upper section of the rearing pond (separated by a screen structure) in February where they remain until release in April to the end of May. The pond does not normally require routine cleaning due to natural breakdown of waste products.

Flaming Geyser Ponds: Transferred fish will be kept in concrete pond, supplied with surface water from Cristy Creek, where they remain until release in April to the end of May.

Feeding at all sites is predominately by hand presentation.

Table 9.2.3.1: Average monthly surface water temperature (°F) at Soos Creek Hatchery, and Icy Creek and Palmer ponds.

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

Source: WDFW hatchery records 2013.

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: Monthly growth data for yearling steelhead smolts rearing at Soos Creek Hatchery and Icy Creek Rearing Ponds.

Month	Size (fish/lb)
May	1,498
June	634
July	192
August	101
September	39
October	26
November	19
December	16
January	13
February	10
March	9
April	8

Source: WDFW hatchery records 2013.

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

See HGMP section 9.2.4.

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).

Fish are started with various brands of starter feed; the food brand used may vary, depending on cost and vendor contacts. Fish are fed frequently after swim-up and ponding, up to 10 times a day

at body weight percentages up to 5%. Fish are gradually increased on feed size from starter, to crumble, to pellet, and feeding frequency decreases as fish increase in size. Fish are converted over to a high protein feed as soon as possible. Feeding frequencies vary depending on the fish size and water temperature and usually begin at eight feedings/seven days a week and end at one feeding/seven days a week. Conversions typically are in the 0.7 - 0.8 range.

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.

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 (age 1+) or older 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.

10 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.

Life Stage	Size (fpp)	Annual Release Level	Release Date	Release Location
1+ smolt	8.0	18,000 (Icy Creek)	May	Green/Duwamish River
1+ smolt	8.0	15,000 (Flaming Geyser)		

Source: Future Brood Document 2014.

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

Stream, river, or watercourse:	Cristy Creek (WRIA 09.0038)	Icy Creek (WRIA 09.0010)
Release point:	Flaming Geyser, RM 0.1	Icy Creek at RM 48.3
Major watershed:	Green River	
Basin or Region:	Puget Sound	

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

Table 10.3.1: Actual number and size at release, 2003-2013.

Release Year	Soos Creek						Icy Creek			Flaming Geyser		
	Yearling 1+ smolt	Avg. Size (fpp)	CV	2+ smolt	Avg. Size (fpp)	CV	Yearling	Avg. Size (fpp)	CV	Yearling	Avg. Size (fpp)	CV
2003*	34,400	7	NA	No releases			No releases			No releases		
2004*	27,500	5	NA									
2005	46,000	7	11.2									
2006	24,800	5	8.6									
2007	33,200	6	6.6									
2008	20,400	8	11.5									
2009	22,300	8	NA									
2010	2,891	7	NA									
2011	25,459	8	7.5				10,564	8	NA			
2012	15,413	6	NA	3,690	6	NA	10,490	6	NA			
2013	No release			5,973	5	NA	No release			11,000	5	NA
Average	**25,236**	**7**		**4,,832**	**6**		**10,527**	**7**				

Source: WDFW Hatcheries Headquarters Database 2014.
* Released from Crisp Creek Hatchery.

10.4 Actual dates of release and description of release protocols.

Table 10.4.1: Annual release dates, by site, 2005-2013.

Release Year	Release Date(s)			
	Soos Creek		Icy Creek	Flaming Geyser
	1+	2+		
2005	5/1	No releases	No releases	No releases
2006	5/1			
2007	5/1			
2008	5/1			
2009	5/1			
2010	5/12			
2011	5/18		5/6	
2012	5/1-6/1	5/1	5/1	
2013	No release	5/1	No release	5/18

Source: WDFW Hatcheries Headquarters Database 2014.

Icy Creek Rearing Pond: Winter steelhead are volitionally released by removing the screens on April 15th. After eight weeks the remaining fish are crowded and forced to leave. Fish are released directly into Icy Creek, which flows approximately 40 yards before entering Green River.

Flaming Geyser Pond: Steelhead are given the opportunity for volitional release for a one to two weeks prior to being force released.

10.5 Fish transportation procedures, if applicable.

From 2005-2010, all fish were released on station, from Soos Creek Hatchery. Icy Creek Rearing Pond was added as a release site in spring 2011, and Flaming Geyser Ponds was added in 2013. As of 2014, all fish are released from Icy Creek and Flaming Geyser. Fish to be reared at Icy Creek or Flaming Geyser ponds are transported in either a 1500- or a 300-gallon tanker truck equipped with re-circulating pumps: transport time is around 30 minutes.

10.6 Acclimation procedures.

Icy Creek Rearing Pond: The water source is high-quality pathogen-free gravity fed-spring water. Fish are raised net pens in the pond for up to four months, then transferred into the upper portion of the pond for approximately three months, and released directly into Icy Creek.

Flaming Geyser Ponds: Fish are raised in ponds supplied with Cristy Creek water for up three months and released directly into Cristy Creek (or the Green River).

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

In the past (brood years 2003 to 2010), the survival rate of smolts may have been impacted by the double mark combination: a reduced survival rate from ventral fin-clips reported in several sources for yearling fish (M. Kimbel WDFW, pers. comm. 2008).

Until brood year 2010, all fish from this program were released as yearling smolts, marked with a combination adipose (AD) and ventral fin-clip. AD/ left ventral (LV) fin-clips were to be applied to fish released in odd-numbered years, while AD/ right ventral (RV) fin-clips were to be applied to even-year releases. A high rate (40%) of missing RV-clips were reported in 2006 year releases. Fish from brood years 2011 and 2012 received blank-wire (BWT) and elastomer tags (see **Table 10.7.1**). Elastomer tags were discontinued, and program smolts have been released BWT'd since brood year 2013 (**Table 10.7.2)**.

Table 10.7.1: Historic mark types utilized for fish released through Green River late winter steelhead program.

Brood Year	Release Site	AD-Clip	Ventral Fin-Clip	CWT	BWT	Elastomer	
						Eye Side	Color
2003	Soos Creek	X	Left				
2004	Soos Creek	X	Right				
2005	Soos Creek	X	Left				
2006	Soos Creek	X	Right				
2007	Soos Creek	X	Left				
2008	Soos Creek	X	Right				
2009	Soos Creek	X	Left				
2010	Soos Creek	X	Right				
2011	Soos Creek				X	Left	Yellow
	Icy Creek				X	Left	Yellow
2012	Soos Creek				X	Right	Orange, Pink
	Icy Creek				X	Right	Yellow
2013	Soos Creek			X			
	Icy Creek			X			
	Flaming Geyser			X			
2014	Icy Creek				X		
	Flaming Geyser				X		

Source: WDFW hatchery records 2014.

Table 10.7.2: Proposed number released, by brood year, mark type and age.

Brood Year	Stage	Release Site	Numbers	Mark Type
2014	1+ smolt	Icy Creek	18,000	BWT
	1+ smolt	Flaming Geyser	15,000	BWT

Source: WDFW Future Brood Document 2014.

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

Monitoring of fish numbers, growth and mortality at the hatchery will provide reasonably accurate estimates of live fish throughout their rearing life. Surplus program fish may be produced in years with extremely high survival (unexpected). Depending on success of higher survival or lower survival, egg takes may be adjusted in order to reach needed goals. Future supplementation strategies may also be developed for using these fish in other parts of the Green River system.

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.

During severe drought conditions, fish may be released early to prevent fish loss.

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 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).

- 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.
- 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 wild fish to assess and adjust, if necessary, hatchery production and release strategies to minimize effects on wild fish.

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.

11 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. Enhanced monitoring and evaluation programs focus on risks posed by ecological interactions with listed species.

WDFW monitors salmon and steelhead 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 allows 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 wild and hatchery winter steelhead to assess freshwater migration pathways, rates and use of estuary, nearshore, and marine habitat by juvenile steelhead (Goetz et al. 2008; Final Report Unpublished; Moore et al. 2013).

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, age composition (including jack contribution), broodstock mortality (including handling and pathology), fecundity, egg mortality rate, sex ratios, and juvenile marking protocols; and pNOB and PNI in areas where pHOS is known).
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 Wild Steelhead Populations	WDFW will continue to conduct a genetic monitoring program to measure introgressive hybridization between segregated hatchery (early winter and early summer) steelhead and wild populations on selected streams in the Puget Sound DPS.

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.

12 SECTION 12. RESEARCH

12.1 Objective or purpose.

Research for this program 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.

13 SECTION 13. ATTACHMENTS AND CITATIONS

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14 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:_____

15 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 (SCoRE 2014).

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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"Take" Tables

Table 1. 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 Native Winter (late) Steelhead
Location of hatchery activity: Soos Creek Hatchery	**Dates of activity:**	**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)				
Capture, handle, tag/mark/tissue sample, and release d)				
Removal (e.g. broodstock) e)			Up to 50	
Intentional lethal take f)			Up to 50	
Unintentional lethal take g)	Up to 20,000	Up to 30,000	Up to 25 adults	
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.

Instructions:

1. *An entry for a fish to be taken should be in the take category that describes the greatest impact.*
2. *Each take to be entered in the table should be in one take category only (there should not be more than one entry for the same sampling event).*
3. *If an individual fish is to be taken more than once on separate occasions, each take must be entered in the take table.*

Table 2. Estimated listed salmonid take levels of by hatchery activity.

Listed species affected: Fall Chinook *(Oncorhynchus tshawytscha)*	**ESU/Population:** Puget Sound Chinook	**Activity:** Green River Native Winter (late) Steelhead
Location of hatchery activity: Soos Creek Hatchery	**Dates of activity:**	**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.